DEVELOPMENT SERVICES DEPARTMENT
ENVIRONMENTAL COORDINATOR
450 100th Ave NE., P.O. BOX 90012
BELLEVUE, WA 98009-9012

DETERMINATION OF NON-SIGNIFICANCE

PROPONENT: Abe Santos, City of Bellevue Utilities Department

LOCATION OF PROPOSAL: 13200 SE 30th Street (Generally)

NAME & DESCRIPTION OF PROPOSAL:

City of Bellevue Utilities Sunset/Richards Creek Flood Control and Habitat Improvement Project

Critical Areas Land Use Permit to modify channels of Sunset and Richards Creeks for flood control and habitat improvements.

FILE NUMBER: 10-121739-LO

The Environmental Coordinator of the City of Bellevue has determined that this proposal does not have a probable significant adverse impact upon the environment. An Environmental Impact Statement (EIS) is not required under RCW 43.21C.030(2)(C). This decision was made after the Bellevue Environmental Coordinator reviewed the completed environmental checklist and information filed with the Land Use Division of the Development Services Department. This information is available to the public on request.

☐ There is no comment period for this DNS. There is a 14-day appeal period. Only persons who submitted written comments before the DNS was issued may appeal the decision. A written appeal must be filed in the City Clerk's office by 5:00 p.m. on ____________.

X This DNS is issued after using the optional DNS process in WAC 197-11-355. There is no further comment period on the DNS. There is a 14-day appeal period. Only persons who submitted written comments before the DNS was issued may appeal the decision. A written appeal must be filed in the City Clerk's Office by 5 p.m. on **March 3, 2011**.

☐ This DNS is issued under WAC 197-11-340(2) and is subject to a 14-day comment period from the date below. Comments must be submitted by 5 p.m. on _________________. This DNS is also subject to appeal. A written appeal must be filed in the City Clerk's Office by 5 p.m. on ______________.

This DNS may be withdrawn at any time if the proposal is modified so that it is likely to have significant adverse environmental impacts; if there is significant new information indicating, or on, a proposals probable significant adverse environmental impacts (unless a non-exempt license has been issued if the proposal is a private project): or if the DNS was procured by misrepresentation or lack of material disclosure.

Michael A. Paine for
Environmental Coordinator

February 17, 2011
Date

OTHERS TO RECEIVE THIS DOCUMENT:
State Department of Fish and Wildlife
State Department of Ecology,
Army Corps of Engineers
Attorney General
Muckleshoot Indian Tribe

City of Bellevue
Development Services Department
Land Use Staff Report

Proposal Name: City of Bellevue Utilities Sunset/Richards Creek Flood Control and Habitat Improvement Project

Proposal Address: 13200 SE 30th Street (Generally)

Proposal Description: Critical Areas Land Use Permit to modify channels of Sunset and Richards Creeks for flood control and habitat improvements.

File Number: **10-121739-LO**

Applicant: Abe Santos, City of Bellevue Utilities Department

Decisions Included: Critical Areas Land Use Permit (Process II. LUC 20.30P)

Planner: David Pyle, Planner

State Environmental Policy Act Threshold Determination: **Determination of Non-Significance**

Michael A. Paine for

Carol V. Helland, Environmental Coordinator
Development Services Department

Director's Decision: **Approval with Conditions**

Michael A. Paine for

Carol V. Helland, Land Use Director
Development Services Department

Application Date:	September 10, 2010
Notice of Application Publication Date:	October 7, 2010
Decision Publication Date:	February 17, 2011
Project/SEPA Appeal Deadline:	March 3, 2011

For information on how to appeal a proposal, visit Development Services Center at City Hall or call (425) 452-6800. Comments on State Environmental Policy Act (SEPA) Determinations can be made with or without appealing the proposal within the noted comment period for a SEPA Determination. Appeal of the Decision must be received in the City's Clerk's Office by 5 PM on the date noted for appeal of the decision.

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Attachments

1. Sunset and Richards Creek Flood Control and Sediment Management Plan
2. Phase 1 Permit Staff Report and Project Plans
3. Critical Areas Report – Habitat Improvement Plan, Flood Control Plan, Restoration Plan
4. Project Plans
5. Public Comment Letter
6. City Response to Public Comment
7. Environmental Checklist

I. Proposal Description

This is an application for approval to modify a degraded section of Sunset and Richards Creek to address a flooding and stormwater problem within a section of stream impacted by high volume flood events common to urban environments. This proposal is the second phase of the Sunset and Richards Creek Flood Control and Sediment Management Plan and is designed to comprehensively address chronic flooding, promote channel stability, and improve channel and wetland habitat conditions. The Sunset and Richards Creek Flood Control and Sediment Management Plan is included as **Attachment 1.** Phase 1 improvements were constructed in 2009 under permit number 08-128529-LO including the replacement of the culvert and sediment trap at SE 30th Street as well as channel modifications upstream and downstream to provide a stable streambed transition to the culvert inlet and outlet. The Phase 1 permit staff report and plans are included as **Attachment 2** to this staff report.

Phase 2 will continue the channel and habitat improvements and flood control measures that were initiated in Phase 1 along a reach of Sunset Creek downstream (North) of SE 30th Street as well as along a reach of Richards Creek upstream of the confluence with East Creek. Primarily characterized as a habitat improvement and flood control project, the project design includes the following elements:

- Channel regarding and enlargement for a stable, wetted channel;
- Installation of log grade control and habitat structures (wood) to prevent head-cut migration and provide stable, physical habitat;
- Construction of an engineered containment berm (stream bank) to contain flood events and limit the extent of flooding into neighboring properties;
- Removal of non-native invasive vegetation within project vicinity;
- Re-vegetation of project area with native plants, including mitigation enhancement areas;
- Construction of a wetland bench within the proposed channel to promote the reestablishment of wetland species and provide high-flow low-velocity shelter areas for fish.

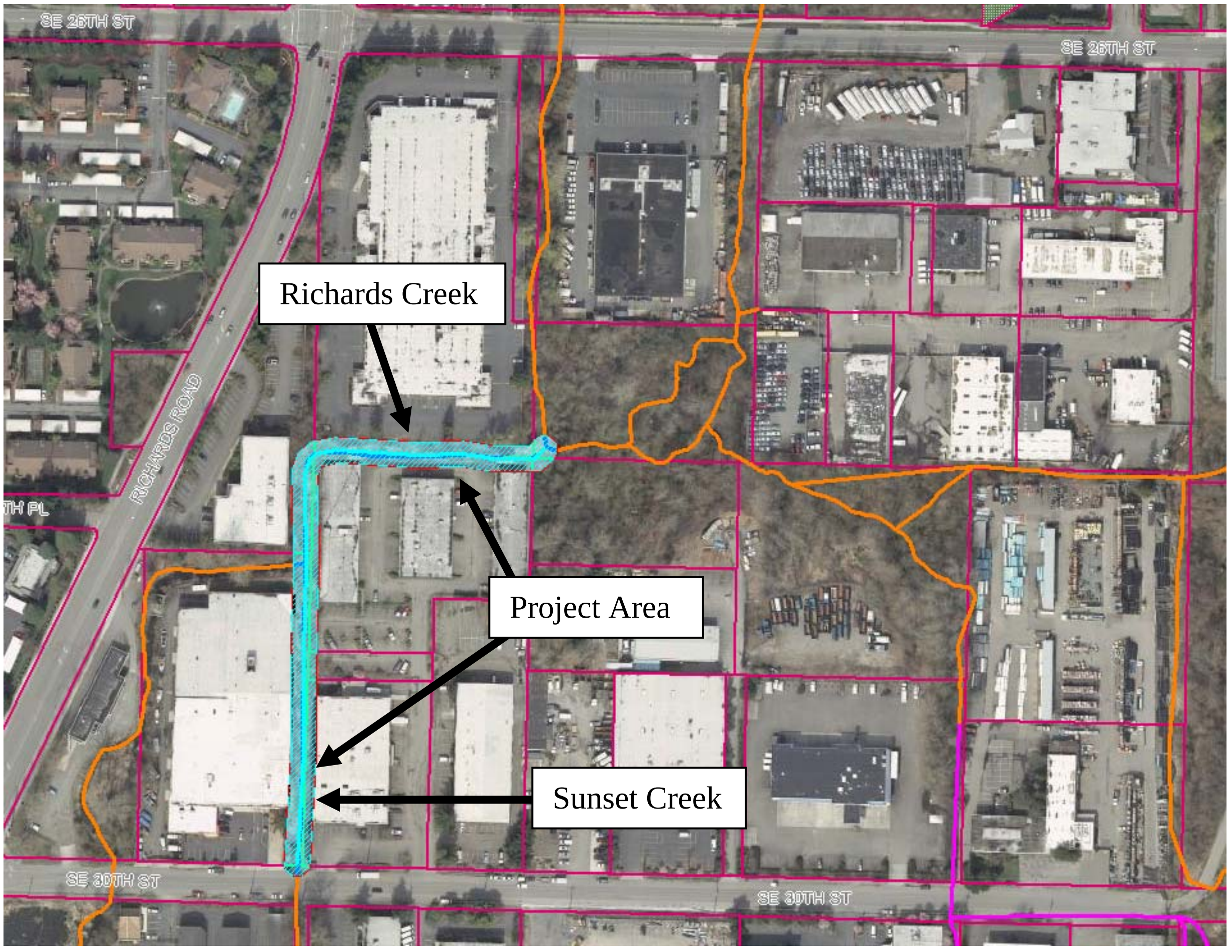
The habitat improvement and flood control work proposed will be located within the channel of Sunset and Richards Creek, within the associated stream buffer, within adjacent associated wetlands, and within a regulated floodplain, all considered protected critical areas. Construction mobilization and designed improvements will temporarily impact the stream's riparian areas, associated wetland systems, and floodplain, and will have permanent impacts to the stream channel and associated wetlands. Due to the presence of stream and wetland critical areas and regulated floodplain, the project is regulated by the city of Bellevue Land Use Code (LUC) Critical Areas Overlay District requirements found in LUC 20.25H. The proposed habitat improvement and flood control work is allowed by LUC 20.25H.055.B subject to compliance with applicable performance standards. Proposed in-stream work constitutes modifications of the stream channel and is allowed under LUC 20.25H.080.B which specifies that the stream channel may be only be modified through a critical areas report in conjunction with a stream stabilization measure or a habitat improvement project where there is a net benefit in ecological function. In response to this requirement, the applicant has obtained the services of a qualified professional who has prepared a critical areas report and has identified, in addition to required impact mitigation, how habitat improvements can be achieved. The critical areas report contains a complete project summary and outlines potential impacts and actions being taken to avoid or when unavoidable provide mitigation as abatement. The project critical areas report is included as **Attachment 3**. Project plans are included as **Attachment 4**.

II. Site Description, Zoning, Land Use and Critical Areas

A. Site Description

The project extends within the reach of Sunset Creek that flows north from the culvert outlet under SE 30th Street, through the confluence of Sunset and Richards Creek, and past the bend in Richards Creek. A map of the project area is included as **Figure 1** below. Channel modification, site access, and re-vegetation activities associated with channel and wetland modifications will occur on private parcels outside of the right of way. The site is characterized by commercial and industrial development on parcels of land that were filled and drained to create useable land from a larger wetland complex. The overall site is flat and is prone to flooding due to the limited capacity of the Sunset/Richards/Valley Creek stream system. Stream channels are frequently backwatered and wetland conditions exist within the streams causing for an intertwined wetland and stream network throughout the unfilled remnant portions of the project vicinity.

Figure 1 – Project Vicinity



A complete description of the conditions of Sunset and Richards Creek is available in the project critical areas report included as **Attachment 3**.

Buffers surrounding the project area wetlands generally consist of native mixed deciduous forest with shrub and herbaceous understory. Existing buffers provide moderate wildlife habitat and moderate water quality functions. Nearby office and industrial uses, parking lots, and road networks limit the areas habitat functions due to traffic and human disturbances. A complete description of the wetland conditions within the project area is available in the project critical areas report included as **Attachment 3**.

B. Zoning and Land Use Context

The proposed activities would be conducted on properties zoned Light-Industrial (LI). The general dimensional standards in LUC 20.20.010 do not apply, because there is no structural development proposed. The existing uses on the affected properties are permitted and there is no proposed change in use of the properties. The project site and surrounding properties are designated light-industrial in the Comprehensive Plan and are developed with light industrial and warehouse uses. The proposed habitat and flood control project will not affect existing land uses and will offer improved flood protection for existing development.

C. Critical Areas Functions and Values

i. Streams and Riparian Areas

a. Stream and Riparian Area Functions:

A healthy aquatic environment relies on processes sustained by dynamic interaction between the stream and the adjacent riparian area. Riparian vegetation in floodplains and along stream banks provides a buffer to help mitigate the impacts of urbanization. Healthy riparian areas support healthy stream conditions.

Upland and wetland riparian areas retain sediments, nutrients, pesticides, pathogens, and other pollutants that may be present in runoff, protecting water quality in streams. The roots of riparian plants also hold soil and prevent erosion and sedimentation that may affect spawning success or other behaviors, such as feeding.

Both upland and wetland riparian areas reduce the effects of flood flows. Riparian areas and wetlands reduce and desynchronize peak crests and flow rates of floods. Upland and wetland areas can infiltrate floodflows, which in turn, are released to the stream as baseflow.

Vegetated riparian areas also provide a source of large woody debris that helps create and maintain diverse in-stream habitat, as well as create woody debris jams that store sediments and moderate flood velocities.

b. Existing Stream conditions:

Sunset and Richards Creek support a variety of native fish species, including anadromous salmonids and also provide food sources to aquatic species including macroinvertebrates, leaf litter, and other organic inputs. Existing in-stream habitat is poor with limited rearing pools; gravel substrates that have been imbedded with sediment. In East Creek just downstream of the project area there is a large, impassible water fall that continually moves upstream as incision of the stream progresses. Although there are areas where vegetation has been damaged or eliminated due to erosion, there are still large swaths of overhanging, native vegetation that primarily consist of willows, red-osier dogwood (*Cornus sericea*), and red alder (*Alnus rubra*). There are small patches of English ivy, Japanese Knotweed (*Polygonum japonica*), and to a greater extent, Himalayan Blackberry (*Rubus armeniacus*). Japanese Knotweed is concentrated on the north and south sides of Richards Creek immediately east of the Optiva curve. A complete description of the conditions of project area stream reaches is available in the project critical areas report included as

Attachment 3.

c. Stream Impacts:

Permanent and temporary impacts to affected stream segments and the adjacent riparian area resulting from construction have been identified on the project plans (**Attachment 4**) and are identified Table 1 below. These temporary impacts will be restored as part of the project in accordance with an approved restoration plan. The temporary impacts will result from excavating the stream channel to deepen it and laying back the stream banks and installing rock and logs with rootwads. Large woody debris and grade control structures will also be placed within the stream channel. Once the construction is complete, the stream will be returned to its slightly modified course. The stream channel will be lower and wider than in its current condition. All stream impacts will be mitigated such that functions are replaced at a minimum ratio of one-to-one. To limit temporary impacts to downstream resources, the channel will be dewatered during construction, and all flow will be bypassed directly to the downstream outlet culvert. Therefore no permanent effects to downstream resources are expected.

Table 1 – Impacts To Project Area Stream Resources

Resource	Temporary Impacts	Permanent Impacts
Sunset Creek channel (below OHWM)	2,033 square feet (0.047 acre)	None
Richards Creek Channel	1,828 square feet (0.042 acre)	None
Stream and Wetland Buffers	8,270 square feet (0.19 acre)	None

OHWM: Ordinary High Water Mark

A complete summary of potential impacts to affected stream segments including mitigation measures is available in the project critical areas report included as **Attachment 3**.

ii. Wetlands

a. Wetland Functions:

Wetlands provide important functions and values for both the human and biological environment—these functions include flood control, water quality improvement, and nutrient production. The benefits provided depend on their size and location within a basin, as well as their diversity and quality. While Bellevue's wetlands provide various beneficial functions, not all wetlands perform all functions, nor do they perform all functions equally well. However, the combined effect of functional processes of wetlands within basins provides benefits to both natural and human environments. For example, wetlands provide significant stormwater control, even if they are degraded and comprise only a small percentage of area within a basin.

b. Existing Wetland Conditions:

Project biologists identified and delineated one large wetland in the project area listed as wetland A (Table 2 below). The location of project area wetland resources is mapped in the project plan set included as **Attachment 4**. Detailed descriptions of the wetlands are provided in the Critical Areas Report (**Attachment 3**).

Table 2 – Project Area Wetland Resources

Wetland Name	Water Quality Functions – Qualitative Rating [a] (numerical score in parentheses)		Hydrologic Functions – Qualitative Rating [a] (numerical score in parentheses)		Habitat Functions – Qualitative Rating [a] (numerical score in parentheses)		Total Score	Department of Ecology Rating Category [b]
	Potential	Opportunity	Potential	Opportunity	Potential	Opportunity		
A	Moderate (8)	Yes	Moderate (6)	Yes	Moderate (12)	Moderate (7)	47	III

[a] Qualitative ratings are based on the Department of Ecology "Using the Wetland Rating System in Compensatory Mitigation" focus sheet (Ecology 2008a)

[b] Wetland category is based on the Department of Ecology rating system (Hruby 2004).

Wetland A is dominated by a forested community of red alder (*Alnus rubra*) and black cottonwood (*Populus balsamifera*) with a shrub understory of willow (*Salix sitchensis, Salix lucida spp. lasiandra*), red-osier dogwood (*Cornus sericea*), salmonberry (*Rubus spectabilis*); and an herbaceous understory of lady fern (*Athyrium filix-femina*), big leaf sedge (*Carex amplifolia*), slough sedge (*Carex obnupta*), giant horsetail (*Equisetum telmateia*), creeping buttercup (*Ranunculus repens*), small fruited bulrush (*Scirpus microcarpus*), and piggyback plant (*Tolmiea menziesii*). Non-native vegetation is also prevalent in the project area and includes Himalayan blackberry, Japanese knotweed, and English ivy. The buffer surrounding the wetland consists primarily of parking lots, and low-lying, large commercial buildings. Existing buffers provide flood control, limited wildlife habitat, and water quality functions.

Wetland functions for the wetland within the project area were evaluated according to data in the Ecology wetland rating forms (Hruby 2004), and supplemental qualitative ratings (high, medium, low) were determined based on Ecology guidance (Ecology 2008a). This methodology entails rating the entire wetland unit which includes a substantial amount of wetland that is outside the project site. Conditions within the project site are more degraded than in the rest of the wetland to the east of the project area. Therefore, the portion of the wetland in the project area may not be providing as high a level of functions as the rest of the wetlands. A summary of the function scores, the total wetland score, and the associated rating (category) for Wetland A is provided in Table 2 above. A complete description of the project areas wetland conditions is available in the project critical areas report included as **Attachment 3**.

c. Wetland Impacts

Temporary impacts to wetlands along the stream will result from excavating the banks along the stream, installation of rock and rootwads along the reconstructed channel and rebuilding the stream banks. Permanent impacts to wetlands will result from filling in the wetland in order to build up the stream banks to prevent flooding of adjacent buildings and excavating the wetland to create more instream habitat. The reconstructed wetland and riparian area will be revegetated and will perform equivalent or better functions as those provided by existing wetlands.

In addition to the functional lift that will be provided by restoring the stream and wetland areas, compensatory mitigation for permanent wetland impacts will also occur. To compensate for the permanent wetland impacts of 0.036 acre, approximately 0.08 acre of wetland will be enhanced within the project area. This results in a mitigation ratio of 2.25 acres enhanced wetland to 1 acre wetland impact meeting the required 2:1 ration established in LUC 20.25H.105.C. A summary of impacts, proposed mitigation, and pre and post project functional summaries are provided in Tables 3, 4, and 5 below.

Table 3 – Project Area Wetland Resources – Temporary and Permanent Impacts

Resource	Temporary Impacts	Permanent Impacts
Wetland A	11,184 square feet (0.26 acre)	1,567 square feet (0.036 acre)

Table 4 – Project Area Wetland Resources – Permanent Impact Mitigation

Resource	Permanent Impacts	Mitigation	Mitigation Ratio Enhanced Wetland: Wetland Impact
Wetland A	1,567 square feet (0.036 acre)	3,522 square feet (0.08 acre)	2.25:1

Table 5 –Project Area Wetland Resources – Functional Affect

Wetland Rating Before and After Project	Water Quality Functions – Qualitative Rating [a] (numerical score in parentheses)		Hydrologic Functions – Qualitative Rating [a] (numerical score in parentheses)		Habitat Functions – Qualitative Rating [a] (numerical score in parentheses)	
	Potential	Opportunity	Potential	Opportunity	Potential	Opportunity
Rating before	Moderate	Yes	Moderate	Yes	Moderate	Moderate
Rating after	Moderate	Yes	High	Yes	High	Moderate
Rating change	No Change	No Change	Moderate to High	No Change	Moderate to High	No Change

[a] Qualitative ratings are based on the Department of Ecology "Using the Wetland Rating System in Compensatory Mitigation" focus sheet (Ecology 2008a).

[b] Wetland category is based on the Department of Ecology rating system (Hruby 2004).

A complete description of potential impacts to project area wetland conditions including mitigation measures is available in the project critical areas report included as **Attachment 3**.

iii. Areas of Special Flood Hazard

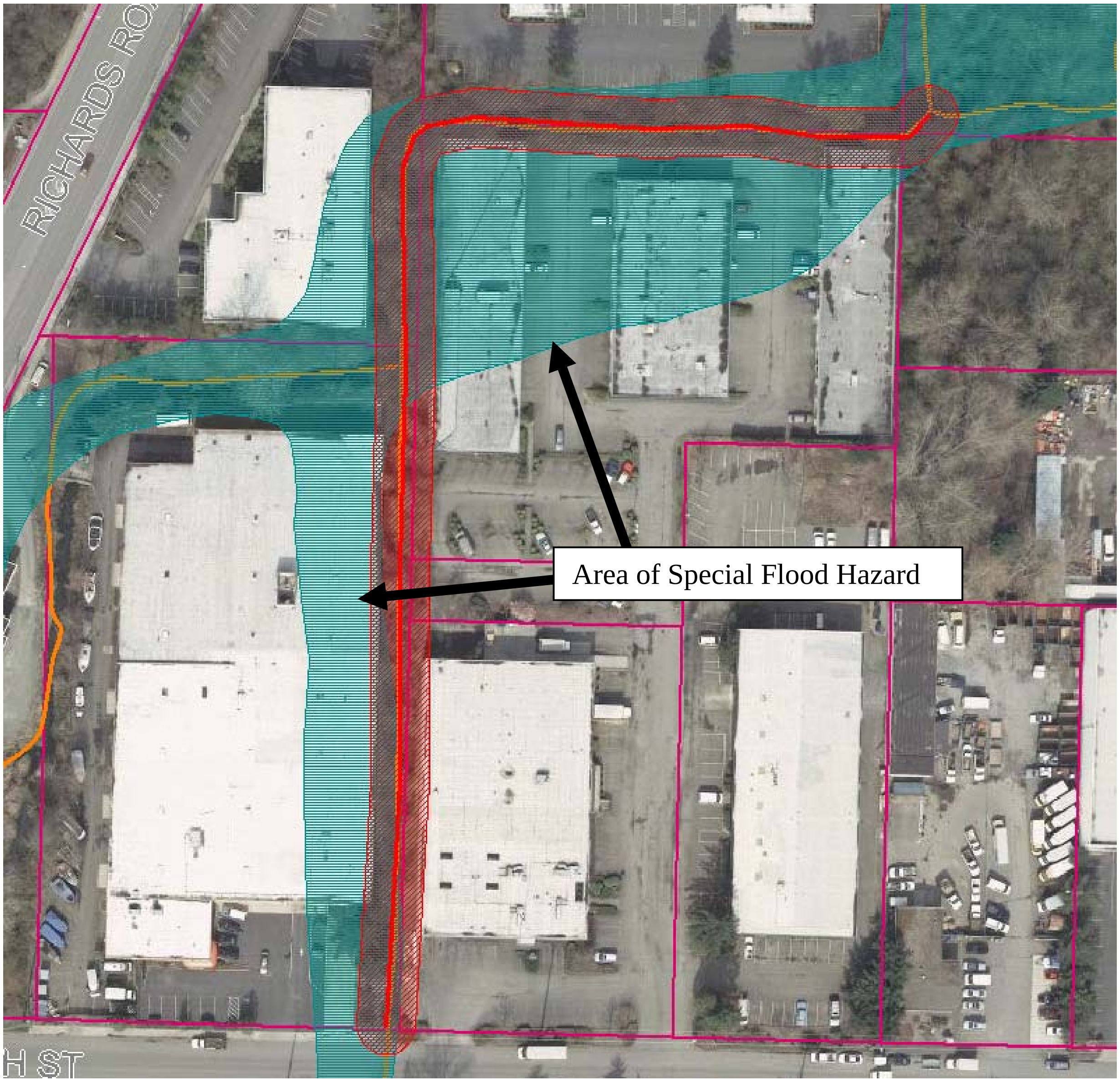
a. Areas of Special Flood Hazard Functions:

The value of floodplains can be described in terms of both the hydrologic and ecological functions that they provide. Flooding of occurs when either runoff exceeds the capacity of rivers and streams to convey water within their banks, or when engineered stormwater systems become overwhelmed. Studies have linked urbanization with increased peak discharge and channel degradation (Dunne and Leopold 1978; Booth and Jackson 1997; Konrad 2000). Floodplains diminish the effects of urbanization by temporarily storing water and mediating flow to downstream reaches. The capacity of a floodplain to buffer upstream fluctuations in discharge may vary according to valley confinement, gradient, local relief, and flow resistance provided by vegetation. Development within the floodplain can dramatically affect the storage capacity of a floodplain, impact the hydrologic regime of a basin and present a risk to public health and safety and to property and infrastructure.

b. Existing Area of Special Flood Hazard Conditions:

A special flood hazard area is defined in LUC 20.25H.175 as land subject to the 100-year flood including areas identified on Flood Insurance Rate Maps (FIRM) as within the base floodplain. The project area falls within a special flood hazard area because it lies within the 100-year floodplain. Flood Hazard Areas within the project vicinity are depicted in Figure 2 below.

Figure 2 – Area of Special Flood Hazard



c. Impacts To Areas of Special Flood Hazard:

The project will have beneficial effects to flood hazard areas. Flooding of adjacent properties will be prevented and BFE will be lowered. The project will result in greater channel conveyance storage than in the current condition as well as improve poor fish habitat and riparian habitat. The project will also prevent further downcutting of the stream bed, further preventing flashy hydroperiods and flooding. The project is designed to reduce the frequency and level of flooding of adjacent properties. Log grade structures will be placed within the streambed in order to prevent further incision of the stream.

iv. Habitat Associated With Species of Local Importance

a. Habitat Functions:

Urbanization, the increase in human settlement density and associated intensification of land use, has a profound and lasting effect on the natural environment and wildlife habitat (McKinney 2002, Blair 2004, Marzluff 2005 Munns 2006), is a major cause of native species local extinctions (Czech et al 2000), and is likely to become the primary cause of extinctions in the coming century (Marzluff et al. 2001a).

Cities are typically located along rivers, on coastlines, or near large bodies of water. The associated floodplains and riparian systems make up a relatively small percentage of land cover in the western United States, yet they provide habitat for rich wildlife communities (Knopf et al. 1988), which in turn provide a source for urban habitat patches or reserves. Consequently, urban areas can support rich wildlife communities. In fact, species richness peaks for some groups, including songbirds, at an intermediate level of development (Blair 1999, Marzluff 2005).

Protected wild areas alone cannot be depended on to conserve wildlife species. Impacts from catastrophic events, environmental changes, and evolutionary processes (genetic drift, inbreeding, colonization) can be magnified when a taxonomic group or unit is confined to a specific area, and no one area or group of areas is likely to support the biological processes necessary to maintain biodiversity over a range of geographic scales (Shaughnessy and O'Neil 2001). As well, typological approaches to taxonomy or the use of indicators present the risk that evolutionary potential will be lost when depending on reserves for preservation (Rojas 2007). Urban habitat is a vital link in the process of wildlife conservation in the U.S.

b. Existing Habitat Features

To evaluate habitat conditions in the project area and vicinity, biologists surveyed the area to identify dominant species, forest maturity, concentrations of native an invasive plant populations, other habitat features (e.g., snags, logs), habitat potential to support protected wildlife species and indications of use by these species. In addition, Herrera reviewed information provided by WDFW's Priority Habitats and Species (PHS) Program (WDFW 2010a), fish usage information from the Salmonscape mapping program (WDFW 2010b), and fish survey data collected as part of the City of Bellevue stream inventory (Watershed Company 2001). There are no PHS areas or documented occurrences of protected species in the project vicinity (WDFW 2010a), except for coho and Chinook salmon, and pileated woodpeckers. Project biologist concluded that only Chinook salmon, coho salmon, green heron, pileated woodpecker, and red-tailed hawk may use the project area or the area downstream of the project.

c. Impacts to Habitat Features:

There will be no direct impacts to the habitat features identified above. While there will be a temporal loss of forested habitat that may affect the pileated woodpecker, the future condition of the project area will provide improved forest habitat. Non-native invasive species will be removed and native species diversity and structural diversity will be increased. The addition of large wood to the stream channel will enhance in-stream habitat and create habitat diversity and cover for fish. Also, restored riparian and wetland habitat will provide shade for the stream, potential food sources (aquatic insects and other fauna) for fish and other aquatic species. All temporarily disturbed vegetation will be restored following construction. Work will occur in the summer, after pileated woodpecker breeding is complete. The addition of LWD as part of the project will enhance pileated woodpecker foraging habitat, as downed logs are a common feeding location for this species. Noise impacts from the project are not expected to be of sufficient magnitude or duration to disturb wildlife species. Sensitive species may move away from construction activity during active work periods, but are expected to return once work is completed. During construction the channel will be dewatered and all flow bypassed to the outlet culvert. After construction, water quality will be monitored and turbid water will be discharged to the sewer. Only after turbidity has been reduced to meet water quality standards will the flow be directed to downstream receiving waters. Therefore no effect on downstream water quality will occur.

III. Consistency with Land Use Code Requirements:

A. Zoning District Dimensional Requirements:

This is a proposal to modify stream channel conditions and improve riparian habitat. Work is limited to grading, the placement of wood and rock, and planting of native vegetation. Standard single family district development standards do not apply.

B. Consistency with Critical Areas Performance Standards LUC 20.25H:

i. Performance Standards for Construction Staging LUC 20.25H.055.C.1

Construction staging associated with an allowed use is considered an allowed activity in critical areas, critical area buffers, or critical area structure setbacks provided the applicable performance standards are adhered to.

The work shall be consistent with all applicable City of Bellevue codes and standards. Site preparation activities include the contractor mobilizing to the project site, developing staging areas, establishing site access routes and traffic control, marking the work and clearing limits, and installing temporary erosion and sediment control (TESC) best management practices (BMPs). Space at the project site is limited and it is anticipated that the contractor will establish staging in the parking lot of a nearby business Staging areas totaling approximately 10,000 square feet are anticipated to be sufficient for the proposed project activities. Access to the project area will occur via SE 30th Street and parking lots adjacent to the stream channel on private property to the east of Sunset Creek and to the north of Richards Creek. The applicant is required to apply for and obtain a Right-of-Way Use Permit for the mobilization and use of this access point. The applicant is also required to apply for and obtain a Clearing and Grading Permit to address temporary erosion and sedimentation control associated with the access route and the temporary construction impacts associated with the in-stream work. This permit also includes review and approval of a stream dewatering plan and turbidity monitoring during the course of the project. Because these permits must be applied for and obtained prior to the commencement of any construction activities, the applicable review department will ensure that all applicable codes and standards are being met. The removal of significant trees for the purpose of staging is prohibited.

All areas of temporary disturbance associated with the work shall be restored to pre-project conditions, pursuant to a restoration plan meeting the requirements of LUC 20.25H.210. A restoration plan has been prepared that seeks to restore all areas of temporary disturbance. The restoration plan is included as part of the Critical Areas Report (**Attachment 3**)

ii. Performance Standards for Public Flood Protection Measures LUC 20.25H.055.C.2 and LUC 20.25H.055.C.3.c

The proposed stream channel modification to regrade and reduce flooding and protect against stream erosion may be approved in accordance with these subsections if:

-There is no technically feasible alternative to in-stream modification; and
-Flood control measures are designed by a qualified professional.

The applicant has submitted as part of the Critical Areas report an analysis of alternatives considered and has demonstrated that the option selected is the optimal action in consideration of the site conditions and project objective. To achieve the objective, the applicant has provided a flood protection plan designed by a qualified professional and is proposing soft stabilization measures including the use of logs and root wads to stabilize the stream after regrading. The applicant is also proposing the use of vegetative enhancements in conjunction with replanting along the banks to increase the plant species diversity and to establish more desirable bank stabilizing species in the area.

iii. Performance Standards for Habitat Improvement Projects LUC 20.25H.055.C.3.j

The project is also classified as a habitat improvement project. It is classified as such because it has been approved by the Director in accordance with the provisions of an approved Critical Areas Report. The primary habitat improvement is the addition of large woody debris to the stream channel to improve habitat diversity and incorporate a source of organic material to improve overall long term stream conditions.

iv. Performance Standards for Stream Critical Areas LUC 20.25H.080.A and LUC 20.25H.080.B

The proposed project has met the criteria of an "allowed use" under LUC 20.25H.055. It includes activities consistent with the uses of a habitat improvement project and public flood protection measures. An approved Critical Areas Report has been prepared and submitted to support the design of the project and its desired objectives.

v. Performance Standards for Wetland Critical Areas LUC 20.25H.100

The following applicable performance standards have been considered and incorporated into the design of proposed project.

There is no current or additional lighting associated with the project that will affect stream or wetlands. The project is not proposing the creation of any noise generating activities other than those temporary noises associated with the construction activity. There will be no new impervious surface as part of the project. Wetland area that will be temporarily and permanently disturbed will be restored. The site will be actively monitored and maintained for a period of 5 years to ensure success of the restoration effort. The use of pesticides, insecticides and fertilizers within 150 feet of the edge of the stream buffer shall be in accordance with the City of Bellevue's "Environmental Best Management Practices," now or as hereafter amended.

vi. Performance Standards for Areas of Special Flood Hazard LUC 20.25H.180.C and LUC 20.25H.180.D.5

Where use or development is allowed pursuant to LUC 20.25H.055, compliance with the performance standards set forth in LUC 20.25H.180.C and LUC 20.25H.180.D.5 must be demonstrated.

The proposed project will maintain established flood elevations within the area of special flood hazard equal to or less than those currently in place. As a habitat improvement project, pool height will be modified to an optimal level in an effort to provide enhanced fish passage. This adjusted pool height will not affect flood storage or flow capacity. The area of special flood hazard will maintain its hydraulic connectivity to the source of flooding. The construction is proposed to occur all in the same season/work window. The proposed project has been evaluated by a qualified engineer and demonstrates that the compensatory storage will not be adversely affected.

C. Consistency with Critical Areas Report LUC 20.25.230:
The applicant supplied a complete critical areas report prepared by a qualified professional. The report met the minimum requirements in LUC 20.25H.250. The report is included as Attachment 3 to this staff report.

D. Consistency with Critical Areas Report – Additional provisions LUC 20.25H.090:
Additional provisions required in a critical areas report for streams are required when the applicant is proposing to reduce the regulatory critical area buffer for the stream. The proposal includes no request to reduce or modify the prescribed critical area buffer or structure setback from Sunset or Richards Creek.

E. Consistency with Critical Areas Report – Additional provisions LUC 20.25H.110:
The Land Use Code specifies additional provisions for critical areas reports for wetlands. This information includes an analysis of wetlands and wetland buffers that may occur within 300 feet of the project area. This section requires a discussion of avoidance and minimization measures, which is included in the applicant's critical areas report.

IV. Public Notice and Comment

Application Date:	September 10, 2010
Public Notice (500 feet):	October 7, 2010
Minimum Comment Period:	October 21, 2010

The Notice of Application for this project was published in the City of Bellevue weekly permit bulletin on October 7, 2010. It was mailed to agencies, tribes, and property owners within 500 feet of the project site. One public comment letter was received from the Muckleshoot Indian Tribe Fisheries Division. The letter included several technical questions and comments related to the following issues:

- Questions related to the removal of significant trees as part of the project design;
- Suggestions related to the quantity and type of wood being placed in the stream as a stream stabilization measure and habitat improvement;
- Question on a downstream condition identified as a fish passage barrier.

The comment letter is included as **Attachment 5**. Staff response to the comments is included as **Attachment 6**. No changes to the project design were made as a result of the comment received.

V. Summary of Technical Reviews

Clearing and Grading:
The Clearing and Grading Division of the Development Services Department has reviewed the proposed development for compliance with Clearing and Grading codes and standards. The Clearing and Grading staff found no issues with the proposed development.

Transportation:
A representative of the Transportation Department was notified of the project proposal. Their review determined that a Right-of-Way Use Permit is required for the use of the public right-of-way for construction staging and access. This permit must be obtained prior to commencement of project activity.

VI. State Environmental Policy Act (SEPA)

The environmental review indicates no probability of significant adverse environmental impacts occurring as a result of the proposal. The Environmental Checklist submitted with the application adequately discloses expected environmental impacts associated with the project. The City codes and requirements, including the Clear and Grade Code, Utility Code, Land Use Code, Noise Ordinance, Building Code and other construction codes are expected to mitigate potential environmental impacts. Therefore, issuance of a Determination of Non-Significance (DNS) is the appropriate threshold determination under the State Environmental Policy Act (SEPA) requirements.

A. Earth and Water

A temporary erosion and sedimentation control plan is included in the project plans, and addresses all requirements for restoring the site to its current condition as well as erosion and sedimentation management practices. Erosion and sediment control best management practices include the use of a dewatering plan to dry out as much as feasible during the proposed construction activity. The proposal also includes the installation of silt fencing around the work area and covering exposed soils to prevent migration of soils to the adjacent stream and wetland. Final approval of the temporary erosion and sedimentation control plan will happen with the required Clearing and Grading Permit. The applicant will also be required to submit information regarding the use of pesticides, insecticides, and fertilizers to avoid impacts to water resources. See Section IX for related conditions of approval.

B. Animals

The project site is located around and within a regulated stream and is part of a habitat corridor. To improve in stream habitat, the applicant is proposing to place large woody debris in the stream channel to improve habitat complexity and improve organic compound inputs. The mature vegetation on the site may provide habitat to several species listed in the critical areas report. However, impacts are anticipated to be limited due to the temporary status construction associated with the project and the beneficial long term objectives of the stream enhancement. The restoration plan for areas of temporary disturbance has been designed to further enhance the vegetation structure on the site, which is expected to have a positive impact on the wildlife resource.

C. Plants

Mitigation for temporary and permanent disturbance will be approved pursuant to an approved mitigation and enhancement plan. A complete restoration plan with monitoring performance standards and contingency plan has been submitted as part of the critical areas report (**Attachment 3**). It will be implemented as a condition of the subsequent clearing and grading permit. See Section IX for related conditions of approval.

D. Noise

Construction noise will be limited by the City's Noise Ordinance (Chapter 9.18 BCC) which regulates construction hours and noise levels. See Section IX for a related condition of approval.

VII. Decision Criteria

A. Critical Areas Report Decision Criteria- General Criteria LUC 20.25H.255

The Director may approve, or approve with modifications, the proposed modification where the applicant demonstrates:

1. **The modifications and performance standards included in the proposal lead to levels of protection of critical area functions and values at least as protective as application of the regulations and standards of this code;**

Finding: The applicant has provided a complete critical areas report that demonstrates that the proposal leads to levels of protection of critical area functions and values that area at least as protective as the regulations and standards of this code. Through the critical areas report process, it is clear that habitat functions will likely be improved, the riparian functions will improve in the long term through the incorporation of additional native plants. The inclusion of large woody debris will enhance the Instream habitat in the project reach.

2. **Adequate resources to ensure completion of any required mitigation and monitoring efforts;**

Finding: The applicant, the City of Bellevue, has adequate resources to complete the required mitigation and monitoring efforts as part of larger project to improve the Sunset/Richards/East Creek areas.

3. **The modifications and performance standards included in the proposal are not detrimental to the functions and values of critical area and critical area buffers off-site; and**

Finding: The proposal complies with all of the applicable performance standards for streams, wetlands, habitat areas, and areas of special flood hazard and includes an appropriate mitigation and restoration plan to offset identified short and long term impacts.

4. **The resulting development is compatible with other uses and development in the same land use district.**

Finding: The construction of the stream modification and habitat improvement work is consistent with the surrounding land uses. There is no change in use on the site or any of the adjacent sites.

B. Critical Areas Land Use Permit Decision Criteria 20.30P

The Director may approve or approve with modifications an application for a critical areas land use permit if:

1. **The proposal obtains all other permits required by the Land Use Code;**

Finding: The proposed activity is required to obtain a clearing and grading permit and right-of-way use permit from the City of Bellevue. The activity is also required to obtain permission from the Washington State Departments of Ecology and Fish & Wildlife, as well as the Army Corps of Engineers.

2. **The proposal utilizes to the maximum extent possible the best available construction, design and development techniques which result in the least impact on the critical area and critical area buffer;**

Finding: The proposal has been designed by qualified professionals from Herrera Environmental Consultants with consultation with City of Bellevue and Washington Department of Fish and Wildlife Habitat Biologists, in order to ensure the best available design and techniques have been incorporated.

3. **The proposal incorporates the performance standards of Part 20.25H to the maximum extent applicable, and ;**

Finding: Section III above discusses how, the proposal incorporates the applicable performance standards.

4. **The proposal will be served by adequate public facilities including street, fire protection, and utilities; and;**

Finding: The area is adequately serviced by public facilities. The proposal will not change the need for public facilities.

5. **The proposal includes a mitigation or restoration plan consistent with the requirements of LUC Section 20.25H.210; and**

Finding: A mitigation and restoration plan consistent with the requirement of LUC 20.25H.210 has been prepared and submitted along with the project's critical areas report.

6. **The proposal complies with other applicable requirements of this code.**

Finding: As discussed in Section IV & V of this report, the proposal complies with all other applicable requirements of the Land Use Code.

VIII. Conclusion and Decision

After conducting the various administrative reviews associated with this proposal, including Land Use Code consistency, SEPA, City Code and Standard compliance reviews, the Development Services Director does hereby **approve with conditions** the proposal to modify the channels of Sunset and Richards Creeks for flood control and habitat improvements.

Note- Expiration of Approval: In accordance with LUC 20.30P.150 a Critical Areas Land Use Permit automatically expires and is void if the applicant fails to file for a Clearing and Grading Permit or other necessary development permits within one year of the effective date of the approval.

IX. Conditions of Approval

The applicant shall comply with all applicable Bellevue City Codes and Ordinances including but not limited to:

Applicable Ordinances	Contact Person
Clearing and Grading Code- BCC 23.76	Savina Uzunow, 425-452-7860
Land Use Code- BCC 20.25H	David Pyle, 425-452-2973
Noise Control- BCC 9.18	David Pyle, 425-452-2973
Transportation Code	Rohini Nair, 425-452-2569

The following conditions are imposed under the Bellevue City Code or SEPA authority referenced:

1. **Clearing and Grading Permit:** Before commencing any construction activity the applicant must apply for and obtain a Clearing and Grading Permit. On-going turbidity monitoring and submittal of turbidity monitoring data sheets will be required as part of the clearing and grading permit inspection process.

   Authority: Bellevue City Code Section 23.76.025
   Reviewer: Savina Uzunow, Development Services Department

2. **Restoration for Areas of Temporary Disturbance:** A restoration plan for all areas of temporary disturbance is required to be submitted for review and approval by the City of Bellevue prior to the issuance of the Clearing and Grading Permit. The plan shall include the documentation of existing site conditions and shall identify avoidance of impacts. Where avoidance is not possible the plan shall identify restoration measures to be taken to return the site to its existing conditions per LUC 20.25H.220.H.

   Authority: Land Use Code 20.25H.220.H
   Reviewer: David Pyle, Development Services Department

3. **Mitigation, Maintenance, and Monitoring Plan:** To ensure the proposed restoration plan is successful, the mitigation, maintenance, and monitoring plan submitted as part of this application shall be submitted as part of the underlying clearing and grading permit required to implement the project. Any modifications to the mitigation plans submitted under this application must be approved prior to issuance of the clearing and grading permit. Mitigation plans must include an updated contingency plan to identify what measures will be taken if monitoring indicates non-compliant results.

   Authority: Land Use Code 20.25H.220, 20.25H.180.C.5
   Comprehensive Plan Policies EN-1, EN-10, EN-28, EN-30
   Reviewer: David Pyle, Land Use

4. **Mitigation Installation:** Mitigation installation shall commence immediately following permit issuance where technically feasible and shall be installed according to the mitigation plans submitted as part of this application within one year of project completion.

   Authority: Land Use Code 20.25H.220, 20.25H.180.C.5
   Reviewer: David Pyle, Land Use

5. **Mitigation Maintenance:** Maintenance of mitigation plantings shall include, at a minimum, three entries per year. During each entry, plant growth will be evaluated, soils amended as needed, and invasives will be suppressed.

   Authority: Land Use Code 20.25H.220, 20.25H.180.C.5
   Reviewer: David Pyle, Land Use

6. **Submittal of Mitigation Maintenance and Monitoring Reports:** As part of the required five years of mitigation maintenance and monitoring, the applicant shall submit annual monitoring reports to the Development Services Department Land Use Division at the end of the growing season by no later than December 31 for each year monitored.

   Authority: Land Use Code 20.25H.220.D
   Reviewer: David Pyle, Land Use

7. **Rainy Season Restrictions:** Due to the proximity to Sunset and Richards Creek and associated wetlands, no clearing and grading activity may occur during the rainy season, which is defined as November 1 through April 30 without written authorization of the Development Services Department. Should approval be granted for work during the rainy season, increased erosion and sedimentation measures, representing the best available technology must be implemented prior to beginning or resuming site work.

   Authority: Bellevue City Code 23.76.093.A,
   Reviewer: Savina Uzunow, Development Services Department

8. **In-Water Work Window:** Work in the active channel approved by the underlying Clearing and Grading Permit must be completed during an in-water work window of July 1 through August 31, unless otherwise authorized in writing by the Washington State Department of Fish and Wildlife.

   Authority: Land Use Code 20.25H.160
   Reviewer: David Pyle, Land Use

9. **Pesticides, Insecticides, and Fertilizers:** The applicant must submit as part of the required Clearing and Grading Permit information regarding the use of pesticides, insecticides, and fertilizers in accordance with the City of Bellevue's "Environmental Best Management Practices".

   Authority: Land Use Code 20.25H.220.H
   Reviewer: David Pyle, Development Services Department

10. **Noise Control:** Noise related to construction is exempt from the provisions of BCC 9.18 between the hours of 7 am to 6 pm Monday through Friday and 9 am to 6 pm on Saturdays, except for Federal holidays and as further defined by the Bellevue City Code. Noise emanating from construction is prohibited on Sundays or legal holidays unless expanded hours of operation are specifically authorized in advance. Requests for construction hour extension must be done in advance with submittal of a construction noise expanded exempt hours permit.

    Authority: Bellevue City Code 9.18
    Reviewer: David Pyle, Development Services Department

11. **Right-of-Way Use:** The proposed project will likely require the use of a portion of the right-of-way adjacent to the subject property, specifically as a haul route for excavated material and imported fill and materials. If required, a right-of-way use permit from the Transportation Department should be obtained.

    Authority: Bellevue City Code 14.30
    Reviewer: Rohini Nair, Transportation Department

12. **Obtain All Other Applicable State and/or Federal Permits:** Before work can be allowed to proceed, all applicable state and federal permits must be presented to the Development Services Department.

    Authority: Land Use Code 20.25H.180.C.2
    Reviewer: David Pyle, Development Services Department

13. **Temporary Erosion and Sedimentation Control Plan:** Prior to the initiation of any clearing or grading activities, a Temporary Erosion and Sedimentation Control Plan must be approved as part of a Clearing and Grading permit and all clearing limits and the location of temporary erosion and sedimentation control measures shall be field staked for approval by the on-site clearing and grading inspector's approval.

    Authority: Bellevue City Code 23.76.060 and 23.76.090
    Reviewer: David Pyle, Land Use

14. **Dewatering Plan**: To ensure the work area is free of moving water and turbid water generated during construction is not able to flow downstream from the work site, a satisfactory dewatering plan must be submitted and approved as part of the underlying clearing and grading permit.

    Authority: Bellevue City Code 23.76
    Reviewer: Savina Uzunow, Development Services Department

15. **Turbidity Monitoring Plan:** A turbidity monitoring plan that meets the requirements of BCC 23.76 must be submitted and approved as part of the underlying clearing and grading permit.

    Authority: Bellevue City Code 23.76
    Reviewer: David Pyle, Land Use

16. **Storm Water Pollution Prevention Plan:** To ensure contaminated stormwater or construction-related runoff does not pollute adjacent surface water, a construction stormwater pollution prevention plan (CSWPPP) is required for all clearing and grading permit applications for industrial, commercial, multi-family, plat and short plat developments. The CSWPPP outline should be generally consistent with the SWPPP requirements of the National Pollutant Discharge Elimination System (NPDES) General Storm water Permit for Construction Activities.

    Turbidity and pH monitoring will be required during the site grading. A monitoring plan must be submitted as part of the CSWPPP with the Clearing & Grading permit application or during review of the Clearing and Grading permit application.

    Authority: Clearing and Grading Code BCC 23.76
    Reviewer: Savina Uzunow, Development Services Department

FLOOD CONTROL AND SEDIMENT MANAGEMENT PLAN

Richards Creek, Sunset Creek, and East Creek Confluence Area

Prepared for

City of Bellevue

October 2008 Draft

Note:
Some pages in this document have been purposefully skipped or blank pages inserted so that this document will copy correctly when duplexed.

FLOOD CONTROL AND SEDIMENT MANAGEMENT PLAN

Richards Creek, Sunset Creek, and East Creek Confluence Area

Prepared for

City of Bellevue
Utilities Department
450 110th Avenue NE
Bellevue, Washington 98009-9012

Prepared by

Herrera Environmental Consultants, Inc.
2200 Sixth Avenue, Suite 1100
Seattle, Washington 98121
Telephone: 206/441-9080

In Association with
CivilTech Corporation
and
Kleinfelder, Inc.

October 22, 2008 Draft

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Executive Summary

The Richards Creek, Sunset Creek, and East Creek channel network in the vicinity of SE 30th Street and Kamber Road has been directly impacted by channel realignment, channel confinement, and increased rates of sediment production associated with land development both local to the project area and in the upper watershed. These impacts include recurrent flooding and sedimentation problems, channel instability, and degraded habitat conditions. Recommended flood control and sedimentation management alternatives are provided in this report to address the following problem areas. This report also presents the technical basis of design for the recommended culvert and channel improvements summarized below.

Flooding and Sedimentation in Sunset Creek in the vicinity of SE 30th Street

To address recurrent flooding and ongoing sedimentation in Sunset Creek at SE 30th Street, a replacement culvert and adjacent channel modifications are recommended and are being implemented in two phases. Channel modifications under both phases include the following project components that will improve the aquatic habitat conditions of Sunset Creek:

- Construction of a two-stage channel
- Biostabilization of stream banks
- The removal of invasive species
- Replanting with native vegetation.

Phase I

Phase I includes a replacement culvert at SE 30th Street and channel modifications upstream and downstream to provide a stable streambed transition to the culvert inlet and outlet. The design of the replacement culvert includes a sedimentation structure that will provide the City of Bellevue Utilities Department greater flexibility in managing the delivery of sediment to SE 30th Street and the channel network downstream. The culvert is designed to improve fish passage through the SE 30th Street crossing, and the channel improvements on either side of SE 30th Street are designed to improve instream habitat.

Phase I design constraints, including the confined channel alignment, change in bed profile at the replacement culvert location, and the SE 30th Street road elevation, necessitate an exemption from the City of Bellevue Engineering Standards that require the 100-year flow to be conveyed through culverts with one foot of freeboard. The proposed replacement can convey the 100-year peak flow in the creek, but not with one foot of freeboard below the top of the culvert structure. The replacement culvert and stream channel modifications on the upstream and downstream sides of the road will greatly reduce the threat of flooding at this location while concentrating sediment removal activity within the culvert structure as opposed to the nearby stream channel.

Phase I is currently in the design and permitting process, on schedule for construction during the summer of 2009.

Phase II

Phase II includes approximately 400 feet of additional channel modifications from the downstream end of Phase I to the confluence of Sunset Creek and Richards Creek. Phase II channel modifications include construction of a containment berm to limit the extent of flooding into neighboring properties. Phase II is currently in the design and permitting process, on schedule for construction during the summer of 2010.

Channel and Habitat Degradation in Richards Creek and East Creek

Downstream (north) of the confluence with Sunset Creek, Richards Creek has cut a new channel through a wetland area and largely abandoned its former channel. As a result, Richards Creek joins East Creek upstream of Kamber Road, whereas its historical connection to East Creek was downstream of Kamber Road. The added flow in the East Creek channel upstream of Kamber Road, and in what is termed the "flow-split channel" in this report, causes concern for erosion and sedimentation downstream of the flow split location.

Recommendations for Phase III of the flood control and sediment management plan for the project area address ongoing channel degradation and sedimentation within the channel network downstream of the Sunset Creek and Richards Creek confluence.

Phase III (Alternative 3)

Grade control structures to reduce channel erosion and other channel modifications within the flow-split channel and East Creek are recommended to address ongoing channel degradation and provide conditions that promote fish passage, hydraulic complexity, floodplain activation and sediment storage. Phase III (Alternative 3) has been has been identified by the City of Bellevue Utilities Department as a future capital improvement project, pending availability of funds and potential property acquisition. Phase III (Alternative 3) as evaluated in this report would result in increased flood flow elevations in the stream corridor downstream of the Richards Creek flow split. It is recommended that the design process for Phase III incorporate two-dimensional hydraulic modeling to evaluate the complex hydraulic flow patterns affecting the flow-split channel and another secondary channel that convey Richards Creek flow into East Creek via a forested wetland area.

Phase III (Alternative 4)

Another alternative to managing flooding and sedimentation in the project area is referred to as Phase III (Alternative 4) in this report. This alternative includes continued maintenance of beaver dams downstream of Kamber Road to minimize the dams' backwater influence that promotes sediment accumulation and increases flooding risks at Kamber Road. This alternative is recommended regardless of whether the City is able to dedicate funding for Alternative 3.

Sediment Source Control and Storage Recommendations

In addition to managing flooding and sedimentation in the channel network in the vicinity of SE 30th Street and Kamber Road, the City may be able to address sources of sediment in the upper Sunset Creek watershed pending availability of funding to do so. Actions that could be taken for sediment source control in the upper watershed are collectively described as Phase IV of the flood control and sediment management plan described in this report. Recommendations for Phase IV of a comprehensive plan are briefly described below.

Phase IV

Phase IV recommendations include bank stabilization and channel grade control measures in three reaches upstream of the project area to address ongoing sediment delivery from the upper Sunset Creek watershed. Additionally, a geomorphic assessment of the East Creek channel network is recommended to determine the relative contribution of sediment generated by reported channel degradation and develop appropriate treatment recommendations.

Introduction

The City of Bellevue retained Herrera Environmental Consultants (Herrera) to evaluate conceptual design alternatives for culvert and channel improvements to support flood control and sediment management improvements for stream channels in the vicinity of SE 30th Street and Kamber Road. This area includes parts of Sunset Creek, Richards Creek, and East Creek within the vicinity of SE 30th Street and Kamber Road to the east of Richards Road and is termed the flood control and sediment management plan project area in this report (Figure 1).

This technical report documents the analysis of recommended flood control and sedimentation management alternatives and details how these alternatives may be implemented to improve conditions of ongoing sedimentation and flooding in channels within the project area downstream of SE 30th Street. This report also serves as the basis of design documentation for the first two phases of flood control and sediment management:

- Phase I: Culvert Replacement and Stream Channel Modifications on Sunset Creek at SE 30th Street.
- Phase II: Additional Stream Channel Modifications on Sunset Creek between SE 30th Street and the confluence with Richards Creek.

Report Organization

The information presented following this introduction provides the background for the development of flood control and sediment management plan alternatives, and includes:

- Description of Project Area
- Recurrent Flooding and Sedimentation Problems in the Project Area
- Geomorphic Context of the Project Area
- Channel and Habitat Characteristics in the Project Area
- Constraints to Address in Solving Flooding and Sedimentation Problems
- Flood and Sediment Control Project Objectives.

Following this background and contextual information, the recommended flood and sediment control alternatives are presented along with pertinent design guidelines and requirements. Hydraulic and sediment transport analyses of the alternatives, design details for the proposed replacement culvert and channel modifications, and sediment reduction recommendations for the upper watershed are presented in the sections entitled:

- Analysis of Flood and Sediment Control Alternatives
- Replacement Culvert and Channel Modification Design
- Upper Watershed Sediment Source Control and Storage Recommendations.

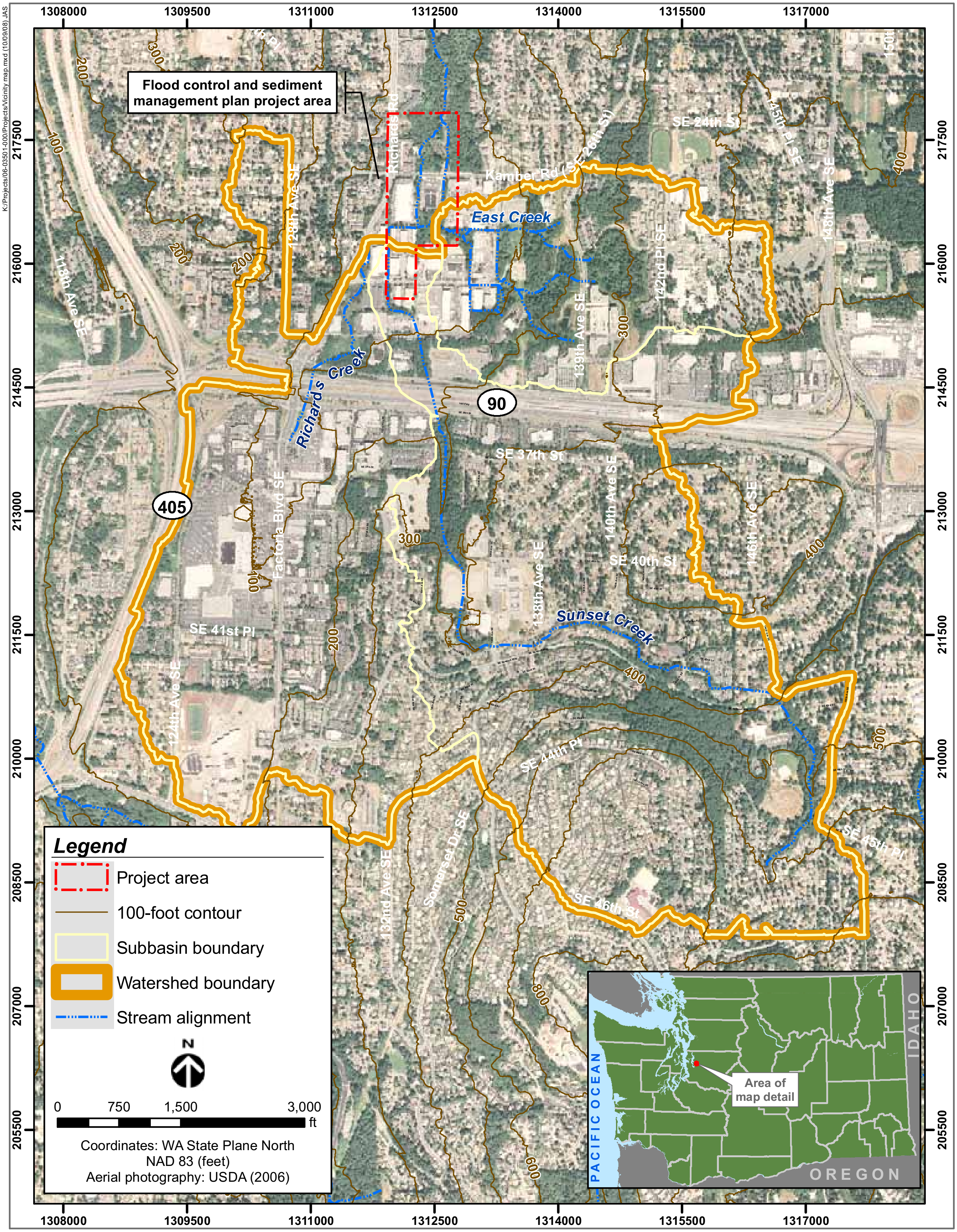

Figure 1. Vicinity map of the Richards Creek, Sunset Creek, and East Creek confluence area watersheds and the location of the flood control and sediment management plan project area.

The sediment source control and storage measures presented at the end of this report are based on findings of the *Sunset Creek Geomorphic Assessment and Sedimentation Analysis* (Herrera 2008). The results of this study also provide the basis of understanding for the geomorphic context of the project area, including historical and present-day characteristics of sediment delivery and deposition.

Description of Project Area

The flood control and sediment management plan project area, referred to as the "project area" within this report, contains a complex network of channels and confluences. Within the last few years, changes in the alignment of the mainstem channel of Richards Creek have occurred between SE 30th Street and Kamber Road, and standard nomenclature to describe the current channel network has not formally been adopted in relation to those changes. Naming conventions for the channel network that are used throughout this report are shown in Figure 2.

At the south end of the project area, Sunset Creek flows north under SE 30th Street. Approximately 450 feet north of SE 30th Street, Sunset Creek joins Richards Creek, which flows generally from the southwest to northeast. Richards Creek flows to the north downstream from this confluence. Within 200 feet the stream alignment turns sharply to the east. Approximately 350 further downstream (east) the channel is split, or bifurcated, into two channel alignments.

From this flow split location, some of the stream flow turns sharply to the north and the remainder of the flow heads to the northeast. The alignment that heads directly north was until recently the main flow path for Richards Creek. Over the last five years an increasing proportion of stream flow has begun to occupy the channel alignment that trends to the northeast, or the "flow-split channel" (Figure 2). At the present time the flow-split channel conveys nearly all of the flow during low stream flow conditions and the vast majority of stream flow during flooding events. The channel alignment that previously conveyed Richards Creek to the north has been effectively abandoned and is referred to in this report as the historical Richards Creek alignment.

The flow-split channel joins East Creek approximately 400 feet downstream from the Richards Creek flow split. Downstream of this confluence, East Creek typically conveys the combined discharge of Sunset Creek, Richards Creek, and East Creek. The East Creek channel is conveyed through a large box culvert that was recently installed beneath Kamber Road approximately 400 feet downstream of its confluence with the flow-split channel. The confluence of the historical Richards Creek alignment with Richards Creek is located 700 feet downstream of Kamber Road.

Recurrent Flooding and Sedimentation Problems in the Project Area

Flooding and sedimentation are recurrent problems within the project area (Figure 3). Sunset Creek has overtopped its banks and flooded SE 30th Street at least six times since January 1, 2005 (Ward 2007). This flooding has impacted local businesses and neighborhood access.

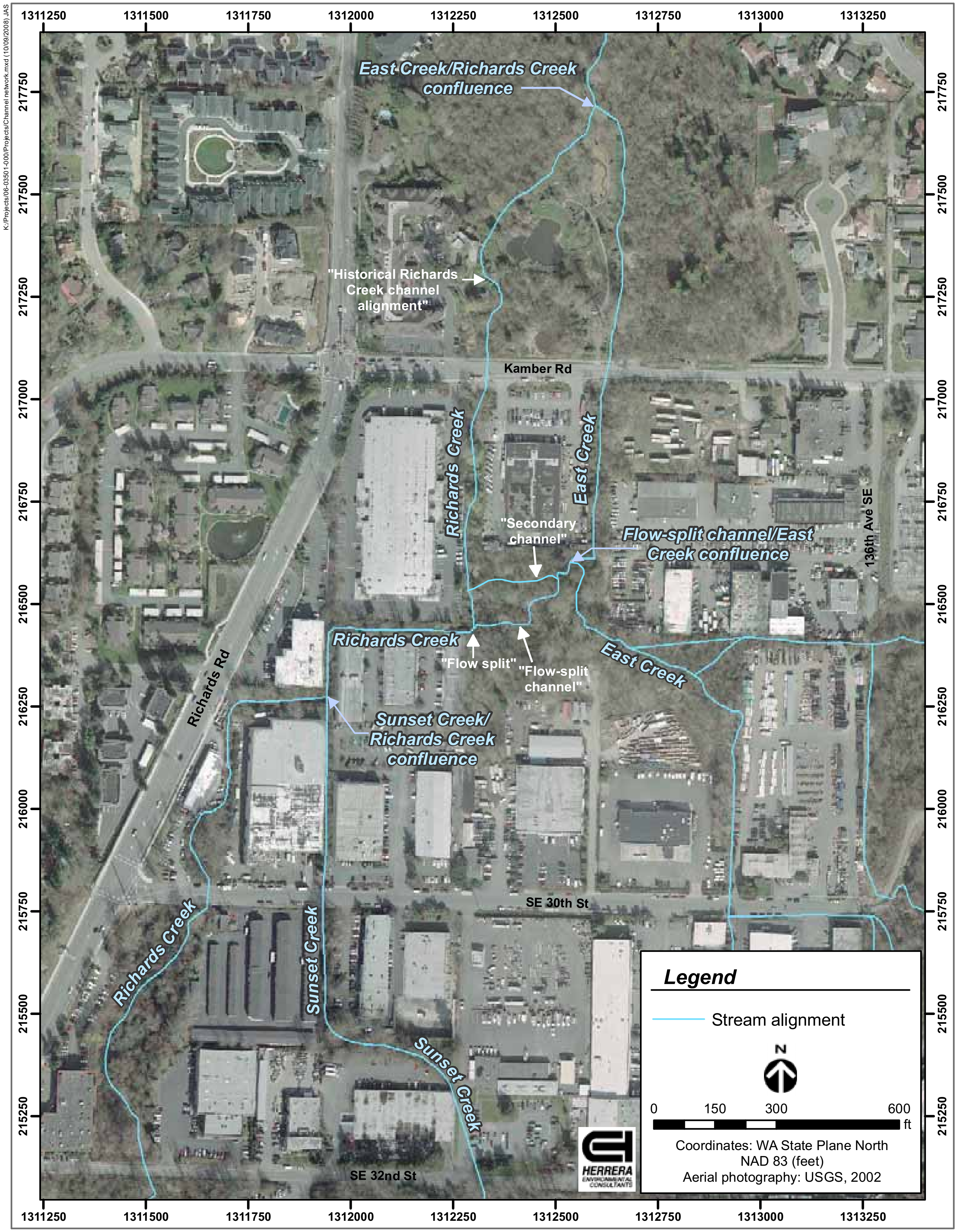

Figure 2. Channel network and naming conventions within the flood control and sediment management plan project area.

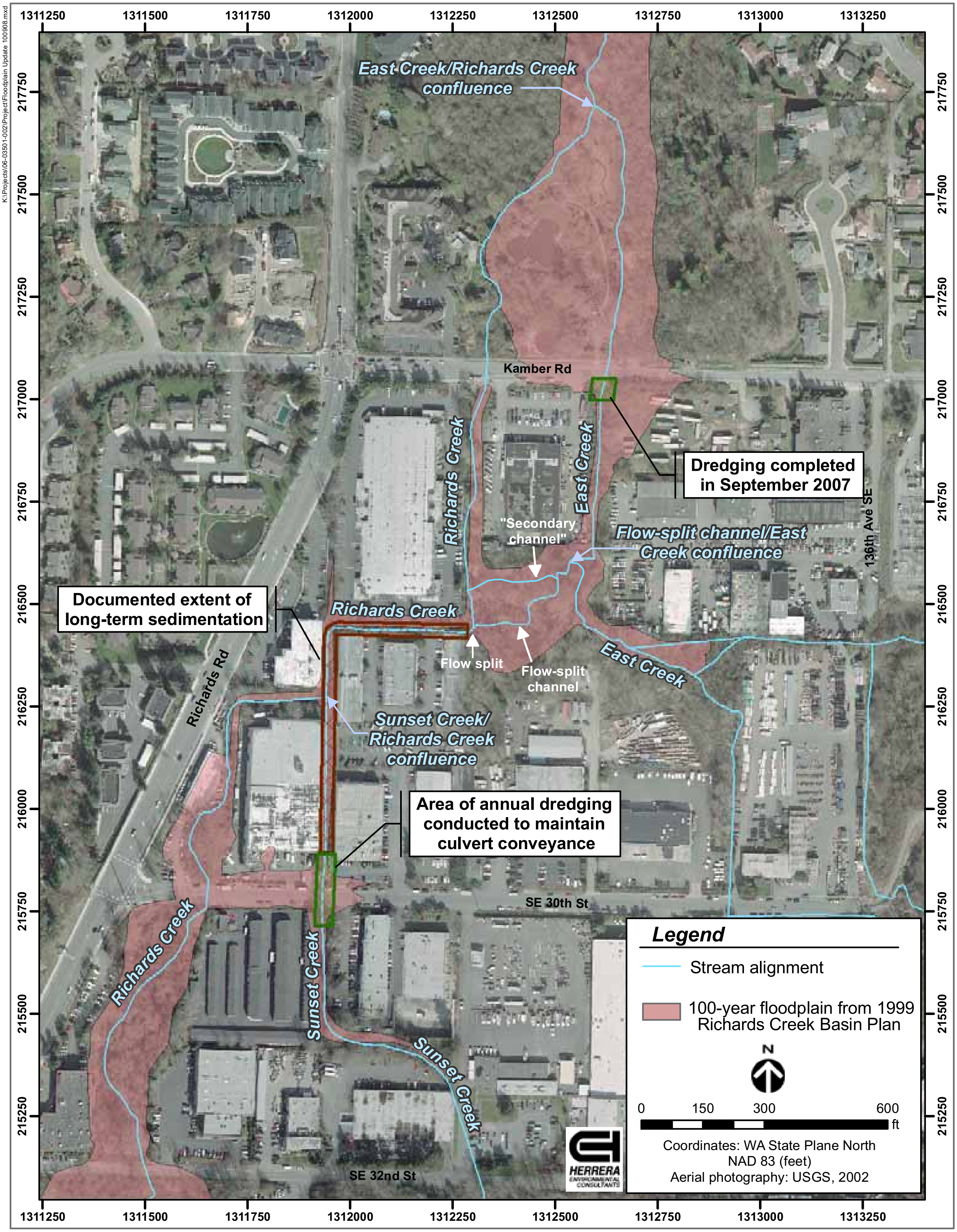

Figure 3. Location and extent of flooding and sedimentation impacts within the flood control and sediment management plan project area.

Persistent sediment deposition within the Sunset Creek channel immediately upstream of SE 30th Street, through the SE 30th Street stream culverts, and in the channel downstream of the street crossing aggravates conditions that lead to flooding. In the last 30 years, sediment deposition between SE 30th Street and the Richards Creek flow split located approximately 1,000 feet downstream has caused channel bed aggradation of between three and four feet depth (Herrera 2008). This is equivalent to an average deposition rate of approximately 40 cubic yards annually within the Sunset Creek and Richards Creek channels between SE 30th Street and the flow split. The long term, chronic aggradation has lowered the effective channel bed slope through the existing 42-inch diameter twin culverts beneath SE 30th Street, which further reduces the local sediment transport capacity. Due to natural channel stabilization and efforts to reduce sediment supply from upstream sources (see Sediment Source Control Options and Recommendations later in this report), the average annual delivery is estimated to be lower than the long term average annual rate of 40 cubic yards (Herrera 2008). Ongoing deposition, however, has required annual removal of sediment on the order of 20 cubic yards from the Sunset Creek channel immediately upstream and downstream of the culverts beneath SE 30th Street in order to maintain the stream flow conveyance capacity in this reach (Table 1).

Table 1. Record of recent maintenance dredging from Sunset Creek at SE 30th Street.

Year of Dredging	Volume of Sediment Removed Downstream of Culverts (cubic yards)	Volume of Sediment Removed Upstream of Culverts (cubic yards))
2004	15-20	--[a]
2005	20	1.5
2006	10	0.75
2007	15-20	--[a]

Notes:
[a] volume of sediment removal upstream of culverts not reported.

Downstream of SE 30th Street, sediment deposition within the East Creek channel at Kamber Road occurred rapidly between 2005 and October 2007 following the replacement of a 36-inch diameter culvert with a 29-foot wide, three-sided box culvert intended to reduce flooding and improve fish passage. Based on channel bed elevations derived from topographic channel cross-sections from November 2005 and April 2007, sediment deposition was occurring at a rate of approximately 200 cubic yards annually at the Kamber Road crossing. This aggradation significantly reduced the conveyance capacity at this location, leading to conditions promoting flooding. In September 2007, approximately 50 cubic yards of sediment were removed under the City's existing programmatic Hydraulic Project Approval culvert maintenance permit authorized by the Washington Department of Fish and Wildlife. Concurrent with sediment removal, backwater conditions that were contributing to the sediment deposition at Kamber Road were addressed by deconstructing beaver dams located downstream. This action temporarily restored flood conveyance by initiating downcutting through accumulated sediments that were not removed as part of the emergency sediment removal, both within the channel below Kamber Road and immediately downstream.

The most recent flooding in the project area occurred as a result of the storm event of December 2-3, 2007. During this event, the 24-hour rainfall total was measured at 4.7 inches in the upper Sunset Creek watershed, which exceeds the 100-year recurrence interval precipitation total (Noeske 2008). Flooding occurred at SE 30th Street and also at Kamber Road at both the East Creek crossing and in the vicinity of the historical Richards Creek crossing during this storm. Flooding of SE 30th Street and Kamber Road at the East Creek crossing in this storm event was caused by insufficient flow capacity at the respective road crossings. Flooding of Kamber Road by flow conveyed in the historical Richards Creek channel was caused by overbank flow in the vicinity of the flow split that was routed to Kamber Road through a parking lot on private property.

Geomorphic Context of Project Area

The flood control and sediment management project area is located in an area that was historically an alluvial fan between the upper Sunset Creek watershed and the lower gradient channel of Richards Creek that flows to the north. Alluvial fans develop where streams emerge from steep reaches in which they are confined to relatively straight and narrow channels and flow into areas where sediment transport capacity decreases because of increases in channel width, reductions in channel gradient, or other influences. The reduced channel confinement at the upper (south) end of the project area, in combination with the significant decrease in channel gradient that occurs from upstream of SE 30th Street to the confluence of the historical Richards Creek alignment with East Creek, causes a significant decrease in sediment transport capacity (Figure 4). Reduced sediment transport capacity, in conjunction with high rates of sediment delivery from the upper watershed, has resulted in the ongoing channel aggradation and conditions that exacerbate flooding. Significant alterations to channels within the project area, for purposes of land development, have further aggravated local sedimentation and flooding.

The historical channel configuration of Sunset Creek, Richards Creek, and East Creek within the project area was significantly different than it is at the present time. Before development of the project area occurred, Sunset Creek crossed SE 30th Street approximately 600 feet to the east of the current channel alignment and joined East Creek upstream of the present location of Kamber Road (Figure 5). The combined flow from these channels flowed north to a confluence with Richards Creek downstream of the present location of Kamber Road. Under these pre-development conditions, the channels within the project area were free to move laterally and shift course as sediment deposition filled channels and locally reduced sediment transport capacity. Such abrupt changes in channel location are typical of channels on alluvial fans, where channel alignments are impermanent and the repeated process of channel relocation and sediment deposition form the characteristic fan-shaped deposits. During the development that occurred during the 1960s, when land was being graded and buildings adjacent to the channel network were being constructed, Sunset Creek, Richards Creek, and East Creek were realigned to their present day locations. To maintain the altered channel locations, the banks of these streams were armored in several areas. This channelization ended the natural process of dynamic sediment deposition and channel relocation and concentrated sediment deposition along the constructed channel alignments, without ability for the channels to shift in response to the sediment deposition.

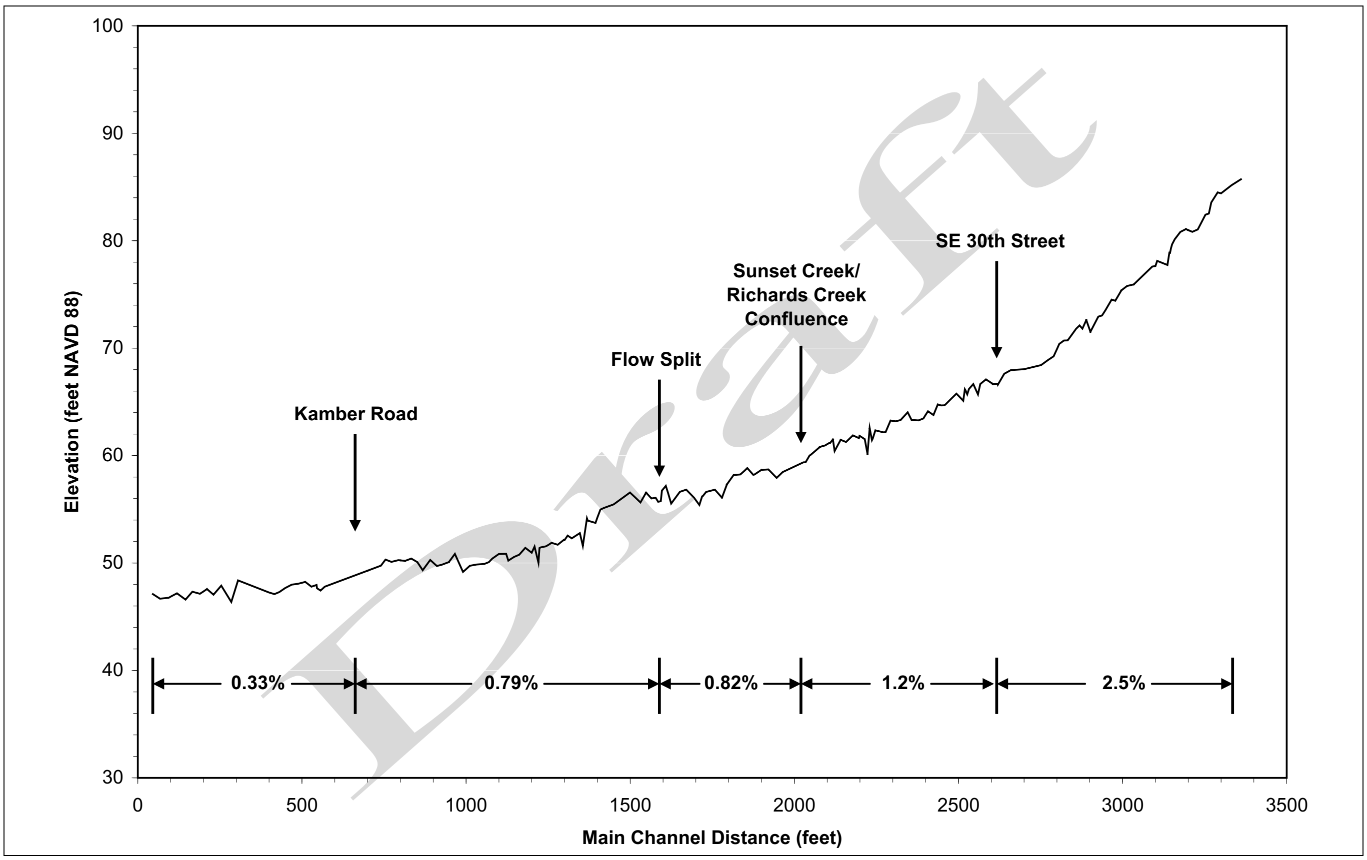

Figure 4. Longitudinal channel bed profile and average channel gradients along Sunset Creek, Richards Creek, and East Creek through the project area.

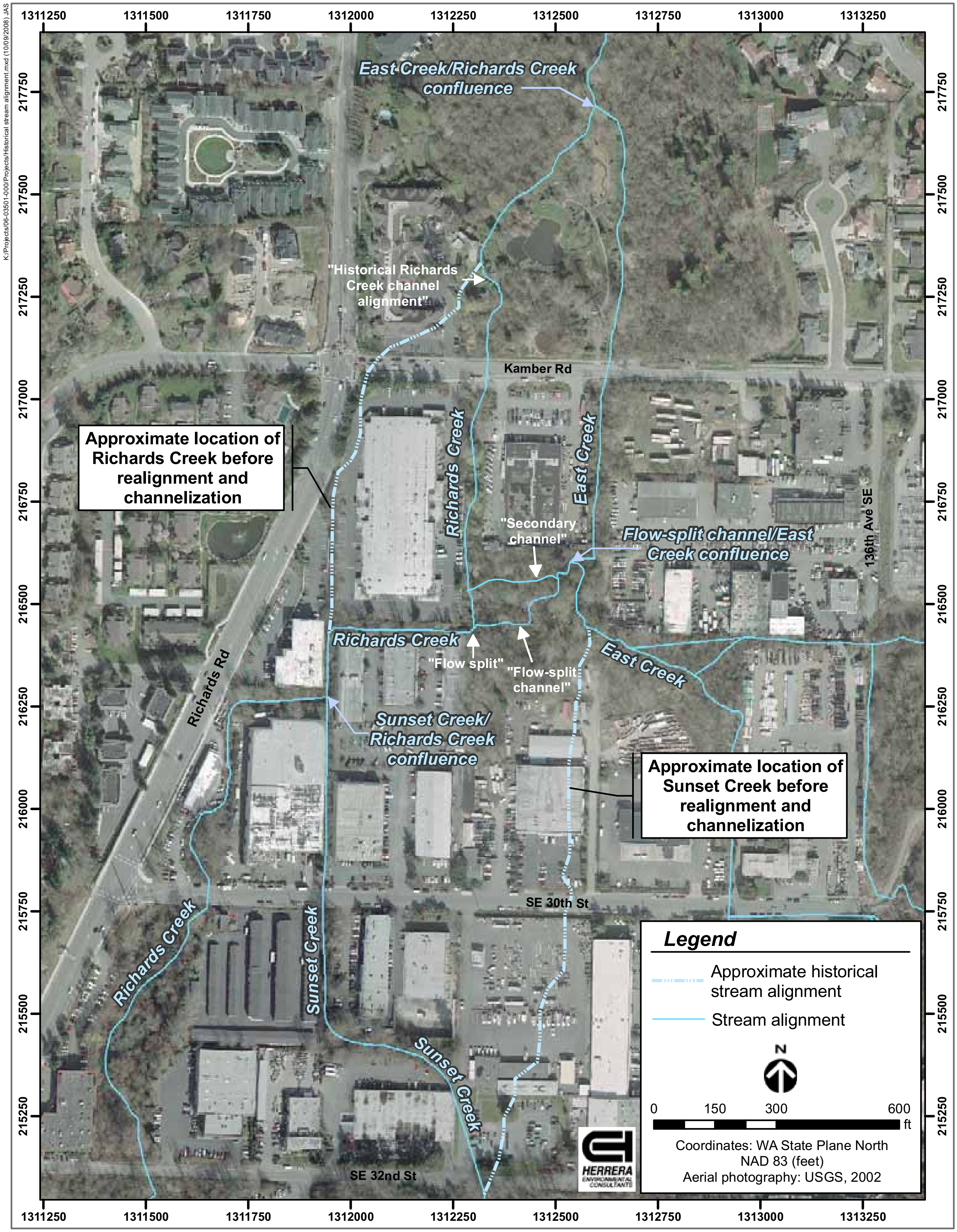

Figure 5. Approximate location of historical Sunset Creek and Richards Creek channel alignments within the flood control and sediment management plan project area.

Channel and Habitat Characteristics in the Project Area

The physical and habitat conditions within channels of the Richards Creek, Sunset Creek, and East Creek confluence area are largely controlled by the confined, channelized alignments and high rates of sediment delivery. In the limited area where the channel is unconfined, the mainstem Richards Creek alignment has recently relocated through an undeveloped forested wetland area, initiating significant responses in channel form (the flow-split channel shown in Figure 2). Habitat conditions are similarly varied, and a range of habitat types exist within the confined and more natural reaches of the project area.

The Sunset Creek and Richards Creek systems are inhabited by both resident and migratory salmonid species. Resident and adfluvial cutthroat trout are known to use the system. Large adfluvial cutthroat (in excess of 25 inches) have been observed spawning in the project area in recent years, and evidence of spring spawning was observed in April of 2008. Chinook salmon and steelhead are known to have used this system historically as well, with distribution extending in Sunset Creek up to and perhaps beyond (south of) SE 30th Street. These species have not been observed in the system in recent years, potentially due to passage barriers imposed by extensive beaver dam complexes in downstream reaches (Paulsen 2007).

Sunset Creek

At the upstream extent of the project area, between SE 30th Street and the confluence with Richards Creek, Sunset Creek is predominantly gravel-bedded and confined within rockery walls that were likely placed at the time the stream was channelized and the adjacent properties were developed. The channel is straight with a typical top width of approximately 12 feet. Ongoing bed aggradation has occurred in this reach due to decreased sediment transport capacity in comparison to upstream reaches. Over the last 30 years, bed elevations in this reach of Sunset Creek have risen from two to four feet. The straight, plane-bed channel pattern provides little hydraulic or habitat complexity during low flow conditions. Additionally, the wide, shallow channel presents a barrier to fish passage. High-flow channels in the confined floodplain above the rockery walls run adjacent to building foundations in numerous locations. Mixed-age deciduous vegetation in the narrow riparian corridor provides moderate cover but little potential for the recruitment of large woody debris. At the SE 30th Street culverts, ongoing sediment deposition requires annual dredging to maintain conveyance. Downwelling within the pool created by the deposited sediments creates favorable spawning habitat conditions immediately downstream where upwelling occurs.

Richards Creek

Downstream of the confluence with Sunset Creek, the Richards Creek channel widens briefly (to approximately 25 feet) as it flows north before again being confined within rockery walls that were likely installed when the stream was channelized. In the wider, upper portion of this reach the stream exhibits increased habitat complexity, and flow is split around small vegetated islands in plane-bed and braided, predominantly gravel-bedded, channels. Approximately 200 feet downstream of the confluence of Sunset Creek and Richards Creek, and almost 600 feet downstream of SE 30th Street, the channel makes an abrupt bend to the east (following property lines). Downstream of the bend, the bed of the confined Richards Creek channel has aggraded up to four feet over the last 30 years. The lower portion of this reach (downstream of the bend) is characterized by alternating pools and depositional bars. The substrate remains predominantly gravel-bedded but contains increased sand compared to upstream locations. The pools here may be used as rearing habitat by resident and juvenile migratory salmonids and larger resident trout.

The downstream end of this reach, at the flow split (see Figure 2), is where recent changes in channel alignment have altered the primary flow path of Richards Creek. Instead of flowing along the historical (post-channelization) Richards Creek alignment to the north from this location, Richards Creek now flows to the east through a wetland to a relatively new confluence with East Creek, along what has been termed the “flow-split channel” for this report. Nearly all of the flow in Richards Creek now crosses Kamber Road in the new East Creek culvert. This flow shift is an important factor for the City’s flood control goals at Kamber Road, as now all flows from Richards Creek, Sunset Creek, and East Creek cross Kamber Road at a single location.

Flow-Split Channel

The flow-split channel has exhibited a range of channel responses due to increased flows along this alignment over the past few years. Up until November of 2007, the channel in the upper portion of this reach provided a broad diversity of habitat types, including rearing pools, substrates suitable for spawning, and abundant vegetative cover. Locally recruited woody debris provided hydraulic complexity and grade control in a number of locations. During the winter of 2007/2008, likely during the storm event of December 3, 2007, high flows wiped out the grade control features and the incised channel conditions that have typified the downstream channel have propagated to the location of the flow split. As described below, the downstream end of the flow-split channel, where it approaches the confluence with East Creek, is characterized by extensive downcutting to the underlying clay substrate. Habitat suitability for spawning and rearing in this segment is poor.

Historical Richards Creek

From the time the channel network in the project area was channelized until just the last few years, the historical Richards Creek alignment conveyed the majority of Sunset Creek and Richards Creek discharges north from the location of the flow split, past Kamber Road, and on to the confluence with East Creek. Long-term bed aggradation within this channel likely promoted increasing proportions of flow to the flow-split channel and secondary channel in the adjacent wetland (see Figure 2), exacerbating deposition in the historical Richards Creek alignment. Today this channel is largely filled with sand and gravel deposits for a distance of approximately 200 feet immediately downstream of the flow split. The historical channel transmits effectively no base flow and limited discharges during peak flow events. Downstream of Kamber Road, the historical Richards Creek channel form remains and is inundated by backwater from downstream. This portion of the channel is also likely to transmit flow only during peak flow events.

East Creek

Upstream and downstream of the confluence with the flow-split channel, East Creek is characterized by extensive widening and downcutting into the underlying clay substrate. Due to the channel confinement and lack of hydraulic complexity, there is little deposition of sediment in the channel until it approaches Kamber Road, where the channel was modified in association with the culvert replacement in 2005. Upstream of Kamber Road, East Creek widens and includes grade control structures that provide the opportunity for hydraulic complexity when backwater conditions are not promoting widespread deposition. Downstream of Kamber Road the channel width remains similar to that of the box culvert width (29 feet) for the approximately 100-foot channel length that was modified in association with the culvert replacement. From this point to the confluence with the historical Richards Creek alignment, the active channel has little hydraulic complexity and is subject to backwater conditions from downstream flow obstructions such as beaver dams. During periods of high flow, overbank flows inundate the floodplain surface between East Creek and the historical Richards Creek alignment.

Constraints in Addressing Flooding and Sedimentation Problems

A number of site conditions impose constraints on alternatives that address flooding and sedimentation within the project area, including the following:

- ***Property ownership***: With the exception of a 20-foot wide easement running south from SE 30th Street along the Sunset Creek corridor, all property within the project area is privately held. Private ownership of the channel corridor and historical floodplain and alluvial fan areas constrain the geographic extent of potential flood and sediment control alternatives.

- ***Utilities at SE 30th Street***: Utilities within the SE 30th Street right of way at the Sunset Creek culvert location include: sewer, natural gas, water, underground power, and underground telephone. Realignment of the natural gas, water, underground power, and underground telephone is proposed at SE 30th Street as part of Phase I of the proposed work. Realignment of the sewer line is cost prohibitive and the alignment of this utility, including a manhole just to the east of the existing Sunset Creek culvert location, defines the east margin of culvert replacement alternatives.

- ***Sediment Delivery***: Sediment delivery to the project reach is expected to continue indefinitely. Even if continued treatment of upstream sediment sources reduces sediment delivery rates to natural levels, the confinement of channels in the project area, particularly Sunset Creek, inhibits the natural process of deposition and channel relocation that is typical of alluvial fan settings. As a result, sediment delivery to the project area that is in excess of the channel's capacity to transport sediment will continue to result in channel bed aggradation and contribute to flooding.

- ***Aquatic Habitat and Species Considerations***: Two aquatic species listed under the Endangered Species Act (i.e., Puget Sound Chinook salmon [*Oncorhynchus tshawytscha*] and Puget Sound steelhead [*O. mykiss*]), are known to occur within the project area. In addition, coho salmon (*O. kisutch*), currently listed as a species of concern, may also occur within the project area. Although the project area does not contain designated critical habitat for any listed species, the design and implementation of project alternatives to reduce flooding and manage sedimentation must also provide improved aquatic habitat conditions.

- ***Funding Availability***: The City of Bellevue is committed to addressing flooding and sedimentation in the project area in a manner that is sustainable and provides enhanced habitat conditions for aquatic and riparian species. The most sustainable approach to restoring natural processes and habitat conditions within the project area would be to purchase those private properties that are affected by flooding and that constrain the channel network, and return these properties to a more natural condition. At the present time, the financial resources available to the City of Bellevue do not support this property buy-out approach. Flood and sediment control alternatives considered herein fall within the scale of a project that the City may feasibly implement.

Flood Control and Sediment Management Project Objectives

The objectives of flood control and sediment management alternatives within the project area are the following:

- Reduce impacts of flooding at SE 30th Street.

- Reduce impacts of sediment removal activities in the active channel of Sunset Creek at SE 30th Street.

- Improve aquatic and riparian habitat conditions within Sunset Creek by increasing channel complexity, removing invasive species, and revegetating with native plants.

- Reduce impacts of flooding within the project area downstream of SE 30th Street.
- Reduce future potential for flooding at Kamber Road.
- Provide improved aquatic and riparian habitat conditions within the project area where feasible.
- Reduce sediment delivery to the project area.

Flood Control and Sediment Management Alternatives and Guidelines

Recommended Alternatives

The recommended alternatives described below were developed to provide improved conditions relating to flooding and sediment control within the project area. The alternatives were developed under four implementation phases. A brief description of each phase and its associated alternative or alternatives follows:

- ***Phase I (Alternative 1): Culvert replacement on Sunset Creek at SE 30th Street and channel modifications approximately 110 feet upstream and 100 feet downstream to provide a stable streambed transition to the culvert inlet and outlet.***
- ***Phase II (Alternative 2): Approximately 400 feet of channel modifications from the downstream end of Phase I to the confluence of Sunset Creek and Richards Creek.***
- ***Phase III (Alternative 3): Implementation of grade control structures and channel modifications within the flow-split channel and East Creek.***
- ***Phase III (Alternative 4): Continued maintenance of beaver dams downstream of Kamber Road to minimize backwater influence and sediment accumulation at Kamber Road.***
- ***Phase IV: Sediment source control and storage recommendations in the Sunset Creek watershed upstream of the project area.***

At the date of the draft publication of this Flood Control and Sediment Management Plan, Phases I and II are funded for design, permitting and construction. Phase I is scheduled for construction in the summer of 2009. Phase II is scheduled for construction in the summer of 2010. Phase III (Alternative 3) has been identified as a potential future capital improvement project by the City of Bellevue, pending availability of funds for design and construction and potentially for property acquisition as well. A more detailed description of each alternative is provided below.

Phase I (Alternative 1)

The primary objective of Alternative 1 is to optimize the flood conveyance capacity of Sunset Creek at SE 30th Street by replacing the existing twin 42-inch diameter culverts. Evaluation of this alternative with an understanding of the high rates of sediment delivery to the project area identified that simply replacing the culverts with a larger hydraulic opening would not solve the persistent aggradation that has occurred within the Sunset Creek channel over at least the last 30 years. Designing a channel that could transport sediment delivered to the Sunset Creek crossing of SE 30th Street to locations downstream was ruled out due to the decreasing gradient of channels downstream and the limited opportunities for large scale aggradation within the project area that would not exacerbate flooding conditions.

Based on these considerations it was determined that a replacement culvert incorporating a sediment retention structure at the downstream end and simulating natural stream conditions at the upstream end would be the best mechanism, given the site conditions and constraints, to provide improved flood conveyance, fish passage to the upstream channel, and sediment control in a manner that would limit disturbance to the active channel. Culvert geometry was determined through an iterative analysis of site constraints (i.e., utility alignments and road surface elevations), flow conveyance, fish passage, sediment transport continuity upstream of the sediment retention structure, and depositional conditions within the sediment retention structure. Based on the resulting culvert dimensions needed to address these constraints, it was determined that channel modifications upstream and downstream of the culvert are required to match the channel bed surface with the culvert inlet and outlet invert elevations (Figure 6).

Background documentation used during the design process for this alternative included a geotechnical evaluation of the culvert replacement site (Appendix A) and a structural and phasing analysis of Sunset Creek culvert replacement options (Appendix B). Design plans complete to the 60 percent level are presented in Appendix C.

Channel Modifications

Upstream of SE 30th Street the average channel gradient of Sunset Creek is approximately 2.5 percent. Under the existing conditions, however, the combination of sediment aggradation extending upstream of SE 30th Street and sediment removal activities performed to maintain flow conveyance near the upstream entrance to these culverts has caused steepening of a short section of the channel just upstream of the road. The channel gradient averages 9 percent for a distance of 30 feet upstream of the twin culverts, with a gradient of up to 18 percent within the 10 feet upstream of the culvert inlets. Based on the existing channel gradient and the inlet invert of the replacement culvert, the channel bed needs to be gradually lowered for a greater distance approaching the new culvert. The design grade of the modified channel is 4.0 percent for a distance of 120 feet upstream. Eight grade-control structures constructed using large woody debris and river boulders are proposed to provide a stable channel. With the grade-control structures, the gradient of the modified channel between grade-control structures will not exceed 2.5 percent and vertical drops are designed not to exceed 4 inches in height for fish passage. Reshaped channel banks will be biostabilized using photodegradable erosion control fabric and thoroughly planted with site-appropriate native species.

Downstream of the replacement culvert, the channel bed and banks will be modified for a distance of 100 feet to create a stable transition of the existing streambed to the replacement culvert outlet. Modifications will include sediment removal from within the channel and installation of two grade-control structures, one composed of large woody debris and one of boulders. In addition to providing grade control, the wood structure will back water into the sedimentation structure for purposes of fish passage and sediment deposition within the culvert structure. Similar to upstream of SE 30th Street, reshaped channel banks will be biostabilized using photodegradable erosion control fabric and thoroughly planted with site-appropriate native species.

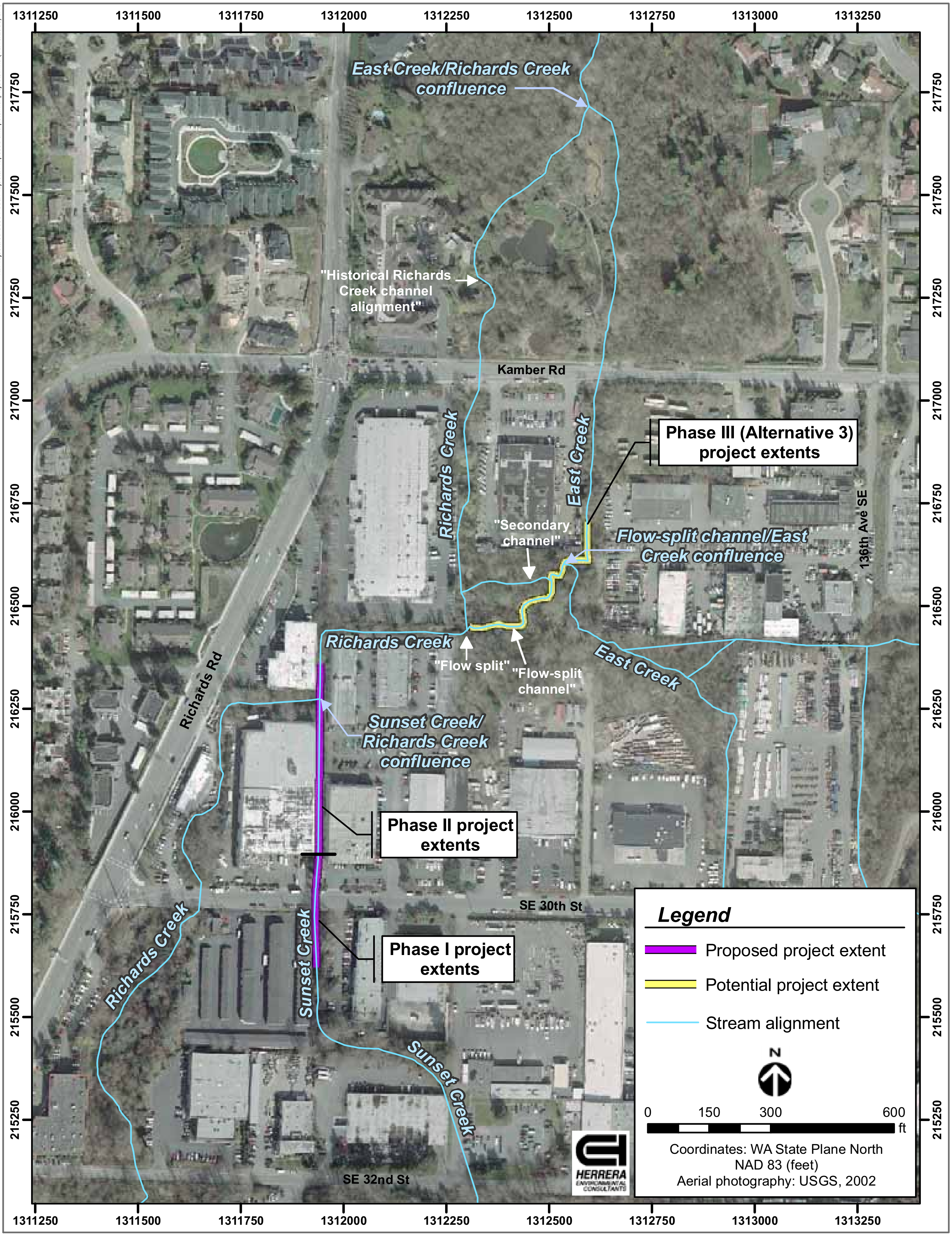

Figure 6. Geographic extents of proposed and potential projects associated with Phase I, Phase II and Phase III alternatives.

Sedimentation Structure

The sediment storage capacity of the sediment retention (sedimentation) structure portion of the replacement culvert is designed to accommodate approximately 50 cubic yards of sediment. This volume was determined primarily through a consideration of estimated historical, existing, and potential future sediment delivery and transport rates, combined with practical sediment removal frequency for City of Bellevue maintenance crews. Additional secondary considerations included site constraints, cost implications and environmental impacts associated with operations and maintenance activities.

Theoretically, if a reach of channel is depositional, there is more sediment entering the reach than there is being transported downstream out of it, and the rate of sediment delivery exceeds the channel's sediment transport capacity. The rate of aggradation, or sediment deposition, within the Sunset Creek and Richards Creek channels between SE 30th Street and the flow split is estimated to average 40 cubic yards of sediment annually over the last 30-year period (Herrera 2008). This indicates that, over that period, the rate of sediment delivery has exceeded the sediment transport capacity of the channel by an average of 40 cubic yards annually. Due to treatment measures implemented in the upper watershed during the 1980s and 1990s (discussed in greater detail in the Upper Watershed Sediment Source Control and Storage Recommendations section) and based on volumes of sediment removed during maintenance activities over the last five years, the current rate of sediment delivery to the channel at SE 30th Street is estimated to be less than 40 cubic yards on an average annual basis. It is likely closer to an average of 20 to 25 cubic yards of sediment annually.

Sediment delivery rates are highly variable and episodic by nature. To accommodate for annual variability in sediment delivery, the capacity of the sedimentation structure is designed to accommodate delivery rates up to two times the estimated current rate. Given this design volume, sediment removal activities are forecast to be required every two years on average. Protocols for structure maintenance based on actual deposition rates and channel monitoring are discussed later in this report.

Phase II (Alternative 2)

The primary objective of Alternative 2 is to optimize the flood conveyance capacity of Sunset Creek from the downstream project extents of Alternative 1 to the confluence of Sunset Creek and Richards Creek through channel modifications and construction of a flood containment berm (Figure 6).

Channel Modifications

Alternative 2 channel modifications include removal of sediment that has accumulated within the Sunset Creek channel over the last 30-year period, removal of riprap on the channel banks, installation of large woody debris and river boulder grade control structures, biostabilization and replanting of stream banks and the riparian corridor, and modification of the channel cross-sectional area to a two-stage channel (incorporating a low flow channel and higher flow terraces). Aggradation of the channel bed promoted lateral movement of the channel alignment through this reach, such that in some locations, the channel presently abuts the concrete footings of buildings at the channel margin. In these locations the channel will be relocated to a more central position within the channel corridor between buildings.

Flood Containment Berm

Where the Sunset Creek channel is not confined within adjacent buildings, a flood containment berm is proposed to contain the 100-year recurrence interval flood within the channel corridor. The proposed flood berm is approximately 150 feet in length and rises to an average height of 12 inches above the parking lot located east of the channel corridor. Hydraulic modeling of flood flows in the modified channel cross-section was used to design the height of this berm (Appendix D).

Phase III

Phase III is inclusive of channel modifications and improvements downstream of the flow split along the flow-split channel and East Creek channel alignments. Phase III is separated into two distinct alternatives.

Alternative 3

Alternative 3 includes grade-control structures and channel modifications within the flow-split and East Creek channels between the flow split and Kamber Road (Figure 6). Within this reach, ongoing channel incision is degrading the channel, producing sediment through channel enlargement, reducing instream sediment storage, physically destroying aquatic habitat, and decreasing the frequency of overbank flooding into the adjacent wetland. Two grade control structures comprised of large woody debris and boulders would be constructed in the flow-split channel upstream of the confluence with East Creek, and six similar structures would be constructed downstream of the confluence. These structures would reduce significant changes in channel gradient caused by channel incision, increase instream sediment storage, provide increased hydraulic diversity, and increase the frequency that flood flows access the adjacent wetland floodplain. Channel modifications would likely include biostabilization of banks where they have been over-steepened by channel incision, modification of the channel cross-sectional area to a two-stage channel, and replanting of stream banks impacted during construction activities.

Alternative 4

Alternative 4 includes maintenance of beaver dams downstream of Kamber Road, in the wetland complex downstream of the confluence of East Creek and the historical Richards Creek channel (Figure 6). Beaver dams in this area can impose significant backwater conditions extending upstream in East Creek to the Kamber Road crossing, exacerbating conditions that promote significant sedimentation and decreased flow conveyance. Beaver dam maintenance activities conducted during the course of this investigation have shown to be effective at maintaining the design bed grade of the East Creek crossing at Kamber Road, facilitating both flow conveyance and sediment transport at this location.

Phase IV

Basin reconnaissance completed during the preparation of the *Sunset Creek Geomorphic Assessment and Sedimentation Analysis* (Herrera 2008) provided the basis for recommendations for addressing ongoing sediment sources and providing increased sediment storage capacity in the upper Sunset Creek watershed. The recommendations are presented in detail in the section entitled Upper Watershed Sediment Source Control and Storage Recommendations, found later in this report.

Design Guidelines and Criteria

Culvert and open channel design guidelines that were utilized for the development of Phase I (Alternative 1) and Phase II (Alternative 2) of the Flood Control and Sediment Management Plan are detailed below.

Open Channel Requirements

Sunset Creek channel modification designs for Phase I (Alternative 1) and Phase II (Alternative 2) were guided by City of Bellevue Surface Water Engineering Standards, Section D4-04.4 (Bellevue 1998). The conveyance requirements set forth therein state that the channel shall be designed to accommodate the peak runoff rate from a 100-year, 24-hour storm with a minimum of one-half (0.5) foot of freeboard below the top of the bank.

Culvert Requirements

Design of the replacement Sunset Creek culvert for Phase I (Alternative 1) was guided by flow conveyance requirements set forth in the City of Bellevue Surface Water Engineering Standards, Section D4-04.6 (Bellevue 1998) and by the Washington Department of Fish and Wildlife's (WDFW) Culvert Design Guidelines (2003).

City of Bellevue Surface Water Engineering Standards

City of Bellevue Surface Water Engineering Standards state that the hydraulic capacity of the culvert shall be determined by analyzing inlet, outlet, and barrel controls. Additional culvert design requirements state that the culvert shall:

- Span the bank full width of the channel

- Be lined with material that is similar to the adjacent channel bed
- Have a similar slope to the existing channel
- Have a sufficient capacity and one-foot freeboard to pass the 100-year, 24-hour design storm.

Requirements in the City of Bellevue Surface Water Engineering Standards related to the culvert geometry are discussed in the section below. Culvert requirements related to flow conveyance are evaluated in the section of this report that presents results of the hydraulic analysis.

WDFW Culvert Design Guidelines

The culvert design process was informed by the guidelines set forth for "stream simulation" culverts (WDFW 2003). This method was employed to promote sediment transport continuity from the upstream channel to the sedimentation trap in the downstream portion of the replacement culvert, and to promote fish passage in both directions through the culvert. Slope ratio, culvert width, culvert bed configuration and design, and bed-retention sill design guidelines were considered during the design process. The 60 percent design details for each of these design criteria for the Phase I (Alternative 1) culvert replacement are evaluated in the Culvert Replacement and Channel Modification Design section later in this report.

Additionally, the replacement culvert is designed to meet the requirements of the Washington State Hydraulic Code Rules for Water Crossing Structures (WAC 220-110-070).

Analysis of Flood Control and Sediment Management Alternatives

Hydraulic and sediment transport analyses were completed to evaluate the expected flow and sedimentation conditions for each of the alternatives described in the previous section. The following sections describe the hydraulic and sediment transport analysis methods and assumptions.

Methods of Hydraulic Analysis

A hydraulic analysis of the project area was performed to evaluate design options for the proposed replacement culvert and channel modifications. The hydraulic model includes the channel networks of Sunset Creek, Richards Creek, and East Creek from SE 30th Street to the confluence of the historic Richards Creek channel and East Creek downstream of Kamber Road. The specific objectives of the hydraulic analysis included the following:

- Estimate and evaluate flow depths, velocities, and shear stresses under existing and potential alternative design scenarios to address flooding and sedimentation in the project area.
- Support design and sizing calculations for the proposed replacement culvert and instream structures
- Compare channel responses under existing and potential alternative design scenarios.

The hydraulic analysis was performed using version 4.0.0 Beta of the Hydrologic Engineering Center - River Analysis System (HEC-RAS) model. HEC-RAS is a one-dimensional, stepped, backwater numerical software model developed by the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC) for river analysis and simulation. This model is commonly used as a flood hazard mapping tool by the Federal Emergency Management Agency (FEMA) for the development of Flood Insurance Rate Maps (FIRMs), as well as for other river and stream engineering applications. HEC-RAS can simulate steady and unsteady, gradually varied flow. The computational procedure of the one-dimensional HEC-RAS model is based on the solution of the energy equation and energy losses between channel/floodplain cross-sections. The model calculates the water surface elevation in a step-wise manner from one cross section to the next (in the upstream direction) based on the hydraulic roughness of the channel and floodplain and on cross sectional area of flow.

Model Geometry

The Sunset Creek model geometry incorporates the channel network of Sunset Creek, extending from Interstate 90 (I-90) to the confluence with Richards Creek, located downstream of SE 30th Street, continues downstream to the flow split with the historical Richards Creek channel and through the flow-split channel, continues past the confluence with East Creek and the Kamber Road crossing, and then downstream past the confluence of East Creek with the historical Richards Creek channel. Figure 7 outlines the channel network simulated within the HEC-RAS model. Table 2 describes the stream reach segments as they were developed within the Sunset Creek model.

Table 2. Sunset Creek stream reach segments.

HEC-RAS River ID	HEC-RAS Reach ID	Downstream River Station (ft)	Upstream River Station (ft)	Corresponding Flow Input Reach	Description
Sunset Creek	SE 30th	48.9477	3272.859	S, R5, R4b, R3b, R2b	Incorporates the Sunset Creek channel from I-90 to the confluence with Richards Creek and includes Richards Creek to the flow split, the flow-split channel, and the East Creek channel from the confluence of the flow-split channel and East Creek down to the confluence with the historical Richards Creek channel
Richards Creek	Historical	240.4131	1507.208	R3a, R2a	Historical Richards Creek Channel from flow split to confluence with East Creek downstream of Kamber Road
Richards Creek	Lower	26.62222	85.48712	R1	Richards Creek from confluence with East Creek to Bannerwood Park

Topographic and cross-section survey data used as input for the Sunset Creek hydraulic model of existing conditions geometry were provided by the City of Bellevue. Details of the channel cross-section and topographic data, the development of Manning's hydraulic roughness values for each cross-section, and location and labeling of cross sections in each of the modeled stream reaches is provided in Appendix C.

Hydrologic Data

Stream discharges used in the hydraulic analysis include the 1.01-, 2-, 10-, 25-, and 100-year recurrence interval flows from the Richards Creek Basin Plan (Entranco 1999). Flows from the Richards Creek Basin Plan were generated using the Hydrologic Simulation Program – FORTRAN (HSPF) model to simulate rainfall runoff processes for 28 subbasins within the Richards Creek basin. Flows from the subbasins that contribute to the channel network modeled in the hydraulic analysis for the basin plan were selected as hydrologic inputs to the Sunset Creek HEC-RAS model (Table 3).

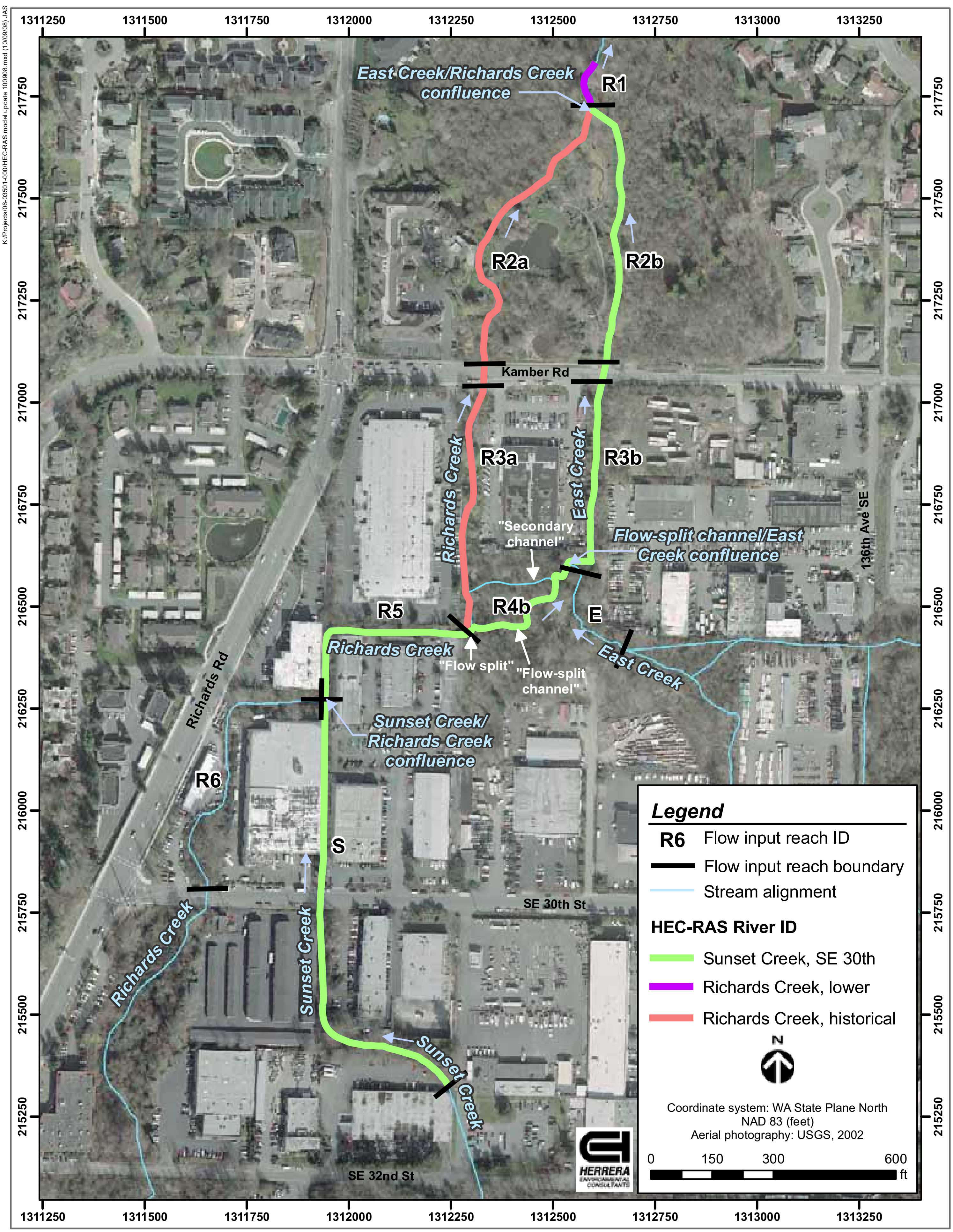

Figure 7. Sunset Creek HEC-RAS model geometry and flow input reaches.

Table 3. 1.01-year, 2-year, 10-year, 25-year, and 100-year recurrence interval flows and used in hydraulic modeling.

HEC-RAS Profile	River (Stream)	Reach	River Station (RS)	Flows (cfs)				
				1.01-year	2-year	10-year	25-year	100-year
1	Richards Creek	Historical	1507.208	15.05	22.65	35.4	44.55	61.8
2	Richards Creek	Lower	85.48712	120.25	181	297	376	525
3	Sunset Creek	SE 30th	3272.859	52.48	79	126	157	212
4	Sunset Creek	SE 30th	2098.229	100.32	151	236	297	412
5	Sunset Creek	SE 30th	1535.154	85.27	128.35	200.6	252.45	350.2
6	Sunset Creek	SE 30th	1177.949	100.55	151.35	236.6	297.45	413.2

cfs – cubic feet per second

Methods of Sediment Transport Analysis

Sediment transport conditions were evaluated to provide input to the replacement culvert and channel modification design. Specific objectives of the sediment transport analysis included:

- Determine the characteristics and volume of sediment expected to deposit in the replacement culvert sedimentation structure under Phase I (Alternative 1).
- Evaluate the continuity of sediment transport within channels to be modified for Phase I (Alternative 1) and Phase II (Alternative 2) improvements.

The following sections describe the methods and assumptions used to complete the sediment transport analysis for these objectives. A discussion of uncertainty associated with sediment transport calculations is also provided.

Depositional Characteristics of Sedimentation Trap

The intent of the sedimentation trap within the replacement culvert at SE 30th Street is to capture the sediment that exceeds the transport capacity of channels downstream of SE 30th Street and results in channel aggradation and increased flooding hazards. Between SE 30th Street and the Richards Creek flow split approximately 1,000 feet downstream, the rate of aggradation has averaged 40 cubic yards annually within the Sunset Creek and Richards Creek channels. The grain-size distribution of surface and subsurface sediment within the project area was evaluated using surface pebble counts and subsurface bulk sediment sampling (Herrera 2008). Figure 8 shows the sediment sampling locations. Grain-size distributions from select streambed substrate samples are provided in Appendix E.

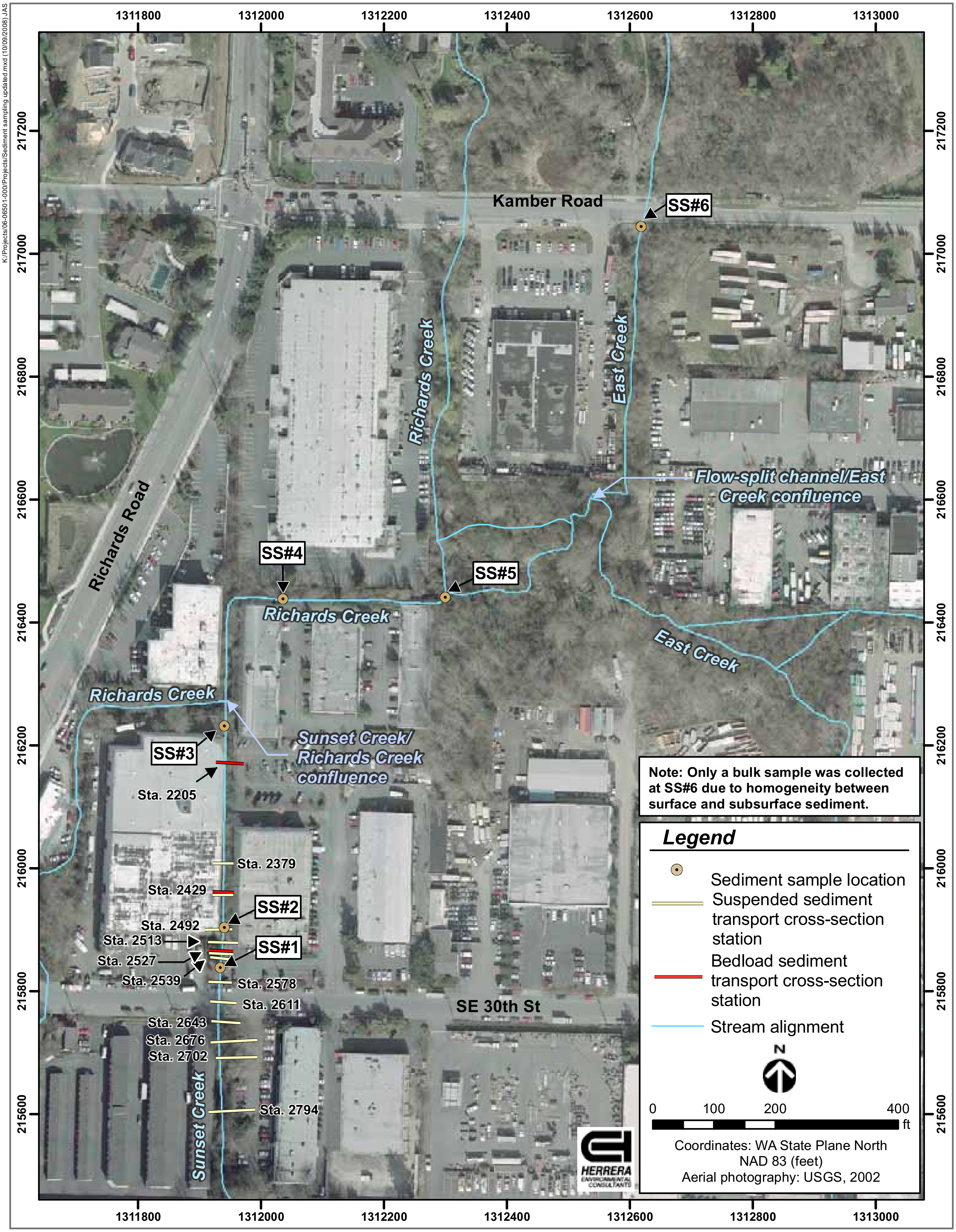

Figure 8. Surface and subsurface substrate sampling and sediment transport calculation locations.

The character of streambed sediment within Sunset Creek and Richards Creek is primarily gravel, with sand (particles less than 2 millimeters [mm] mean diameter) composing between 22 and 40 percent of the substrate by mass (Herrera 2008). Cobbles (particles with a mean diameter greater than 64 mm but not larger than 256 mm) compose no more than 5 percent of the streambeds. This distribution of sediment sizes also characterizes the sediment that is removed annually from the Sunset Creek channel at SE 30th Street by a City of Bellevue maintenance crew to maintain the conveyance capacity of the existing culvert inlets and outlets.

The geometry of the proposed sedimentation structure within the replacement culvert at SE 30th Street is very similar to the geometry of the existing channel that has developed. Following long-term aggradation of the channel bed, the aggraded channel now has created consistent backwater condition at the downstream end of the existing twin culverts. The ongoing maintenance activities provide a recurrent “trap” just downstream of SE 30th Street where sediments accumulate during winter storms. The challenge associated with design of the proposed sedimentation structure is that the hydraulic characteristics that promote flow conveyance (and also fish passage) including increased culvert widths and a backwater grade control structure at the downstream end of the replacement culvert, may also lead to depositional characteristics that promote the deposition of sand.

In addition to the portion of bedload sediment that is composed of sand (22 to 40 percent), sand and other fine-grained sediments (silt and clay) have been observed in suspension during storm events. An analysis of the expected mobility of sand-sized (and smaller) particles in suspension was completed to determine what size of sand-sized particles may also be expected to accumulate in the new sedimentation structure.

Suspended Sediment Transport of Fine-Grained Sediment

The basic premise for evaluating the suspended sediment transport of fine-grained sediments is based on the assumption that a particle will stay in suspension as long as the shear velocity (u_*) associated with the hydraulic characteristics of the flow conditions exceeds the settling velocity (v_s) of the particle.

Particle settling velocity (v_s) was calculated for sand- and silt-sized particles according to Stokes’ Law:

$$v_s = \frac{RgD^2}{18\upsilon}$$

Where v_s = Settling velocity, m/sec
R = $(\rho_s - \rho_w)/\rho_w$
ρ_s = Particle density, 2600 kg/m^3
ρ_w = Fluid density, 1000 kg/m^3
g = Gravitational acceleration, 9.81 m/sec^2
D = Particle diameter, m
υ = Kinematic viscosity, 1.306 x 10^{-6} @ 10° C.

The shear velocity (u_*) in Sunset Creek through the proposed Phase I (Alternative 1) replacement culvert and Phase I and Phase II modified channels was calculated using output from the hydraulic model according to the following equation:

$$u_* = \sqrt{\frac{\tau_b}{\rho_w}}$$

Where $\tau_b = \rho_w g R_H S$, basal channel shear stress
R_H = Hydraulic radius, m
S = Energy gradient, m/m.

Particle suspension through the replacement culvert and sedimentation structure was evaluated for the 1.01-, 2-, and 10-year recurrence interval flows at select cross-section stations in the project area. Particle suspension was evaluated using the estimates of shear velocity (u_*) and settling velocity (v_s) through the relationship presented by Niño (1995) and similar to those of van Rijn (1984).

$$u_*/v_s = \begin{cases} 22.0 R_p^{-4/3} & R_p \le 11 \\ 4.5 R_p^{-2/3} & 11 \le R_p \le 32 \\ 0.45 & R_p \ge 32 \end{cases}$$

Where:

$$R_p = \sqrt{RgD^3}/\upsilon$$

And:

$$R = (\rho_s - \rho_w)/\rho_w$$

In combination with the hydraulic modeling results, the results of this analysis help predict the range of depositional conditions that may occur within the replacement culvert and have also been used to develop the adaptive management approach to operations and maintenance of the sedimentation structure.

Bedload Sediment Transport Continuity within Modified Channels

A sediment transport analysis of existing and modified channel geometries, at different locations within the channel network, was completed to evaluate and inform the design of channel modifications and predict future patterns of sediment transport and deposition. This analysis was performed using the Bedload Assessment of Gravel–Bedded Streams (BAGS) software package developed for the U.S. Forest Service Stream Systems Technology Center. This package produces estimates of sediment transport rates in gravel-bedded rivers using grain size, flow, and channel geometry information.

Five different transport formulas may be used in BAGS to calculate transport rates, depending on the available data. For this analysis, two relations were used, and are referred to by their respective literature citations: Parker (1990) and Wilcock and Crowe (2003). Each formula expresses transport rate as a function of shear stress, which is a function of flow depth and channel slope, as developed in different empirical settings.

Sediment transport is a highly nonlinear process, meaning that small changes in input variables can produce large variation in transport rates. In the absence of calibration based on field measurement of bedload transport, there is considerable uncertainty in any particular sediment transport calculation. For this reason, the transport rates calculated in this analysis were used to describe relative transport capacities under existing conditions, and following implementation of Phase 1 (Alternative 1) and Phase II (Alternative 2) improvements at different locations within the channel network of the project area.

Estimates of transport rates were made at three cross-section locations along Sunset Creek between SE 30th Street and the confluence of Sunset Creek and Richards Creek, approximately 475 feet downstream (Figure 8). Discharge inputs at the modeled cross-section stations include the 1.01-, 2-, and 10-year recurrence interval flows (see Table 2), and were based on hydrologic modeling results presented in the Richards Creek Basin Plan (Entranco 1999). Channel cross-sectional data available from survey efforts completed for this project in 2006 and 2007 were used to describe existing channel geometry. Phase I (Alternative 1) and Phase II (Alternative 2) channel geometries were based on the proposed channel geometries from the HEC-RAS model.

Grain-size distributions of surface and subsurface sediment from these locations were used as input to the sediment transport formulae for existing conditions (Herrera 2008). Because the new sedimentation structure is intended to capture a large portion of the coarse-grained sediment delivered to the channel downstream of SE 30th Street, the grain-size distributions of bedload sediment under the proposed conditions were modified by truncating the existing grain-size distributions above 32 mm and recalculating the percentages composed of the smaller-grained fractions. This modified grain-size is based on the observation that the existing “trap” that has formed as a result of channel aggradation downstream of the existing culverts has limited the downstream transport of particles greater than 32 mm in diameter. The grain-size distributions for the existing and proposed channels and additional inputs to the sediment transport model, including the channel gradients, channel cross-sectional topography, and overbank flow-roughness parameters are included in Appendix E.

Results of Hydraulic and Sediment Transport Analysis

The following sections provide the results of the hydraulic and sediment transport analyses.

Hydraulic Analysis Results

The water surface elevations, water surface gradients, channel velocities, and channel shear stress values predicted by the HEC-RAS model for the existing and proposed channel geometries are presented in Appendix D. Figures 9, 10, and 11 show the 1.01-, 2-, 10-, 25-, and 100-year recurrence interval flow water surface profiles from upstream of SE 30th Street to the confluence of Sunset Creek and Richards Creek for the existing condition, Phase I (Alternative 1), and Phase II (Alternative 2) model geometries, respectively. Figure 12 illustrates the difference in the 2-year and 100-year recurrence interval flow profiles between the existing conditions, Phase I (Alternative 1), and Phase II (Alternative 2) model geometries over the same channel area. Figures 13 and 14 show the 1.01-, 2-, 10-, 25-, and 100-year recurrence interval flow water surface profiles from the Richards Creek flow split to the confluence of the historical Richards Creek channel and East Creek for the existing condition and Phase III (Alternative 3) model geometries.

Model Accuracy and Precision

Model Accuracy

The accuracy of the hydraulic model was evaluated using measurements of stream water surface elevation (stage) under the existing conditions and as observed by City staff during flooding, and comparing these data and observations to output of the existing conditions hydraulic model geometry. Discharge and stage measurements were completed on Sunset Creek downstream of SE 30th Street, on Richards Creek downstream of the Sunset Creek and Richards Creek confluence, and on East Creek downstream of Kamber Road. Historical observations of flooding and photos taken during the December 3, 2007 storm event at SE 30th Street and Kamber Road were provided by the City of Bellevue and were used to evaluate the model representation of high flow events. Details of the evaluation of the model accuracy are provided in Appendix D.

Channel geometry of two of the modeled reach segments was altered significantly since the date of the latest survey. At the first location, between the Richards Creek flow split and the confluence of the flow-split channel with East Creek, a series of small woody debris accumulations that created bed grade controls within the flow-split channel were washed out during the winter of 2007/2008, likely during the high flow event of December 3, 2007. Downstream of this location, where Kamber Road crosses East Creek, maintenance removal of sediment in September 2007, and subsequent erosional processes following lowering of backwater conditions resulting from removal of downstream beaver dams, have lowered the local stream bed elevations. Due to these changes in bed geometry, hydraulic modeling results at these locations are no longer representative of current conditions.

Model Precision

The HEC-RAS model results must be interpreted with an understanding of the limits of the model precision. The precision is largely influenced by the water surface tolerance, which was set to 0.01 feet (this is the default and recommended setting). The model uses this tolerance to compare the assumed water surface elevation against the computed water surface elevation in order to converge to a numerical solution. Differences between existing and proposed conditions that are less than or equal to 0.01 feet are not considered numerically significant and may be only an artifact of the model's convergence calculations.

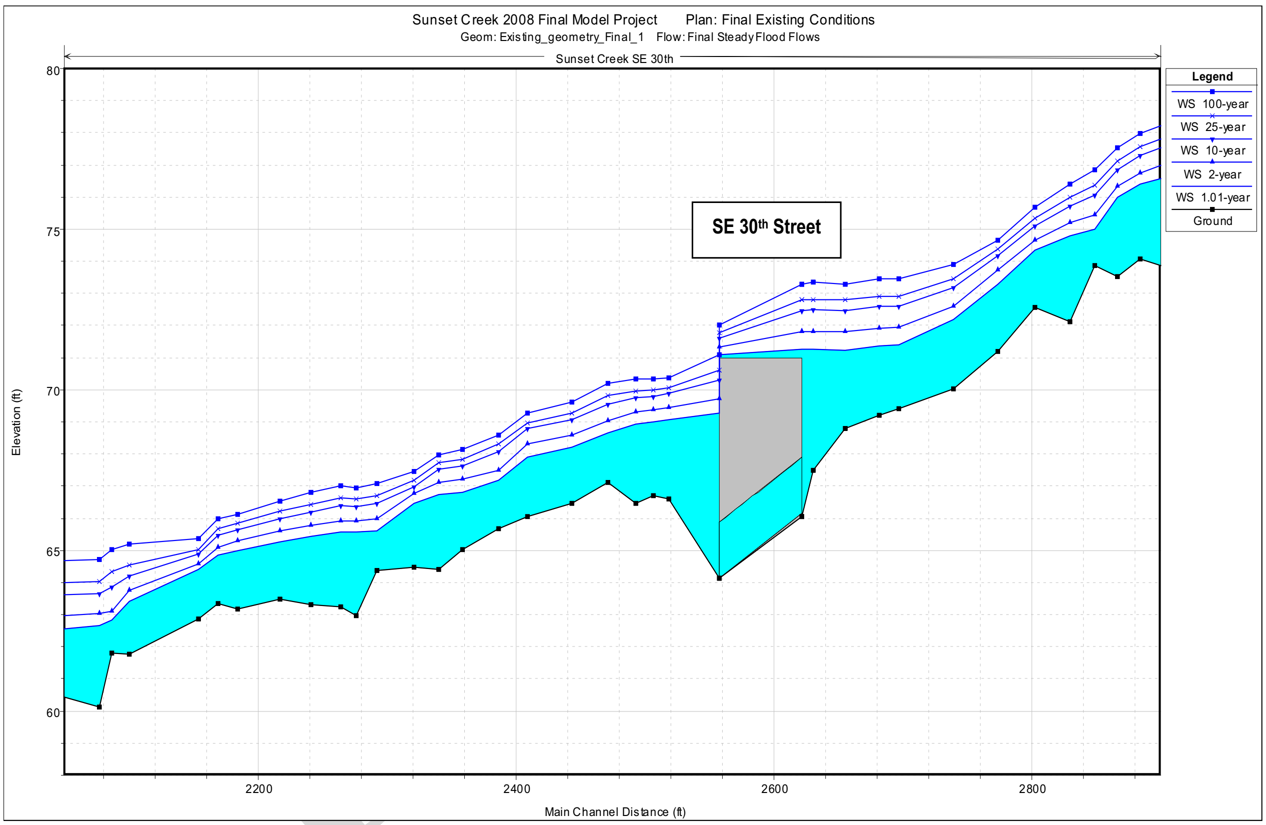

Figure 9. Profile plot of HEC-RAS model output for the Existing Conditions model geometry for the 1.01-, 2-, 10-, 25-, and 100-year recurrence interval flows from upstream of SE 30th Street to the Sunset Creek and Richards Creek confluence.

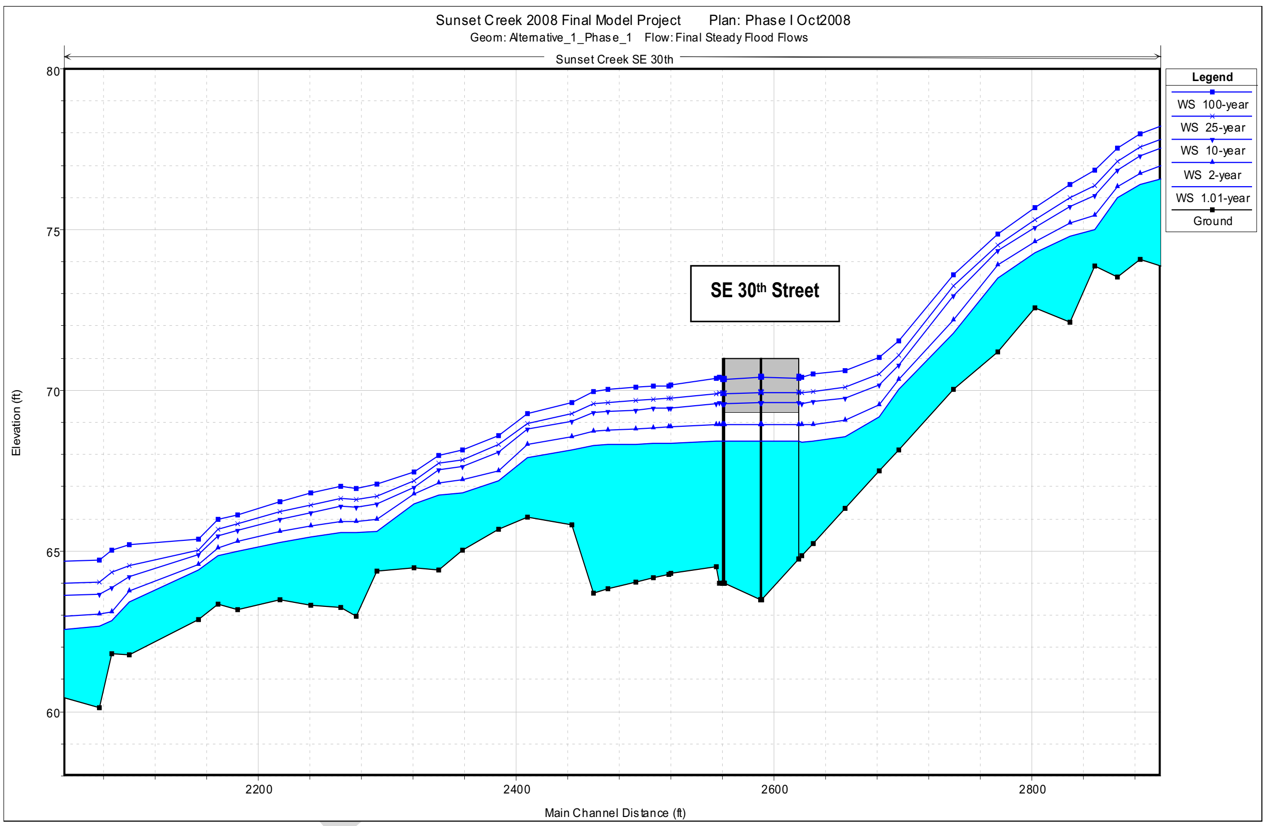

Figure 10. Profile plot of HEC-RAS model output for the Phase I (Alternative 1) model geometry for the 1.01-, 2-, 10-, 25-, and 100-year recurrence interval flows from upstream of SE 30th Street to the Sunset Creek and Richards Creek confluence.

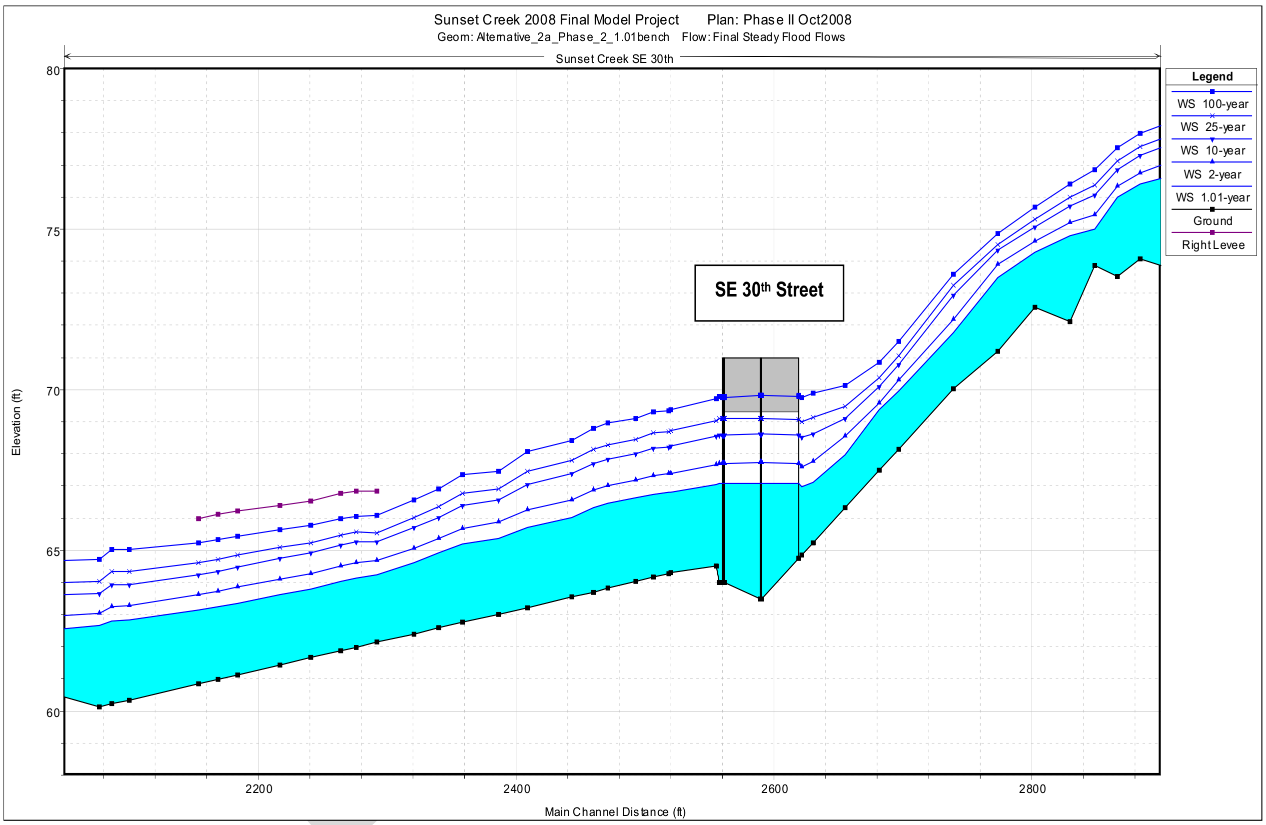

Figure 11. Profile plot of HEC-RAS model output for the Phase II (Alternative 2) model geometry for the 1.01-, 2-, 10-, 25-, and 100-year recurrence interval flows from upstream of SE 30th Street to the Sunset Creek and Richards Creek confluence.

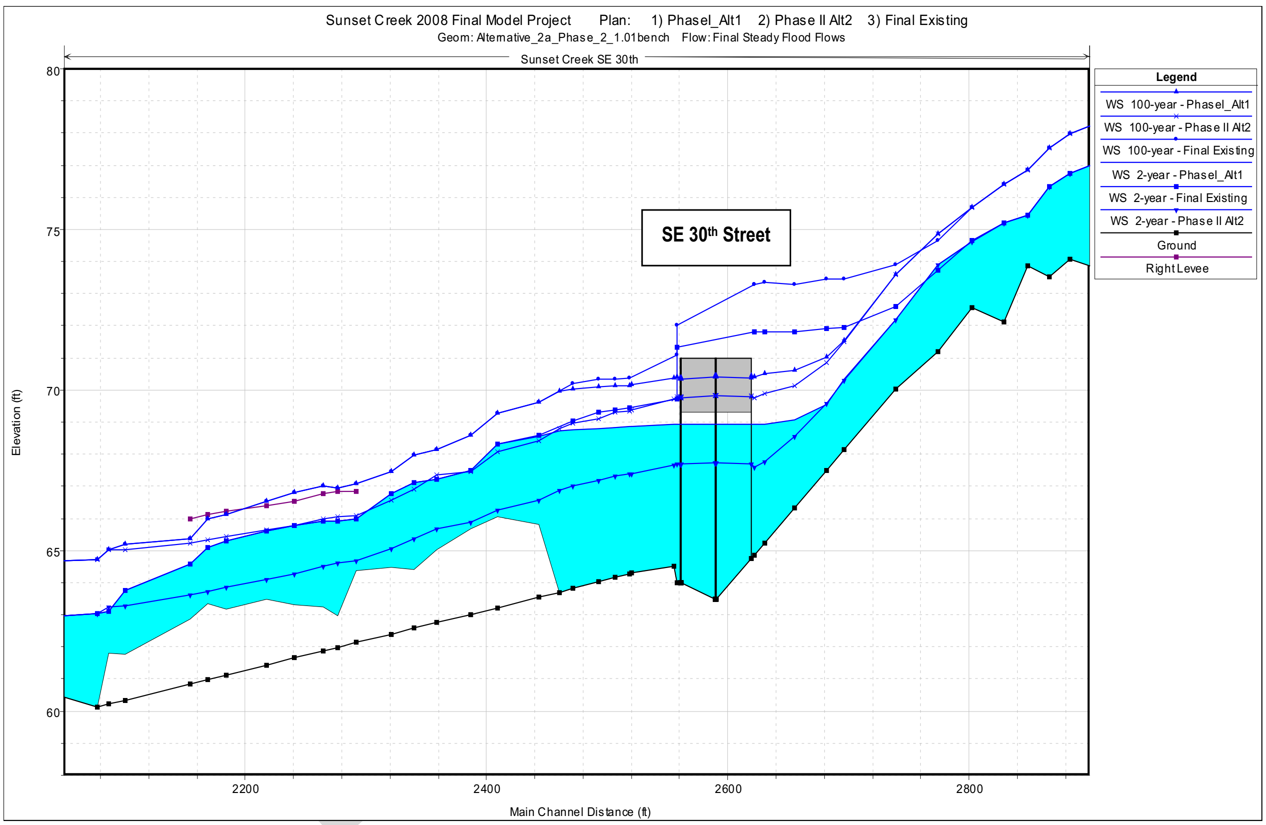

Figure 12. Profile plot of HEC-RAS model output for the Existing Conditions, Phase I (Alternative 1) and Phase II (Alternative 2) model geometries for the 2-year and 100-year recurrence interval flows from upstream of SE 30th Street to the Sunset Creek and Richards Creek confluence.

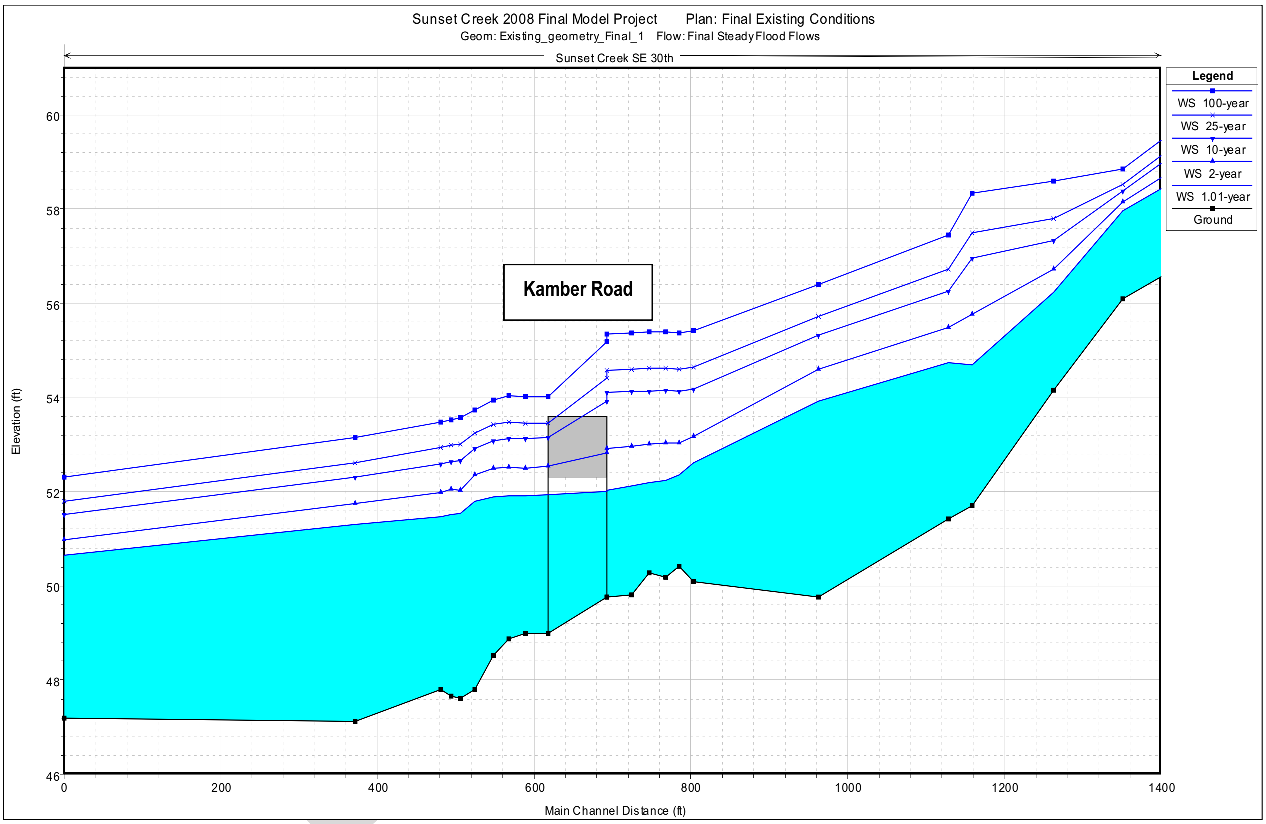

Figure 13. Profile plot of HEC-RAS model output for the Existing Conditions model geometry for the 1.01-, 2-, 10-, 25-, and 100-year recurrence interval flows from the flow split to the historical Richards Creek and East Creek confluence.

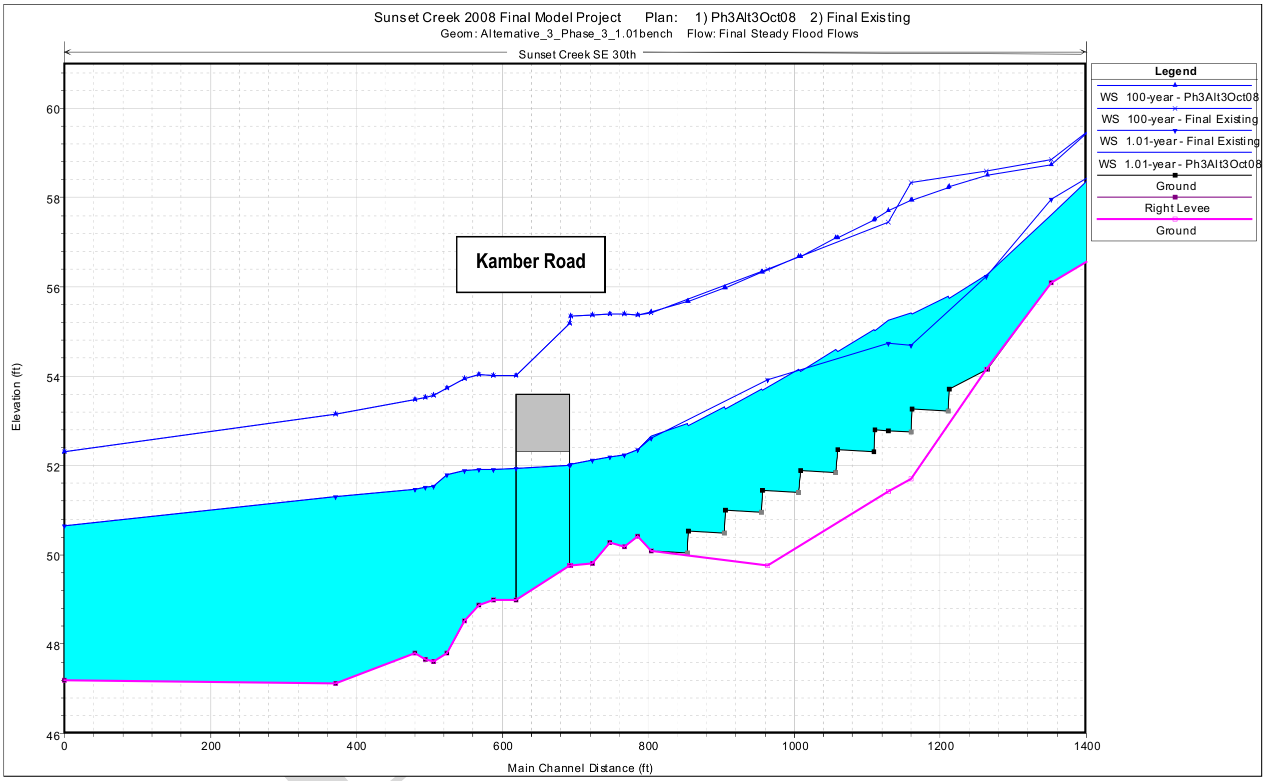

Figure 14. Profile plot of HEC-RAS model output for the Existing Conditions and Phase III (Alternative 3) model geometry for the 1.01-year and 100-year recurrence interval flows from the flow split to the historical Richards Creek and East Creek confluence.

Hydraulic Changes Due to the Alternatives Evaluated

The results presented in Figures 9 through 14 illustrate the existing conditions and the changes in channel bed and water surface elevation associated with the alternatives evaluated. A summary of the hydraulic model results for the existing conditions, Phase I (Alternative 1), Phase II (Alternative 2), and Phase III (Alternative 3) model geometries is provided below.

Existing Conditions

Results of the hydraulic analysis of existing conditions illustrate the high risk of flooding during moderate peak flow events at both SE 30th Street and Kamber Road. The model results at SE 30th Street indicate flooding during the 1.01-year flood flow, which is consistent with the observed frequency of flooding in recent years (Figure 9). The bulge in the bed profile between SE 30th Street (at approximately Station 2600) to the confluence of Sunset Creek and Richards Creek (at approximately Station 2180) illustrates the aggradation that has occurred along this reach over the last 30 years.

The model results at Kamber Road indicate that a “free” water surface (i.e., water surface that remains below the top of the culvert opening) is lost in flood flows through the culvert in that location at flow magnitudes less than the 2-year flow, and flooding of the road may occur at flows in the range of the 10-year event. As mentioned above in the discussion of model accuracy, the removal of sediment at the culvert crossing at Kamber Road due to maintenance in September 2007 and through erosional processes following removal of downstream beaver dams renders the bed geometry and model output at this location obsolete (Figure 14). The results do, however, reinforce the potential flood impacts of sediment deposition at this location and the importance of limiting backwater conditions in an effort to minimize sedimentation and maintain the designed flood conveyance capacity of the box culvert beneath Kamber Road [see Phase III (Alternative 4)].

Phase I (Alternative 1)

Phase I hydraulic model results illustrate the geometry of the replacement culvert and channel modification both upstream and downstream of SE 30th Street (Figure 10). Figure 10 also shows the decrease in flood flow water surface profiles resulting from Phase I improvements. This decrease in flood risk is evident as the replacement culvert is estimated to pass the 2-year flow with a free water surface and flows up the 100-year event are not predicted to overtop the road. The downstream limit of bed modifications proposed under Phase I construction activities is also evident at approximately Station 2480.

The limit of Phase I streambed modifications and the height of the downstream bed will result in temporary backwater conditions through the replacement culvert. The backwater condition will be resolved with the construction of the proposed Phase II channel modifications. The streambed topography creating backwater through the culvert may also be eliminated naturally by a geomorphic response of the channel during high flows following the onset of bedload sediment capture at the replacement culvert. It is conceivable that streambed sediment mobilization will occur downstream of the limits of the Phase I improvements at the channel's topographic high point due to increased flow conveyance through the replacement culvert, coupled with decreased rates of coarse sediment delivery as a result of sediment capture in the new culvert. If this occurs, the downstream bed elevation will be lowered, reducing backwater into the culvert. If, however, the initial peak flows through the replacement culvert are relatively low in magnitude, yet with high concentrations of sand in transport, there is the potential for aggradation of the bed through the replacement culvert to the upstream extent of the Phase I channel modifications. An evaluation of the sediment transport conditions that would contribute to this condition are provided in the Sediment Transport Analysis Results section below.

Although the risk of severe aggradation occurring prior to the implementation of Phase II channel modifications is considered low, such aggradation would have an effect on flow profiles at the replacement culvert, as illustrated in Figure 15. These model results are based on a very conservative modification of the bed topography, in terms of hydraulic analysis, as the modified bed topography represents aggradation of the entire channel bed up to 2.5 feet over a distance of approximately 200 feet, from the upstream end of the replacement culvert to a distance 140 feet downstream. This represents a total of over 220 cubic yards of sediment deposition following construction of Phase I, including filling up the storage capacity provided by the sedimentation structure. Although increases of the bed elevation under this potential scenario would result in temporary increases in water surface elevation for all flood flow profiles, none of the flows are predicted to overtop SE 30th Street. Thus, these conditions would still represent an overall decrease in flood risks at the replacement culvert site when compared to the existing conditions (Figure 15).

Phase II (Alternative 2)

Model results presented in Figure 11 represent the long-term water surface profile conditions sought in Sunset Creek from upstream of SE 30th Street to the Sunset Creek and Richards Creek confluence following implementation of Phase II channel improvements. Figure 12 illustrates the improvements in the 2-year and 100-year recurrence interval flow profiles between existing conditions, Phase I (Alternative 1), and Phase II (Alternative 2) conditions over the same channel area. At SE 30th Street, the replacement culvert is designed to provide conveyance of the 25-year flow event with 0.2 feet of freeboard and provide conveyance of the 100-year flow without flooding of the road. These hydraulic conditions do not fully satisfy the City of Bellevue Engineering Standards which state that culverts should pass the 100-year flow with one foot of freeboard. However, given the site constraints, including the change in bed profile at the culvert location and the limited channel width, the Engineering Standards cannot be fully met without raising the surface elevation of SE 30th Street by 1.5 feet where it crosses Sunset Creek. The consequences of raising the roadway by 1.5 feet at the replacement culvert location, aside from added project cost, include:

- Increasing the project limits and re-grading the approach along SE 30th Street.

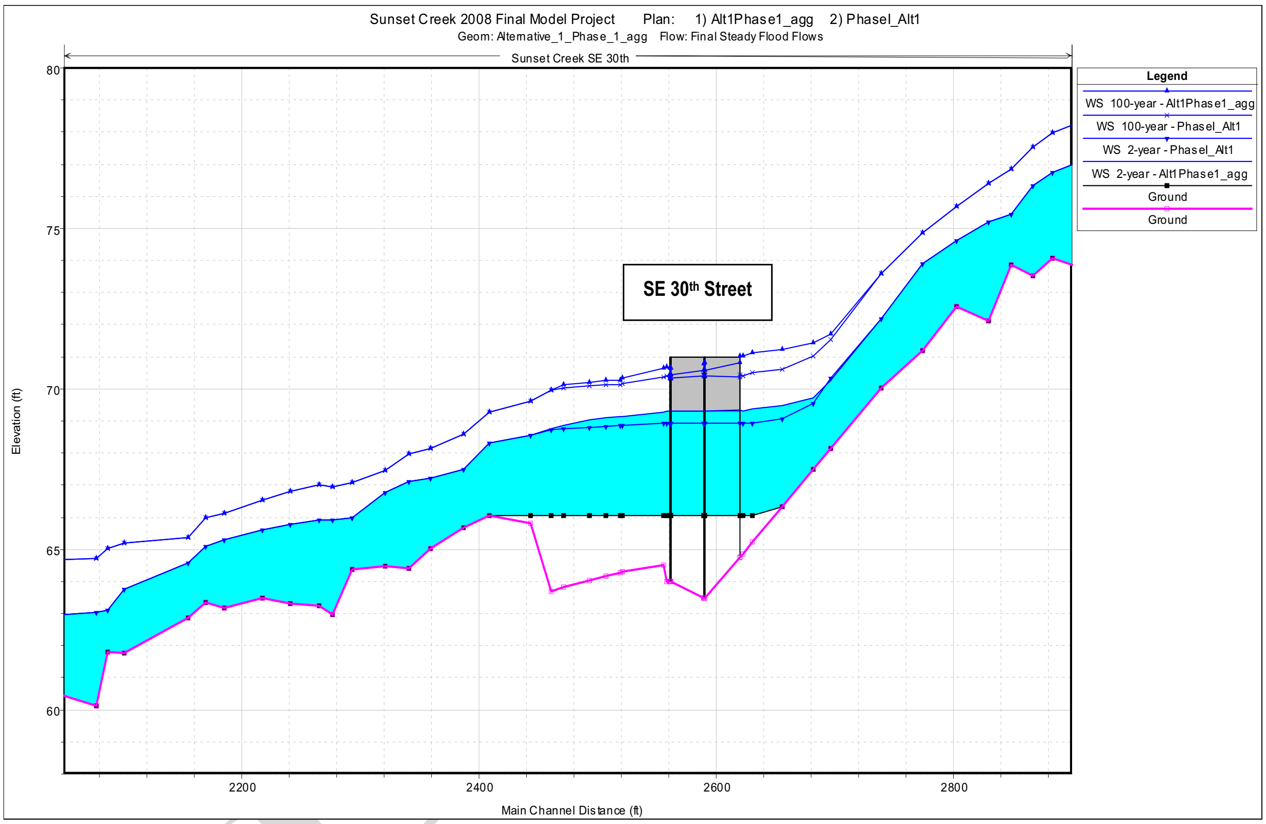

Figure 15. Profile plot of HEC-RAS model output for the potential aggradation scenario following Phase I for the 2-year and 100-year recurrence interval flows from upstream of SE 30th Street to the Sunset Creek and Richards Creek confluence showing both the aggradation scenario and Phase I constructed bed geometry.

- Re-grading driveway entrances to properties to the northwest, northeast, and southeast. This work would require agreements with the property owners.

- Resolving modified surface drainage flow paths resulting from local super elevation of the roadway.

Downstream of SE 30th Street, the proposed Phase II channel modifications and flood containment berm between the channel and a parking lot between Stations 2313 and 2175 are estimated to provide conveyance of the 100-year flow with a minimum of 0.75-foot of freeboard along Sunset Creek to the confluence with Richards Creek, consistent with City of Bellevue Engineering Standards (see Appendix D).

Phase III

Alternative 3

Figure 14 illustrates the proposed Alternative 3 bed modifications between the Richards Creek flow split and Kamber Road compared against the existing conditions. Comparison of the 1.01-year and 100-year flow profiles illustrates how the proposed grade control structures can be utilized to provide local increases in water surface elevation to restore floodplain reconnection.

The impacts of increases in water surface elevation in this reach on neighboring properties were not evaluated. It is anticipated that channel modifications resulting in increases in water surface elevations would also require construction of flood berms at the boundary of adjacent parcels.

As discussed above, the modeled bed topography of the flow-split channel between the Richards Creek flow split and the East Creek confluence no longer represents the existing conditions, as naturally occurring grade control features composed of small woody debris did not persist through the winter of 2007/2008. As such, the location of grade control structures will need to be re-evaluated at the onset of Alternative 3 design activities based on the channel conditions at that time.

Because of the complex floodplain flow dynamics between the flow split and the East Creek confluence, including the secondary channel from the historical Richards Creek alignment to the flow-split channel that was not included in the model geometry, it is recommended that the Alternative 3 design process include a two-dimensional hydraulic analysis of these features.

Alternative 4

Figure 16 shows the modeled differences in the 2-year and 100-year water surface profiles for the Alternative 3 channel modifications. These differences result from an increase in the downstream reach boundary condition normal depth (gradient) from 0.0013 in Phase III Alternative 3 to 0.003 in Phase III Alternative 4, which approximates the effect of reducing the backwater influence from downstream beaver dams.

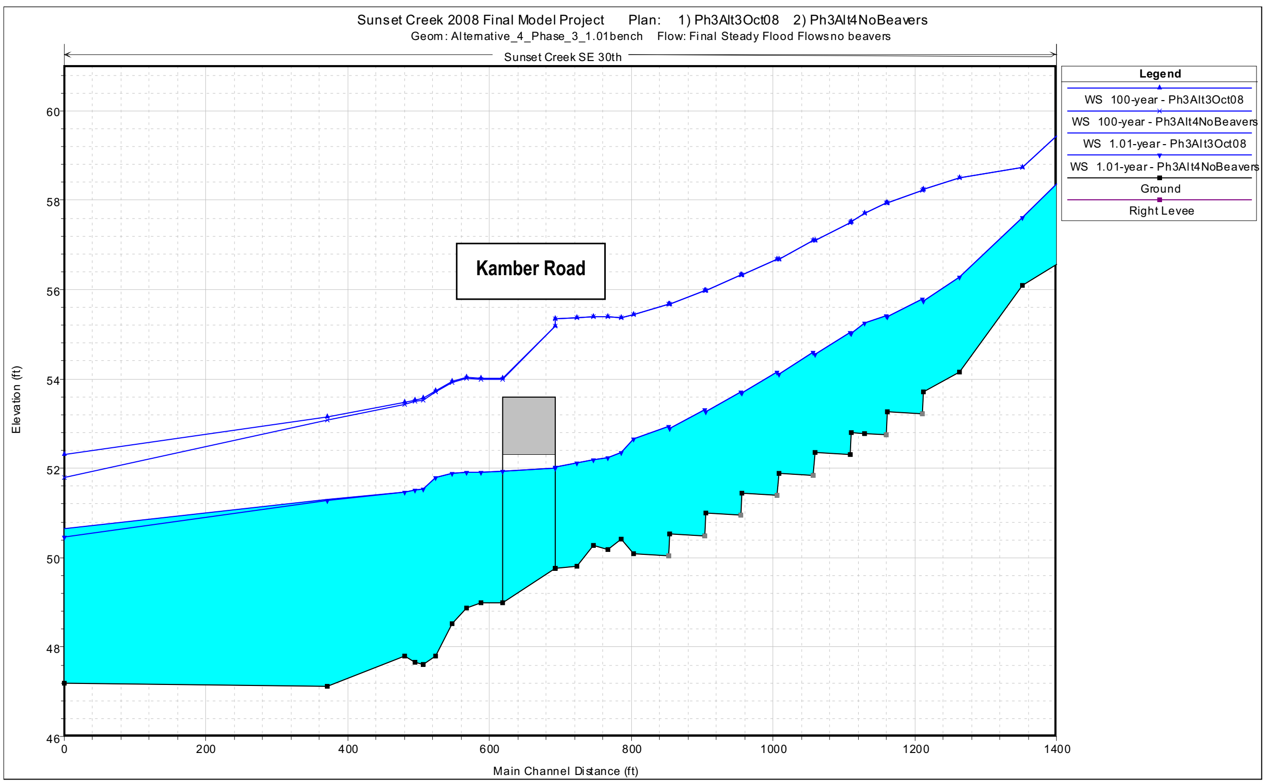

Figure 16. Profile plot of HEC-RAS model output for the Phase III Alternative 3 and Alternative 4 model geometry for the 2-year and 100-year recurrence interval flows from the flow split to the historical Richards Creek and East Creek confluence.

The results presented in Figure 16 also indicate limitations in the accuracy of the model at Kamber Road. The model output does not predict that downstream changes in the reach boundary conditions will affect water surface profiles at Kamber Road or upstream. Observations of water surface elevations and depositional conditions, both during significant backwater conditions and following beaver dam maintenance activities consistent with Alternative 4, have shown that changes in the water surface elevation downstream of the model geometry influence flow conditions at Kamber Road. These inconsistencies between model output and observed conditions are likely due to complex hydraulic geometry that is not adequately represented by the model geometry, particularly in the transition from the wide modified channel in the vicinity of the Kamber Road box culvert to the narrow channel downstream.

Sediment Transport Analysis Results

The analysis of sediment transport conditions associated with the sedimentation structure within the replacement culvert at SE 30th Street and the continuity of sediment transport conditions within modified channels in the project area was conducted iteratively during the design development process for the project alternatives. The results of those analyses provide an indication of the future sediment transport and depositional characteristics of Phase I (Alternative 1) and Phase II (Alternative 2). Results from the analysis of fine-grained sediment transport through the replacement culvert, and bedload transport through Sunset Creek from SE 30th Street to the confluence with Richards Creek are provided in the following sections.

Suspended Transport of Fine-Grained Sediment

Analysis of suspended transport of fine-grained sediment was conducted to predict the character of sediment that can be expected to be trapped within the sedimentation structure in the replacement culvert at SE 30th Street (Phase I). The primary intent of the sedimentation structure design is to capture coarse-grained sediments, including cobble and gravel, in addition to medium- and coarse-grained sand, particle sizes that range from up to 256 mm to as small as 0.25 mm. This range of sediment sizes is typical of the streambed material downstream of SE 30th Street and is the material that is delivered to the channel at rates in excess of the channel's sediment transport capacity. The risk in the sedimentation structure design is that the deposition of finer sediment, including fine sand and smaller particles less than 0.25 mm in diameter, will occur at rates that will result in an excess accumulation of sediment within the culvert structure, particularly since high rates of sand accumulation have been observed in East Creek at Kamber Road under backwater conditions.

Settling velocities for sand-sized particles, their settling velocities, and the necessary shear velocities required to keep the particles in suspension were calculated in metric units and converted to English units. These velocities are presented in Table 4. These shear velocity values were compared to calculated shear velocities at select cross-section station locations using hydraulic model output in order to predict the largest particle size that would remain in suspension for the 1.01-, 2-, and 10-year flows under existing conditions, and following construction of Phase I and Phase II culvert and channel improvements (Table 5). Results of the calculations for existing conditions were compared to observations of depositional patterns within the project area in order to predict how the calculated suspended transport conditions will translate into future patterns of deposition indicated by the calculation results for Phase I and Phase II site conditions.

Table 4. Settling velocities for sand based on Stokes' settling equation, and calculated shear velocities necessary to maintain particles in suspension.

Sediment Class	Maximum Particle Size (mm)	Settling Velocity (ft/sec)	Necessary Shear Velocity for Entrainment (ft/sec) [a]
Very coarse sand	2	8.8	3.9
Coarse sand	1	2.2	0.99
Medium sand	0.5	0.55	0.25
Fine sand	0.25	0.14	0.099

[a] Necessary shear velocity for entrainment calculated according to the method presented by Niño (1995).

The maximum grain sizes predicted to be transported in suspension through the replacement culvert (Stations 2611 and 2578) range from 0.2 mm to 0.5 mm under Phase I, and from 0.3 mm to 0.5 mm under Phase II. These sizes compare to maximum values of 0.5 mm to 0.6 mm that are estimated to be transported in suspension through the existing 42-inch diameter culverts under the existing conditions. Although the grain sizes estimated to remain in suspended transport through the replacement culvert are the smallest grain sizes calculated at any location evaluated in the channel network, the magnitude of differences between the calculation results for existing, Phase I, and Phase II conditions does not indicate that significant deposition of fine sediment is expected in the replacement culvert and adjacent channel sections under the proposed conditions.

In addition, the maximum grain sizes predicted to be transported in suspension under existing conditions in the 1.01- to 10-year flow events at Station 2643, just upstream of SE 30th Street, are also comparable to the estimates within the replacement culvert in Phases I and II and the extent of channel modifications under Phase I. The lack of flow conveyance through the existing culverts frequently creates a backwater condition at this station, however the sediments that accumulate here are predominantly gravel and cobble and do not appear to contain any more sand than at downstream sample locations within Sunset Creek. This indicates that the flow conditions proposed under Phase I and Phase II are not likely to promote significant fine-grained sediment deposition within the replacement culvert.

Bedload Sediment Transport Continuity within Modified Channels

An analysis of bedload sediment transport was completed at three locations on Sunset Creek between SE 30th Street and the confluence with Richards Creek to evaluate the continuity of sediment transport conditions and predict future conditions of deposition and transport in the modified channels. Because the sediment transport relations are not calibrated, and calculated rates of sediment transport may vary by orders of magnitude from actual rates, there is considerable uncertainty in the absolute sediment transport rates calculated. The sediment transport rates presented below, therefore, are for use in comparing relative transport rates at different locations along the channel between the existing, Phase I, and Phase II channel conditions.

Table 5. Calculated channel shear stress, channel shear velocity, and predicted maximum grain size in suspension for select cross-sections (stations) under existing, Phase I, and Phase II conditions.

Station	Flow	Existing Conditions			Phase I Conditions			Phase II Conditions		
		Channel Shear Stress (lb/ ft^2)	Channel Shear Velocity (ft/sec)	Predicted Maximum Grain Size in Suspension (mm)	Channel Shear Stress (lb/ ft^2)	Channel Shear Velocity (ft/sec)	Predicted Maximum Grain Size in Suspension (mm)	Channel Shear Stress (lb/ ft^2)	Channel Shear Velocity (ft/sec)	Predicted Maximum Grain Size in Suspension (mm)
2794	1.01-year	3.01	1.25	1.1	2.13	1.05	1.0	2.14	1.05	1.0
	2-year	3.04	1.25	1.1	2.29	1.09	1.0	2.30	1.09	1.1
	10-year	3.68	1.38	1.2	2.95	1.23	1.1	2.95	1.23	1.1
2702	1.01-year	0.50	0.51	0.7	3.45	1.33	1.2	2.27	1.08	1.0
	2-year	0.51	0.51	0.7	3.61	1.36	1.2	3.39	1.32	1.2
	10-year	0.63	0.57	0.8	3.71	1.38	1.2	4.16	1.46	1.2
2676	1.01-year	0.38	0.44	0.7	1.3	0.82	0.9	3.76	1.39	1.2
	2-year	0.46	0.49	0.7	1.42	0.86	0.9	2.88	1.22	1.1
	10-year	0.63	0.57	0.8	1.71	0.94	1.0	3.42	1.33	1.2
2643	1.01-year	0.07	0.19	0.4	0.21	0.33	0.6	1.02	0.73	0.9
	2-year	0.12	0.25	0.5	0.31	0.40	0.6	1.13	0.76	0.9
	10-year	0.21	0.33	0.6	0.49	0.50	0.7	1.10	0.75	0.9
Upstream end of Culvert at SE 30th Street										
2611	1.01-year	--	--	--	0.01	0.07	0.2	0.02	0.10	0.3
	2-year	--	--	--	0.02	0.10	0.3	0.04	0.14	0.4
	10-year	--	--	--	0.04	0.14	0.4	0.06	0.18	0.4
2578	1.01-year	0.10	0.23	0.5	0.02	0.10	0.3	0.05	0.16	0.3
	2-year	0.18	0.30	0.6	0.04	0.14	0.4	0.08	0.20	0.4
	10-year	0.33	0.41	0.6	0.08	0.20	0.5	0.12	0.25	0.5

Table 5 (continued). Calculated channel shear stress, channel shear velocity, and predicted maximum grain size in suspension for select cross-sections (stations) under existing, Phase I, and Phase II conditions.

		Existing Conditions			Phase I Conditions			Phase II Conditions		
Station	Flow	Channel Shear Stress (lb/ ft^2)	Channel Shear Velocity (ft/sec)	Predicted Maximum Grain Size in Suspension (mm)	Channel Shear Stress (lb/ ft^2)	Channel Shear Velocity (ft/sec)	Predicted Maximum Grain Size in Suspension (mm)	Channel Shear Stress (lb/ ft^2)	Channel Shear Velocity (ft/sec)	Predicted Maximum Grain Size in Suspension (mm)
Downstream end of Culvert at SE 30th Street										
2539	1.01-year	0.71	0.60	0.8	0.13	0.26	0.5	0.48	0.50	0.7
	2-year	1.00	0.72	0.9	0.21	0.33	0.6	0.62	0.57	0.8
	10-year	1.54	0.89	1.0	0.36	0.43	0.7	0.81	0.65	0.8
2527	1.01-year	0.66	0.58	0.8	0.11	0.24	0.5	0.43	0.47	0.7
	2-year	0.88	0.67	0.8	0.18	0.30	0.6	0.55	0.53	0.7
	10-year	1.22	0.79	0.9	0.30	0.39	0.6	0.71	0.60	0.8
2513	1.01-year	0.58	0.55	0.7	0.14	0.27	0.5	0.62	0.57	0.8
	2-year	0.73	0.61	0.8	0.23	0.34	0.6	0.80	0.64	0.8
	10-year	0.92	0.69	0.8	0.39	0.45	0.7	1.03	0.73	0.9
2492	1.01-year	1.01	0.72	0.9	0.16	0.29	0.5	0.68	0.59	0.8
	2-year	1.03	0.73	0.9	0.26	0.37	0.6	0.81	0.65	0.8
	10-year	0.85	0.66	0.8	0.42	0.47	0.7	0.98	0.71	0.8
2429	1.01-year	0.57	0.54	0.7	0.57	0.54	0.7	0.66	0.58	0.8
	2-year	0.70	0.60	0.8	0.70	0.60	0.8	0.85	0.66	0.8
	10-year	0.97	0.71	0.8	0.97	0.71	0.8	1.16	0.77	0.9
2379	1.01-year	0.75	0.62	0.8	0.75	0.62	0.8	0.54	0.53	0.7
	2-year	0.85	0.66	0.8	0.85	0.66	0.8	0.68	0.59	0.8
	10-year	1.15	0.77	0.9	1.15	0.77	0.9	0.89	0.68	0.8

Bedload sediment transport capacity rates for the existing, Phase I, and Phase II channel conditions using the Parker (1990) and Wilcock and Crowe (2003) transport equations are presented in Table 6. These results show relatively equivalent rates of sediment transport at Stations 2429 and 2205 in the existing, Phase I, and Phase II conditions but inconsistent results at Station 2527, which is located within the Phase I channel modifications, approximately 50 downstream from the replacement culvert outlet. At this location sediment transport rates following Phase I channel modifications are estimated to be effectively zero, and rates following Phase II channel modifications are predicted to be an order of magnitude lower than under the existing conditions.

Table 6. Estimated bedload sediment transport capacity rates for existing, Phase I, and Phase II conditions for the 1.01-, 2- and 10-year flow rates based on existing channel surface grain-size distributions.

	Sediment Transport Rate (kg/min)								
	Existing Conditions			Phase I Conditions			Phase II Conditions		
Station	1.01-year	2-year	10-year	1.01-year	2-year	10-year	1.01-year	2-year	10-year
Parker (1990)									
2527	13.2	45.0	137	2.13×10^{-8}	3.54×10^{-7}	6.78×10^{-6}	0.75	3.76	14.6
2429	29.6	91.1	259	29.6	91.1	259	113	218	484
2205	118	285	652	118	285	652	83.6	196	394
Wilcock and Crowe (2003)									
2527	5.62	20.9	69.4	1.32×10^{-5}	7.56×10^{-5}	4.66×10^{-4}	0.317	1.70	7.62
2429	9.12	30.4	92.4	9.12	30.4	92.4	40.3	91.1	172
2205	48.1	117.1	272	48.1	117	272	36.1	83.5	178

The decrease in calculated Phase I sediment transport rates at Station 2527 are due to backwater conditions imposed by the high point in the channel profile downstream from the limits of Phase I channel modifications. Because of this anticipated backwater condition, the modified channel downstream of SE 30th Street following Phase I will be largely depositional until the high point in the channel downstream is lowered, either by Phase II channel modifications or due to geomorphic response of the channel to reduced sediment delivery. As discussed in the Hydraulic Analysis Results section above, the sediment storage capacity of the sedimentation structure and modified channel following construction of Phase I improvements will exceed 200 cubic yards. The likelihood of sediment delivery to the channel at over 10 times the rate that typically accumulates in the existing condition until Phase II channel improvements are constructed, or natural geomorphic channel response occurs near Station 2527, is considered highly unlikely.

Sediment transport rates at Station 2527 under Phase II conditions are approximately an order of magnitude lower than those predicted under the existing conditions. These results indicate that low rates of sediment transport at this location could potentially result in depositional conditions and discontinuity of bedload transport. The sediment transport results presented in Table 6, however, are based on the existing grain-size distribution of sediment that is presently transported through the existing culverts.

Using the existing grain size distributions from the Sunset Creek channel provides conservative (low) estimates of sediment transport rates under the modified channel scenarios. The reason for this is that during typical years, the sedimentation structure will capture approximately 50 cubic yards of sediment, including the largest particles delivered. During years when sediment delivery rates exceed the sedimentation structure capacity, either due to significant delivery rates, or by design following adaptive management of the sediment structure (see the Protocols for Channel Monitoring and Replacement Culvert Sedimentation Structure Maintenance section below) the bedload sediment likely to be transported downstream of the sedimentation structure will be finer than the bedload sediment in the channel today. This is because the coarsest particles will be retained within the sedimentation structure.

Table 7 presents modified sediment transport capacity rates incorporating truncated grain size distributions (above 32 mm) for calculations associated with Phase I and Phase II conditions. These results show close to zero transport rate at Station 2527 following Phase I, similar to the calculations described above that assumed existing sediment grain size distributions, but otherwise Phase II bedload transport rates that are slightly greater than the transport rates under the existing conditions. Given that the rates of sediment delivery to the Sunset Creek channel have exceeded the sediment transport capacity by approximately 40 cubic yards annually for the past 30 years, a modified channel with similar transport capacity rates and a sedimentation structure that captures the excessive sediment delivery is expected to maintain an equilibrium channel profile in the future, albeit with ongoing maintenance obligations at the sedimentation structure.

Table 7. Estimated bedload sediment transport capacity rates for existing, Phase I, and Phase II conditions for the 1.01-, 2- and 10-year flow rates with potential future bedload sediment grain-size distributions.

	Sediment Transport Rate (kg/min)								
	Existing Conditions [a]			Phase I Proposed Conditions [b]			Phase II Proposed Conditions [b]		
Station	1.01-year	2-year	10-year	1.01-year	2-year	10-year	1.01-year	2-year	10-year
Parker (1990)									
2527	*13.2*	*45.0*	*137*	3.33×10^{-5}	0.000602	0.0122	15.3	44.9	119
2429	*29.6*	*91.1*	*259*	63.9	171	438	201	394	734
2205	*118*	*285*	*652*	192	420	879	143	308	597
Wilcock and Crowe (2003)									
2527	*5.62*	*20.9*	*69.4*	0.000894	0.00513	0.0320	6.89	20.4	55.3
2429	*9.12*	*30.4*	*92.4*	19.2	54.6	147	66.7	141	255
2205	*48.1*	*117.1*	*272*	72.8	164	358	56.4	122	253

[a] Existing conditions bedload sediment transport rates calculated using the existing surface grain-size distributions from station locations.
[b] Proposed conditions bedload sediment transport rates calculated using the existing surface grain-size distributions from station locations truncated above 32mm.

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Replacement Culvert and Channel Modification Design

The following sections provide a description of the design calculations and materials associated with the proposed replacement culvert and channel modifications under Phase I (Alternative 1) and Phase II (Alternative 2), and proposed protocols for channel monitoring and replacement culvert sedimentation structure maintenance. Engineering design plans (60 percent level of design completion) for Phase I are attached as Appendix C.

Replacement Culvert Design

The proposed replacement culvert design includes removal of two existing 42-inch diameter corrugated metal pipes and installation of a much larger structure containing a sedimentation trap with approximately 50 cubic yards of storage capacity at the downstream end and a simulated stream within the culvert at the upstream end to provide fish passage through the culvert to the channel upstream. As presented earlier, the replacement structure is designed to prevent flooding of SE 30th Street during the 100-year event and to provide storage for sediment that exceeds the transport capacity of downstream channels in a location outside of the active channel to minimize disturbances associated with maintenance activities.

Evaluations with respect to WDFW (2003) design criteria for slope ratio, culvert width, and culvert bed configuration and design, including bed-retention sill design, are provided below.

Slope Ratio

The slope ratio is a measure of the difference between the culvert bed slope, S_{culv} and the natural channel slope, S_{ch}, where:

$$\text{Slope Ratio} = \frac{S_{culv}}{S_{ch}}$$

For the proposed Phase I (Alternative 1) culvert replacement this ratio is 1.1. This ratio is based on a bed slope of 4.3 percent within the stream simulation portion of the culvert (S_{culv}), and a slope of 4.0 percent within the modified channel upstream (S_{ch}). This ratio is within the range recommended for stream simulation culverts (WDFW 2003).

Culvert Width

WDFW (2003) recommends that culvert width, $W_{culvert\ bed}$, be determined according to the following equation:

$$W_{culvert\ bed} = 1.2W_{ch} + 2 \text{ (in feet)}$$

Where: W_{ch} = The width of the bankfull channel.

This design guideline is intended to provide adequate width for natural channel forming processes in self-forming alluvial channels where the width of the bankfull channel, W_{ch}, may be evaluated using parameters associated with the active channel width, the ordinary high water width, and the bankfull width.

The Sunset Creek channel upstream of SE 30th Street is a constructed channel, confined within a narrow corridor with little room for planform variations. As such, the existing channel width is not indicative of a natural channel geometry that would occur at this location in the absence of significant modification. Because of these confined and constructed conditions, consistent with the characteristics of an incised channel, there is relatively little variation in flow width with changes in stage and typical “bankfull channel” indicators are not appropriate as the channel is not self-forming and does not access the adjacent floodplain even during peak flow events (see Appendix D). Channel width was therefore evaluated using indicators including changes in bank vegetation, active erosion along channel banks, and the extent of deposition features within the channel. Based on these indicators the channel width was estimated to range between 9 and 12 feet. These observed widths correspond to the average wetted channel width of 11.3 feet predicted by the modeled 1.01-year recurrence interval flow for the channel for a distance of 600 feet upstream of the culvert (see Appendix D).

Based on the these measured and predicted indicators of channel width, and the flow conveyance and sediment transport analysis, the design width of the culvert, $W_{culvert\ bed}$, was set at 13 feet.

Culvert Bed Configuration and Design

The 4.3 percent design gradient of the stream simulation portion of the replacement culvert is near the threshold criteria of a 4.0 percent gradient that dictates whether Scenario 1 or Scenario 2 of the WDFW guidelines are recommended (WDFW 2003). The unique function and geometry of the culvert and sedimentation structure, and the potential for future changes in sediment delivery to the culvert, require elements of both Scenarios as well as utilization of bed retention sills.

The design geometry of the culvert includes bed retention sills to ensure that the natural bed materials placed in the stream simulation portion of the culvert are not transported downstream into the sedimentation structure. The designed bed of the stream simulation portion of the replacement culvert includes placing rounded river boulder upstream of each sill. These boulders will function similarly to the well graded rock bands recommended by WDFW (2003) under Scenario 1 and will function to from a natural channel structure and maintain the channel gradient.

Boulder and Sill Geometry

The bed-retention sills are designed consistent with WDFW (2003) guidelines. The minimum height of the sills at the culvert centerline is designed to be 0.5 feet, with the crest height 0.5 feet below the designed streambed. The minimum 1-foot height of the sill and streambed material placed upstream of each sill is equivalent to 20 percent of the culvert inlet height of 5 feet. The crest of the sills will be V-shaped, with a slope of 10:1 laterally. Upstream of each sill, 12 to 36-inch diameter streambed boulders will be placed and arranged to maintain the 10:1 lateral slope and a 0.5 foot depth of streambed material above the sill crest. The maximum drop between adjacent sills is 0.31 feet.

Culvert Bed Material

Streambed material designed to be stable within the culvert will provide a natural channel bottom layer above the sills and fill the culvert bottom between the sills and river boulders. The gradation of stable streambed material within the culvert was determined according to the following equation provided in WDFW (2003) and based on Bathurst (1987):

$$D_{84} = 3.45 S_{eg}^{\ 0.747} \left(1.25 q_c\right)^{2/3} \Big/ g^{1/3}$$

Where: D_{84} = The intermediate axis of the 84th percentile particle in the sediment grain-size distribution (ft).

S_{eg} = Energy slope of the proposed culvert.

q_c = The critical unit discharge (design discharge divided by culvert width) at which incipient motion of D84 occurs (cubic feet per second [cfs]/foot).

g = The acceleration due to gravity (32.2 ft/sec^2)

The modeled energy gradient in the culvert under the 100-year flow condition is estimated to range between 0.000375 and 0.000540, or 0.0375 percent and 0.0540 percent. This gradient is considerably less than the design gradient of 3.6 percent of the stream simulation portion of the culvert and the channel upstream. Within 20 feet upstream of the culvert inlet, the energy gradient approaches 0.8 percent. To provide a factor of safety for greater stability, an energy gradient of one percent was used in this calculation. The critical unit discharge is equivalent to 16.3 cfs per foot and is calculated as the 100-year recurrence interval flow of 212 cfs divided by the 13-foot opening width of the replacement culvert.

The stable D_{84} particle diameter calculated according to this method is 0.26 feet or 80 mm. A factor of safety of 1.5 was applied to this diameter, increasing stability of the streambed material, to determine the design D_{84} particle diameter of 0.39 feet or 120mm. Based on this grain-size distribution parameter the culvert streambed material is specified as “8-inch diameter Streambed Cobble” as set forth in section 9-03.11(2) of the Washington State Department of Transportation Standard Specifications (WSDOT 2008) (Table 8).

Channel Modification Design

Under Phase I, the Sunset Creek channel upstream and downstream of the replacement culvert structure will need to be modified in order to match the upstream and downstream culvert invert elevations that are necessary to achieve maximum flow conveyance and sediment retention. Under Phase II, the channel modifications at the downstream end of Phase I will be continued to the confluence with Richards Creek.

Table 8. Culvert bed material gradation.

Approximate Particle Size	Percent Passing
8-inch	100
5-inch	70 max.
3-inch	40 max.
3/4-inch	10 max.

Channel Bed Material

A number of bed materials are specified for areas of the channel that will be modified. Upstream of SE 30th Street, under Phase I, streambed boulders designed to be stable and immobile are specified for placement at the base of the modified channel. Downstream of SE 30th Street, streambed cobbles designed to be stable and immobile are specified for placement at the base of the modified channel. Streambed gravel material is specified for placement over the streambed boulders and cobbles.

Streambed Boulders

Specifications for streambed boulders designed for placement at the base of the modified Phase I (Alternative 1) channel were determined according to the method presented above for Culvert Bed Material as provided in WDFW (2003) and based on Bathurst (1987).

The maximum modeled energy gradient of the modified channel upstream of SE 30th Street is 0.045 or 4.5 percent. To provide a factor of safety against mobility, an energy gradient of 5-percent was used in this calculation. The maximum critical unit discharge is equivalent to 16.3 cfs per foot and is calculated as the 100-year recurrence interval flow of 212 cfs divided by the approximately 13-foot minimum top width of the modified channel during the modeled 100-year flow event.

The stable D_{84} particle diameter calculated according to this method is 0.86 feet or 263 mm. A factor of safety of 1.5 is applied to this diameter for increased stability to determine the design D_{84} particle diameter of 1.29 feet or 395 mm. Based on this stability criteria, the streambed boulders for the base of the channel upstream of SE 30th Street are specified as “One Man Streambed Boulders”, 12 to 18 inches in diameter , as per section 9-03.11(3) of the Washington State Department of Transportation Standard Specifications (WSDOT 2008).

Streambed Cobbles

Streambed Cobbles are specified in the design for both Phase I (Alternative 1) and Phase II (Alternative 2) to line the modified channel downstream of SE 30th Street. The gradation for streambed cobbles was determined according to the method presented above for Culvert Bed Material as provided in WDFW (2003) and based on Bathurst (1987).

The maximum modeled energy gradient of the modified channel between SE 30th Street and the confluence of Sunset Creek and Richards Creek is 0.025 or 2.5 percent. The maximum critical unit discharge is equivalent to 17.6 cfs per foot and is calculated as the 100-year recurrence interval flow of 212 cfs divided by the approximately 12-foot minimum top width of the modified channel during the modeled 100-year flow event.

The stable D_{84} particle diameter calculated according to this method is 0.54 feet or 165 mm. A factor of safety of 1.5 is applied to this diameter for increased stability to determine the design D_{84} particle diameter of 0.52 feet or 248 mm. Based on this grain-size distribution parameter the culvert streambed material is specified as “10-inch diameter Streambed Cobble” as set forth in section 9-03.11(2) of the Washington State Department of Transportation Standard Specifications (WSDOT 2008) (Table 9).

Table 9. Phase I and Phase II streambed cobble material gradation.

Approximate Particle Size	Percent Passing
10-inch	100
6-inch	70 max.
4-inch	40 max.
3/4-inch	10 max.

Streambed Gravel

Streambed gravel gradations for Phase I and Phase II channel modifications are based on observed grain-size distributions in the existing channel (Appendix E). Based on these grain-size distributions, the channel streambed gravel material is specified as “Streambed Sediment” as set forth in section 9-03.11(1) of the Washington State Department of Transportation Standard Specifications (WSDOT 2008) (Table 10).

Table 10. Streambed gravel bed material gradation.

Sieve Size	Percent Passing
2 1/2” square	100
2” square	65-95
1” square	50-85
U.S. No. 4	26-44
U.S. No. 40	16 max.
U.S. No. 200	5.0 -9.0

Grade Control Structures

Grade control structures are proposed in conjunction with Phase I (Alternative 1) and Phase II (Alternative 2) channel modifications. In Phase I, eight grade control structures are proposed upstream of SE 30th Street and two are proposed downstream of SE 30th Street. The design of the grade control structures upstream of SE 30th Street is based on step-pool channel geometry in natural channels and incorporates design parameters for both log sills and boulder control structures (WDFW 2003). The design of grade control structures proposed downstream of SE 30th Street under Phase I include one log sill and one boulder control structure.

Grade Control Structure Geometry

The design of the grade control structures upstream of SE 30th Street is based on step-pool channel geometry in natural channels. Field measurements and flume experiments indicate that stepped pools evolve towards a condition of maximum flow resistance because maximum resistance implies maximum stability (Abrahams et al. 1995, Zimmerman and Church 2001). The maximum stability of step-pool structures is associated with the relationship:

$$1 \leq H_S / L_S / S \leq 3$$

Where: H_S = The total step height

L_S = Step-pool unit wavelength ("crest to crest" length)

S = Channel bed gradient

Based on a channel gradient of 0.036, the design of the grade control structures upstream of SE 30th Street includes total step heights of 1.5 feet and a wavelength of 13 feet so that $H_S / L_S / S$ equals 3. Grade control structures upstream of SE 30th Street are designed with a maximum 4-inch drop and pool depths are designed to be approximately one foot.

Boulder Stability

Sizing of boulders for grade control structures was completed using the same approach as described above for streambed boulders except the energy gradient was increased to 0.083, or 8.3 percent, to reflect the vertical drop of 4 inches over a distance of approximately 4 feet at each grade control structure.

The stable D_{84} particle diameter calculated according to this method is 1.26 feet or 384 mm. A factor of safety of 1.5 was applied to this diameter for increased stability to determine the design D_{84} particle diameter of 1.89 feet or 576 mm. Based on this size, boulders for the porous boulder weir structures, pools, and pool tailouts are specified as "Two Man Streambed Boulders", 18 to 28 inches in diameter, as set forth in section 9-03.11(3) of the Washington State Department of Transportation Standard Specifications (WSDOT 2008).

Log Anchoring to Counteract Buoyancy

Log buoyancy was calculated by assuming an upward vertical force on each log caused by the log's submergence and the anchoring needed to counteract that buoyancy was calculated by assuming a downward vertical force due to the weight of each log and the weight of the overburden or ballast directly above the log. These calculations assume unsaturated woody material and a specific void ratio for the overburden material. Over time, the factor of safety is expected to increase as the log weight increases due to saturation. These calculations also assume only the percentage of each log directly under the ballast is subjected to the distributed load from the weight of the overburden. The sensitivity of anchoring to counteract log buoyancy was analyzed by altering the specific gravity, depth, and compaction characteristics of the overburden and the percentage of each log that is not subject to the overburden weight. The log anchoring factor of safety for all logs in the initial, unsaturated state is greater than 2.5.

Protocols for Channel Monitoring and Replacement Culvert Sedimentation Structure Maintenance

The sedimentation structure within the replacement culvert proposed under Phase I will provide greater capacity and greater flexibility to manage the rate of sediment delivery and accumulation in Sunset Creek downstream of SE 30th Street. The proposed structure will have sufficient storage capacity to capture the majority of the bedload sediment in flux during years when delivery rates are low to average. The long-term reduction of bedload sediment delivery downstream of SE 30th Street will create the potential for undesirable geomorphic impacts on downstream channel conditions. Specifically, reduced sediment supply to downstream reaches that results in loss of salmonid spawning opportunity must be avoided. The Kelsey Creek watershed is generally considered to be spawning limited, due to the relative lack of suitable spawning substrate that has not been impacted by fine sediment accumulation. The substrate distribution in lower Sunset Creek and at the Richards Creek confluence is suitable for salmonid spawning, but the channel configuration and substrate stability are undesirable. Maintaining suitable substrate conditions while improving the channel configuration to support a range of habitat functions is the desired outcome.

Accordingly, the City will need to implement an active monitoring and adaptive management strategy and commit to operating and maintaining the culvert structure in ways that ensure that desirable habitat conditions are maintained. Adaptive management tools incorporated into this plan include monitoring of the channel configuration in downstream reaches, sediment removal protocols that are iterative with observed sediment delivery rates, and, if and when necessary, substrate augmentation. The adaptive management plan will also include monitoring and management of restored vegetation. The City of Bellevue Utilities Department Engineering Division will lead these activities to ensure proper function of the sedimentation structure and prevent adverse impacts to aquatic habitat downstream of SE 30th Street.

Active monitoring of channel responses to sediment management will be used to develop adaptive management protocols. These protocols will be used to respond to channel conditions should very high or low amounts of sediment delivery initiate excessive channel degradation or aggradation. The design volume of the sediment trap in the replacement culvert beneath SE 30th Street is based on calculated sediment transport rates and estimates of sediment delivery to the project reach using long-term estimates of channel aggradation. The intent of the structure design is not to trap all course sediment delivered to the project area. Rather, its design objective is to trap the largest sediments and the approximate volume that has caused ongoing channel aggradation downstream of SE 30th Street, while maintaining a sufficient flux of gravels as needed to provide desirable substrate conditions in the downstream channels. To achieve this intent, the maintenance protocol will need to be iteratively developed following installation of the structure, as understanding of sediment delivery rates and channel response increases. If over a period of time following implementation, observed rates of sediment delivery vary sufficiently from the rates developed from historical estimates, or depositional patterns are significantly different than predicted, additional measures such as gravel nourishment or sediment removal from downstream locations may be warranted.

The monitoring protocol includes establishment of four to five permanent monitoring locations approximately every 200 to 250 feet along the channel length beginning 100 feet downstream of the replacement culvert. The following monitoring activities will be conducted at each location:

- Channel cross-sectional geometry will be surveyed.
- The composition of streambed sediment will be surveyed using a combination of surface pebble counts and subsurface bulk sampling and sieve analysis.

Channel surveying and streambed sediment sampling will be performed annually for a period of five years and semi-annually for the following 10 years to establish management protocols. At that time future monitoring needs can be reevaluated.

Baseline sedimentation structure monitoring protocols will consist of the following:

- Scheduled visual inspections of remaining sediment storage capacity in the culvert and additional inspections following significant storm events. The design of the replacement culvert includes access hatches and lids readily accessible on the street above to promote ease of inspections and maintenance.
- Documentation of the timing and quantity of all sediment removed from the structure.
- Bulk sieve analysis of sediment removed to document grain size distribution of captured sediment.

Current rates of deposition in the channel near SE 30th Street and further downstream near the confluence with Richards Creek indicate that annual to semi-annual sediment removal from the culvert should be expected in the near term. If sediment production and delivery from the upstream basin decreases as a result of additional channel stabilization and sediment reduction measures, the frequency of sediment removal is expected to decrease. Should sediment production in the upper basin reduce to a level such that maintenance of the sedimentation structure is no longer necessary, the replacement culvert structure is designed to function as a stream simulation culvert without need for further modifications.

Upper Watershed Sediment Source Control and Storage Recommendations

Rates of sediment delivery to the project area exceed the capacity of the channel network to transport sediment and contribute to recurrent flooding. A number of factors contribute to the relationship between sediment delivery and transport capacity within the project area including:

- The position of the site on a historical alluvial fan between the high gradient upper watershed to the south and the low gradient streams to the north
- Confinement of the channel to a single and fixed alignment, limiting the extent where streambed aggradation can occur
- Sediment production from the upper watershed.

At the present time, adjacent land uses limit the opportunity to restore the natural distributary channel pattern and dynamic processes of channel relocation that once occurred in the vicinity of the project area. Although much of the sediment production in the upper watershed is produced from indistinct sources, there are a range of opportunities to treat discrete sediment sources and also provide capacity for increased sediment storage upstream of the project area.

Summary of Sediment Production Mechanisms

Mechanisms of sediment production and routing in the upper Sunset Creek watershed were evaluated in the *Sunset Creek Geomorphic Assessment and Sedimentation Analysis* (Herrera 2008). High rates of sediment production from the upper watershed result from changes in land use related to development and associated increases in impervious surfaces and volumes of stormwater runoff. The increased stream discharges that resulted from development in the Sunset Creek watershed have caused channel enlargement through much of the channel network upstream of the project area. These changes in channel form have resulted in increased sediment production in the upper watershed and have increased the rate of sediment delivery to the project area.

Further, the channel incision and widening caused by increased magnitudes and volumes of stormwater runoff disconnected the channel from adjacent floodplain areas and reduced the ability of floodplain areas to store sediment. Sediment storage within the channel and adjacent floodplain areas has been further reduced in many parts of the Sunset Creek watershed where changes in land use have degraded riparian vegetation conditions. These degraded conditions result in reduced potential for recruitment of large woody debris (LWD), which provides hydraulic complexity, channel grade control and sediment storage.

In response to channel instability and bank erosion, bank protection and grade control measures have been implemented by the City of Bellevue and private landowners in many locations, however moderate levels of bank erosion remain widespread. There are three particular subreaches of Sunset Creek in the watershed upstream of the project area where treatment of ongoing bank erosion and channel instability could result in decreased rates of sediment delivery to the channel and increases in in-channel sediment storage (Figure 17). Descriptions of the three highest priority treatment reaches, presented from upstream to downstream, and recommendations for reducing sediment inputs and increasing sediment storage at each, based on a conceptual level design evaluation, are detailed below.

High Priority Sediment Sources and Control Locations

Reaches in the Sunset Creek watershed are numbered from 1 (downstream) to 7 (upstream). The three highest priority treatment reaches, and recommendations for reducing sediment inputs and increasing sediment storage, are presented below from upstream to downstream.

Treatment Reach #6

Upstream of SE Newport Way, two bank-erosion sites contribute to sediment production and slope instability.

Site #6.1

Approximately 500 feet upstream of SE Newport Way, instream LWD is lacking and as a result, channel downcutting is causing erosion of the channel's right bank. This erosion is over-steepening the bank and undermining the toe of a steep hillslope. Erosion at this location is affecting approximately 60 feet of the channel, and the eroding bank is up to 10 feet in height (Figure 18). Continued erosion into the right bank could lead to larger and more significant mass wasting and hillslope instability. The channel in this section is approximately 12 feet wide and a floodplain surface at the channel's left bank and approximately 10 feet in width appears to be isolated from the stream due to channel downcutting.

The recommended method for treating channel instability and bank erosion at this location is by strategically placing logs to provide grade control and deflect flows away from the eroding bank. If properly placed and anchored, logs can redirect flow from the eroding bank, and grade control logs across the channel bottom would also provide sediment storage capacity thereby increasing the upstream bed elevation, decreasing the height of the cut bank, and reducing the instability of the hillslope toe. Three sets of grade-control and flow-deflection log placements, at approximately 15 to 20 feet spacing and beginning just downstream of the eroding bank should be sufficient to increase channel instability and decrease bank erosion.

The placement of the grade-control and flow-deflection logs should be complementary so that two logs placed together have increased stability than would occur if logs were placed individually. The conceptual design developed for this site includes a grade-control log wedged within the channel, at an angle approximately 30 degrees from perpendicular to the channel orientation, with the downstream end of the log set into the eroding bank. For this geometry the grade-control log should be approximately 14 to 15 feet in length. Because the flow would be

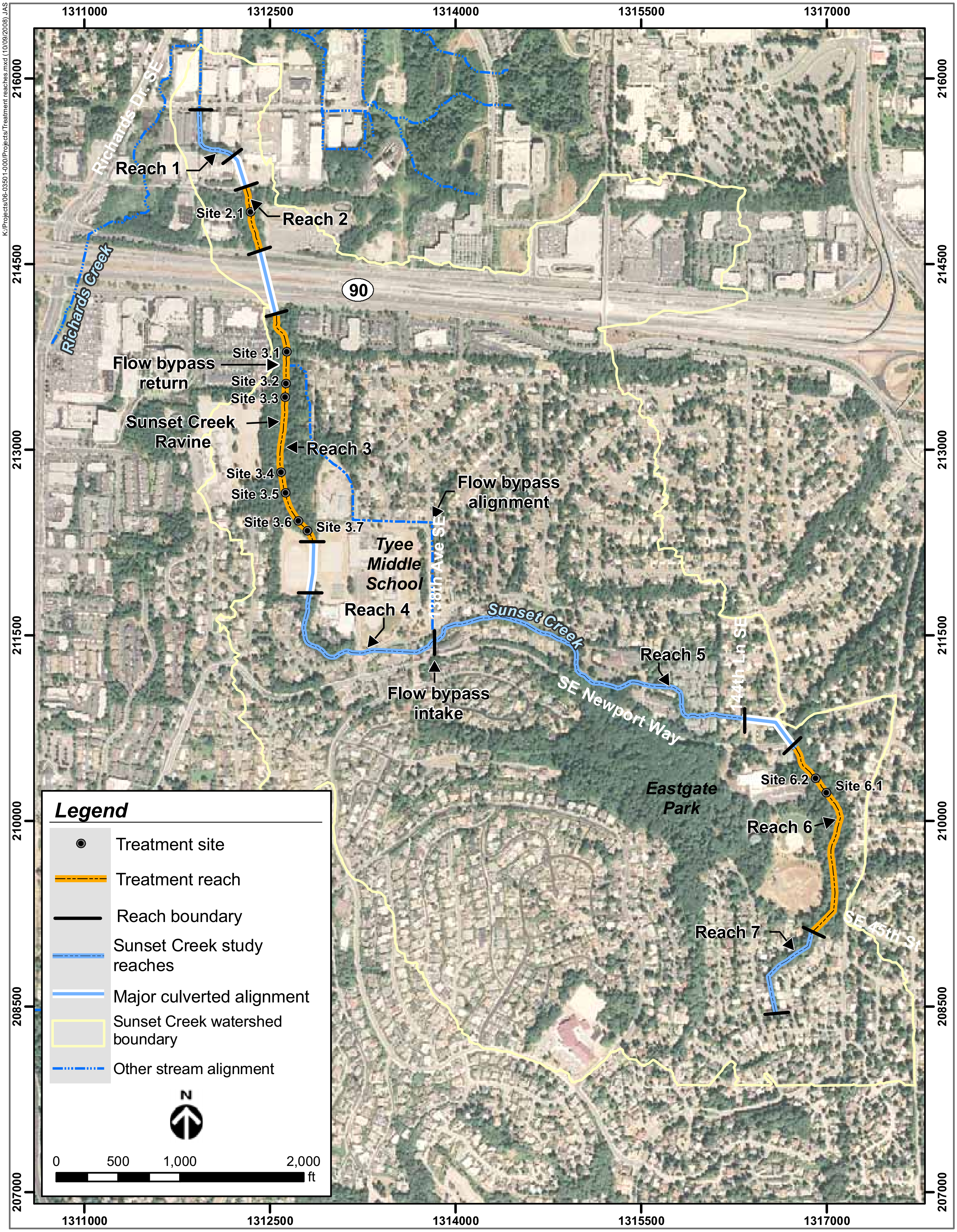

Figure 17. Potential treatment reach and site locations in the Sunset Creek watershed upstream of the flood control and sediment management plan project area.

perpendicular to the direction of the grade control log, the log's orientation would direct flows away from the eroding bank. A flow-deflection log should be placed upstream of the grade control log, adjacent to the bank. If the flow-deflection log includes a root wad, the rootwad could be placed at the downstream end, overlapping the grade-control log. If the flow deflection log is without a root wad, the downstream end of the flow-deflection log should be placed to abut into the upstream side of the grade-control log.

Figure 18. Right bank erosion at Site 6.1. Continued erosion at this location could lead to larger and more significant mass wasting and hillslope instability. Photo taken January 8, 2007.

Logs for the design described above may be sourced from the immediate site. A 20-inch diameter Douglas fir tree located at the top of the eroding bank could serve as a local source for LWD pieces. This tree is already leaning at approximately 20 degrees and will be recruited to the channel as the bank is further undercut. Once felled, this tree could be cut into multiple log pieces for placement. An additional piece of LWD, approximately the same diameter and 20 feet long, is largely suspended over the channel with one end in the channel and the other at the top of the eroding right bank. This piece could be repositioned for incorporation into a grade-control and flow-deflection structure. If alternative or additional materials are necessary, the likely construction access route is from Eastgate Park to the northwest. An alternative access route may be possible down the steep hillslope to the east. This route would require a temporary easement through private property off of 148th Avenue SE and has not been evaluated.

Site #6.2

Downstream of Site #6.1 and approximately 400 upstream of SE Newport Way, a section of Sunset Creek is confined and has incised approximately three feet for a length of 30 feet. The channel is approximately 8 feet wide with an actively eroding vertical left bank and an inset floodplain to the right of the channel (facing downstream). Due to the incision, the floodplain surface appears to be somewhat disconnected from the channel. Above the left bank and the floodplain to the right, adjacent hillslopes are gently sloped. Similar to Site #6.1 described above, the channel in this location is lacking significant LWD.

Two to three log grade-control structures, each up to 12 inches in height, are recommended to stop downcutting, promote sediment deposition to raise the channel bed, promote inundation of the inset floodplain at lower magnitude flows, and reduce the height of the eroding bank. Grade control placements should begin downstream of the incised channel and include another placement or two upstream at 15 to 20 foot intervals. Grade-control placements in this location would likely require excavation to adequately anchor the logs and achieve an appropriate factor of safety against buoyancy and movement to ensure long-term success. As at Site #6.1, the principal construction access route is from Eastgate Park.

Treatment Reach #3

In the Sunset Creek ravine, located immediately upstream of I-90, increases in the cross-sectional area of the channel have long resulted in toe erosion of steep ravine hillslopes, and increased rates of landslides and sediment delivery to the channel network. In the mid- to late-1980s the City installed a number of rock gabion and riprap grade-control structures through the length of the ravine. These structures are spaced at approximately 100 to 200 foot intervals along the channel, span the width of the ravine, and create, on average, 2- to 3-foot steps in the channel profile. Additional gabion structures were also installed at the base of the largest slides in the upper end of the ravine reach.

In 1998, the City took further action by constructing a high flow bypass pipeline to divert flood flows around the upper ravine where hillslopes have been most susceptible to erosion. The intake for the flow bypass is located at 138th Street SE and the flow bypass discharges to Sunset Creek approximately 400 feet upstream of the I-90 culvert inlet. The bypass was designed to reduce the magnitude of a 2-year recurrence interval flow in the ravine from 57 cubic feet per second (cfs) to 23 cfs, and the magnitude of a 100-year event from 149 cfs to 51 cfs (Entranco 1999). The stabilization and flow control measures effectively reduced both the rate of sediment delivery to the channel and the rate of downstream transport. Yet, because of the patterns of sediment transport downstream, and the rates of sedimentation in the vicinity of SE 30th Street and Kamber Road, it is clear that considerable sediment remains in transport through this ravine reach. Additional bank-protection and grade-control structures could be implemented within this reach to address locations of ongoing and recurrent erosion and provide additional sediment storage capacity within the channel.

Riprap grade-control structures placed in the Sunset Creek ravine reach have provided significant sediment storage capacity and have also inhibited the process of channel downcutting that was initiated by greater peak discharges following basin land development. Deformation of a number of the riprap grade-control structures, however, has occurred since their placement. The deformation appears to have resulted from toe scour at the downstream face of the structures and from the downstream transport of central pieces of riprap from the structures' crests, and likely occurred prior to the implementation of the flow bypass when peak flow magnitudes were at their greatest levels. Where this deformation has occurred such that the height of a grade control structure is reduced, the sediment storage capacity upstream of the structure is reduced. Where the deformation has resulted in a downstream "U" or "V" assemblage of riprap, flows passing over the deformed structure are directed to the outside of the channel and are eroding banks, in some cases at the toes of steep slopes.

The following sites present good opportunities for addressing ongoing bank erosion and increasing the sediment storage capacity of the Sunset Creek channel through the ravine reach.

Site #3.1

Downstream of the flow bypass return, there are good opportunities to construct additional channel-spanning grade-control structures to increase the sediment storage capacity of the channel. Grade-control structures could be assembled out of LWD and boulders, or riprap if that is permittable, and would require heavy equipment for construction. Access to the Sunset Creek channel between the flow bypass return and the culvert inlet at the upstream end of I-90 is readily available from SE 36th Street (Figure 19).

Figure 19. Site 3.1 location for channel-spanning grade-control structures to increase channel sediment-storage capacity. Photo taken January 5, 2007, looking downstream.

Sites #3.2 – 3.4

These three sites are typical of the deformed riprap grade-control structures described above, where sediment storage capacity has been reduced and altered riprap geometries have redirected flows into adjacent downstream banks. At these locations bank protection and grade-control structures assembled out of LWD and boulders, or riprap if permittable, are recommended to address eroding banks and increase local sediment storage capacity. Construction of the structures would require mobilizing heavy equipment and materials up, or adjacent to, the channel. This access becomes increasingly complex with increased distance from SE 36th Street and would also require removal of vegetation, although very few significant trees (defined as trees greater than 8 inches in diameter per City of Bellevue Land Use Code 20.50.046) were noted along potential access routes.

Site #3.5

Left bank erosion (facing downstream) at this site is occurring at the base of a steep slope, potentially increasing the potential for a hillslope failure. Although previously stabilized by riprap grade-control structures, the local channel gradient approaches nearly 10 percent. High velocities resulting from the steep gradient and the orientation of flows towards the bank have promoted the erosive conditions.

A range of treatments are recommended at this site to reduce further erosion of the bank. These treatments include direct placements of LWD to deflect flows from the bank, LWD channel roughening structures to reduce flow velocities, and grade-control structures made of wood or riprap to reduce local channel gradients and provide additional sediment storage capacity. Construction requirements and access challenges at this site are similar to downstream sites (Sites #3.2 – 3.4 described above).

Site #3.6

Right bank erosion at this site is occurring at the toe of a steep slope as a result of left bank revetments protecting a King County sewer manhole at the channel margin and a deformed riprap grade-control structure downstream (Figure 20). Gabion revetments lining the left bank upstream of the eroding bank area both confine the channel and direct flows into the eroding bank. Deformation of the downstream riprap grade-control structure has locally lowered the channel bed elevation, increasing the height of the eroding bank.

Treatments recommended at this structure are similar to those at Site #2.5 and include LWD bank protection to deflect flows from the bank, LWD channel roughening structures to reduce flow velocities, and grade-control structures made of wood or riprap to promote local aggradation, thereby reducing the height of the eroded bank. Construction requirements and access challenges at this site are similar to downstream sites (Sites #3.2 – 3.5 described above).

Site #3.7

The Sunset Creek ravine terminates at the upstream end at a culvert outfall beneath facilities at Tyee Middle School. At this location there a number of steep exposures of glacial till that have formed as a result of slope failures following channel downcutting. The equilibrium profile of these exposures has not been evaluated but these near-vertical slopes will certainly continue to erode and retreat. This process will continue to contribute sediment to the channel and could potentially threaten the ball fields and fencing associated with the middle school at the top of the slopes. A geotechnical slope stability analysis is recommended to determine if remedial measures should be taken to stabilize or reduce the gradient of these slopes.

Figure 20. Right bank erosion at Site 3.6 is occurring as a result of left bank revetments protecting a metro manhole at the left channel margin. Photo taken September 17, 2008.

Treatment Reach #2

Located in a reach of Sunset Creek between SE 32nd Street and I-90, two bank erosion sites contribute to sediment production and slope instability, and debris from historical industrial activities at neighboring properties litters the channel and riparian corridor.

Site #2.1

At the midpoint of this reach two sharp channel meanders direct flows into eroding banks. The downstream eroding bank, at the left side of the channel, is eroding into an approximately 8-foot high bank below a gently graded hillslope. This hillslope surface once served as the bedding for a concrete pipeline apparently used to transmit water diverted from the channel at the I-90 culvert outlet to a pump house located approximately 100 feet west of the channel near SE 32nd Street. Just upstream of this bank, the right bank is eroding into the toe of a steep hillslope. At the top of the 8-foot eroding bank an approximately one-foot layer of asphalt mantles the hillslope (Figure 21). Ongoing erosion into this hillslope has undermined the asphalt layer and multiple pieces of asphalt up to two-feet across litter the channel below this bank.

Figure 21. Left bank erosion at Site 2.1 in reach 2. Photo taken January 5, 2007.

LWD bank-protection and grade-control structures made of wood or riprap are recommended to deflect flows away from these eroding banks and locally aggrade the channel bed to reduce the height of the eroding banks and promote inundation of adjacent inset floodplain surfaces. Additional grade-control structures throughout the reach would provide increased sediment storage and increased inundation of, and sediment deposition upon, floodplain surfaces located between the eroding banks and SE 32nd Street. Construction access to the subreach is possible from SE 32nd Street. Additional access routes may be possible from adjacent properties.

Though not specific to sediment production or storage, additional treatments that would benefit this subreach, include:

- Invasive species removal

- Revegetation
- Removal of industrial debris including concrete, metal and plastic pipe, rubber tubing, concrete rubble, and tires
- Removal of an abandoned and decrepit pump house operation and related infrastructure including an above-ground 5,000-gallon fuel tank.

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APPENDIX A

Geotechnical Report

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DRAFT GEOTECHNICAL ENGINEERING REPORT
SE 30TH / SUNSET CREEK
FLOOD IMPROVEMENT PROJECT
BELLEVUE, WASHINGTON

File No.: 82981
July 28, 2008

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July 28, 2008
File No.: 82981

Mr. Chase Barton
Herrera Environmental Consultants
2200 Sixth Avenue, Suite 1100
Seattle, Washington 98121-1820

Subject: Draft Geotechnical Engineering Report
SE 30th / Sunset Creek Flood Improvement Project
Bellevue, Washington

Dear Mr. Barton:

Kleinfelder is pleased to present the attached draft geotechnical engineering report summarizing performed for the above referenced project. The purpose of our study was to evaluate the subsurface soil conditions along the alignment of the proposed Sunset Creek Culvert crossing and provide design and construction recommendations for the culvert replacement.

Based on the results of our field exploration and laboratory testing program, it is our professional opinion the proposed culvert may be constructed as planned. Specific geotechnical issues to be addressed during construction include design of a braced and dewatered excavation, protection of existing utilities, and measures to protect the culvert subgrade during construction. Specific recommendations regarding geotechnical aspects of the project design and construction are contained in the following report.

We appreciate the opportunity of providing our services for this project. If you have questions regarding this report or if we may be of further assistance, please contact the undersigned at (425) 562-4200.

Sincerely,

KLEINFELDER

DRAFT

Marcus Byers, P.E.
Geotechnical Group Manager

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DRAFT GEOTECHNICAL ENGINEERING REPORT SE 30TH / SUNSET CREEK FLOOD IMPROVEMENT PROJECT BELLEVUE, WASHINGTON

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July 28, 2008
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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE OF SERVICES

This report presents the results of the geotechnical engineering study performed for the proposed SE 30th / Sunset Creek flood improvement project located in Bellevue, Washington. We understand that the Sunset Creek culvert crossing under SE 30th will be replaced with a new, larger structure and portions of the creek improved to reduce flooding in the area and enhance fish habitat.

The purpose of our study was to evaluate site soil and groundwater conditions at the culvert location and provide geotechnical design and construction recommendations for the culvert replacement. Our study included subsurface exploration and soil sampling, laboratory testing, engineering analyses, and preparation of this draft report; a final report will be issued after receiving review comments. The work performed for this report was authorized by Mr. Mark Ewbank of Herrera Environmental Consultants and was conducted in accordance with our proposal dated November 6, 2006.

1.2 PROJECT DESCRIPTION

Based on information provided to us by Hererra Environmental Consultants and 60 percent plans, we understand that the culvert replacement project is part of the larger Sunset stream flow improvement project. It is proposed to replace two existing 36-inch diameter corrugated metal pipes. Currently, the existing pipes are inadequate to convey the design flood event, and improvements are needed to increase the culvert capacity and trap sediment. The location of the project is shown on the Vicinity Map, Figure A-1.

At the culvert location, SE 30th Street is approximately 50 feet wide. The new culvert section will be a 4-sided concrete culvert with an inside width of 13 feet and a depth that varies from about 6 to 14 feet. The culvert is designed with a sloped bottom and sediment trap. We understand the grade of SE 30th will not be changed. In addition, it is proposed to stage culvert construction to maintain at least one-lane of traffic flow during construction. An existing warehouse is located near the west side of the culvert at the south side of NE 30th Street, and the foundations for this warehouse are expected to be located within 8 to 15 feet of the excavation zone of the new culvert. Several utilities, including a nearby Metro Sewer manhole, telephone vault, water and gas lines, and overhead power are expected to affect construction and will require relocation and/or temporary support.

2.0 FIELD AND LABORATORY PROGRAMS

2.1 FIELD EXPLORATION

The subsurface soil and groundwater conditions at the culvert replacement project were explored by drilling three borings to depths ranging from 26½ to 36½ feet below the existing SE 30th street grade. The approximate locations of the borings are shown on the Site Plan (Figure A-2). Summary logs of the subsurface conditions encountered in the borings and presented on the Boring Logs, Figures A-4 through A-6. A key to soil symbols and terms used on the logs is presented on Figure A-3.

Drilling was performed with a hollow-stem auger drill rig equipped for soil sampling. Representative disturbed soil samples were obtained at 2½ to 5-foot depth intervals during drilling using a standard 2-inch outside-diameter split-spoon sampler driven into the soil by a 140-pound automatic trip hammer free falling through a distance of 30 inches. Sampler driving resistance, expressed as "blows per 6 inches of penetration", is presented on the boring logs at the respective sampling depths.

Information provided on the boring logs presented in the appendices includes soil descriptions, consistency evaluations, boring depths, sample depth, type and intervals, and free-water observations.

2.2 LABORATORY TESTING

Representative samples were tested in the laboratory to evaluate the pertinent physical and engineering properties of the soils. Laboratory testing included natural moisture content and grain size analyses (sieve analyses). Moisture content test results are presented on the Boring Logs, Figures A-3 through A-5, and sieve analyses results are presented on the Particle Size Distribution Reports in Appendix B.

3.0 SITE CONDITIONS

3.1 SURFACE CONDITIONS

At the time of our explorations, SE 30th Street consisted of a two-lane asphalt-surfaced street with paved shoulders and concrete sidewalks. The area on each side of SE 30th was occupied by light industrial and office buildings, with landscaping and some trees located around parking areas and behind sidewalks. Sunset creek flows through a relatively shallow channel that runs perpendicular to SE 30th. In the vicinity of SE 30th, the creek drainage is somewhat channelized, with rip rap linings at each end of the culvert and trees growing along the creek banks. The creek banks extend to within about 10 feet of some of the structures.

3.2 SUBSURFACE CONDITIONS

3.2.1 General Geologic Conditions

General geologic information for the project area was obtained from the *Geologic Map of King County Washington* (Booth et. al, 2002). According to the map, the project site is underlain by recessional outwash of the Vashon stade of the Frasier glaciation. Recessional outwash is described as stratified sand and gravel, moderately to well sorted, and well-bedded silty sand to silty clay deposited in proglacial and ice-marginal environments.

3.2.2 Soil Conditions

In general, soil conditions encountered in our explorations are consistent with those described by Booth et. al and consisted of sand to silty sand with some gravel. Two to 4½ inches of asphalt concrete paving was encountered in our explorations. The pavement was underlain by medium dense Silty SAND, and Silty SAND with GRAVEL (SM) extending to depths of 3 to 7½ feet below ground surface. Very loose to loose SAND with SILT (SP-SM) was encountered below the upper Silty SAND and extended to depths of 15 to 24 feet. This stratum included two layers of PEAT in B-3 (½-inch thick at 13.4 feet, and 8 inches thick at 20.8 feet). From 24 to 27½ feet a soft SILT (MH) was encountered in B-3, and medium dense to dense SAND (SP) and Silty SAND with GRAVEL was encountered from 27½ feet to the termination depths of 26½ to 36½ feet below ground surface.

3.2.3 Groundwater

Groundwater was observed at a depth of 8 feet at B-1, 5 feet at B-2, and 7½ feet in B-3 at the time of exploration. In general, the groundwater level is expected to be similar to the adjacent creek level. It should be noted that groundwater levels will fluctuate with the season, level of precipitation and other factors. The evaluation of these factors is beyond the scope of this report.

4.0 DESIGN AND CONSTRUCTION RECOMENDATIONS

4.1 KEY GEOTECHNICAL CONSIDERATIONS

Based on the results of our site exploration and laboratory testing, it is our opinion that the proposed culvert may be constructed provided the recommendations contained in this report are followed. In our opinion, key geotechnical issues to be addressed during design and construction of the new culvert are ground water, loose to medium dense sand below the ground water table, temporary excavation support, construction dewatering, potential instability at the bottom of the excavation, and maintaining temporary support of the utilities and adjacent structures. The following report sections present our design and construction recommendations.

4.2 CULVERT DESIGN

4.2.1 General

We estimate the culvert will weigh less than the soil it replaces and that the bearing pressure will be relatively low due to weight distribution across the bottom of the culvert. Foundation performance will be controlled by settlement and be subject to foundation subgrade preparation. Foundation subgrade should be prepared in accordance with Section 4.3.3 and a minimum 1-foot thick layer of compacted crushed rock placed over the subgrade prior to constructing culvert foundations in accordance with Section 4.3.4.

In general, we anticipate that the ground water level outside the culvert will be very similar to the level of the creek in the culvert. We have assumed that normal operation and maintenance of the culvert will not result in a situation where the ground water level outside of the culvert is significantly higher than the water level inside the culvert, such as pumping the sediment trap dry. Based on this, we do not anticipate that it will be necessary to design for unbalanced hydrostatic forces or buoyancy forces.

4.2.2 Design Parameters

We recommend culvert foundations be designed for a nominal allowable bearing pressure of 2,500 psf, with a 1/3 allowable increase for transient loading conditions. Settlement of the culvert foundation will be largely dependent on avoiding disturbance of the subgrade and on other factors such as piping of fines or flow around the culvert. Assuming the foundation is founded on properly prepared subgrade, we estimated settlement to be less than about 1 inch with differential settlement of about ½ inch over the length of the culvert. Settlement will essentially be immediate and occur as the culvert is constructed.

Culvert walls should be designed using an at-rest lateral earth pressure of 50 pcf equivalent fluid weight (EFW) above the ground water table. Below the ground water table, an at-rest lateral earth pressure of 26 pcf EFW (based on a buoyant backfill unit weight) plus the unbalanced hydrostatic pressure of 62.4 pcf EFW should be used.

We recommend a uniform lateral surcharge of 100 psf be applied to the top ten feet of the culvert wall to account for traffic surcharge (based on an assumed 250 psf uniform vertical traffic surcharge). A uniform seismic surcharge equal to 6H psf may be applied over the full height of the culvert, where H is the height of the culvert in feet, to account for seismic surcharges due to an event with a 10 percent probability of exceedence in 50 years. Soil Type

4.3 EARTHWORK

4.3.1 General Excavation

We anticipate that soils encountered in the culvert excavation will generally consist of sand and gravel with silt, and limited areas of peat or soft silt. We anticipate that these soils can be readily excavated with conventional equipment such as backhoes and trackhoes.

4.3.2 Excavation Slopes

Where space permits, the excavation may be sloped in a typical cut-and-cover operation. The contractor is responsible for establishing and maintaining safe slope inclinations in accordance with WISHA safety requirements. Site soils will likely classify as "Type C Soils" (loose granular soils). Accordingly, temporary excavation cut slopes for the proposed culvert construction should be inclined no steeper than 1½ H:1V. However, excavations near or below the water table will encounter seepage, and flatter slopes, shoring, and/or dewatering will be required. All slopes should be protected from erosion and raveling.

4.3.3 Subgrade Preparation

Subgrade encountered for the culvert foundation will generally consist of sand with gravel to silty sand below the ground water table. Prior to preparing subgrade, the ground water table should be drawn down to at least 2 feet below the subgrade level to facilitate subgrade compaction and placement of structural fill and minimize potential for disturbance. Subgrade that is disturbed and becomes unsuitable due to inadequate dewatering should be repaired or replaced at no cost to the owner. Furthermore, once subgrade is approved, the contractor should take measures to protect the subgrade including maintaining the ground water draw down 2 feet below subgrade, minimizing traffic on the subgrade, and/or placing a layer of crushed rock.

We recommend that all exposed culvert and pavement subgrade be prepared by compacting to at least 95 percent of it modified proctor maximum dry density and a firm and unyielding condition. Subgrade should be evaluated by a representative of the geotechnical engineer. Any areas identified as being soft or yielding should be over-excavated to the depth determined by the geotechnical engineer. In some instances, re-compaction may be inappropriate and should be limited at the discretion of the geotechnical engineer. In areas where subgrade is excessively soft or loose, use of quarry spalls or placement of a geotextile fabric separator conforming to Section 9-33 Construction Geotextile for Separation of the *WSDOT Standard Specifications*.

4.3.4 Structural Fill Materials

All fill placed below areas to be paved or behind culvert walls should be considered structural fill. All foundations should be underlain by a minimum 1-foot thick of compacted crushed rock conforming to the requirements of Section 9-03.9(3) Crushed Surfacing Base Course of the *WSDOT Standard Specifications*. Culvert and trench backfill should consist of a well-graded, free-draining sand and gravel containing less than 7 percent fines by weight (material passing the U.S. Standard No. 200 sieve) based on the portion of the material passing the ¾ inch sieve. We anticipate that a portion of the on-site soils may be suitable for re-use as structural fill, depending on where it is excavated from and how much mixing may occur with soils with high fines content during excavation and stockpiling. However, re-use of on-site soils may be impractical due to limited construction staging area. We recommend that the project budget include a provision for import of all culvert backfill, with a unit price deduction for provide cost savings when on-site soil can be used. All imported backfill should conform to Section 9-03.14(1) Gravel Borrow of the *WSDOT Standard Specifications*.

Pipe bedding should confirm to manufacturer's recommendations or appropriate *WSDOT Standard Specifications*.

4.3.5 Structural Fill Compaction

All structural fill placed below structures or pavements should be compacted to a minimum of 95 percent of its modified proctor maximum dry density (MDD). Material placed within 3 feet of culvert walls should be compacted to 92 percent of its MDD to reduce the potential for over-stressing the structure. Structural fill should be placed in maximum 12-inch thick loose lifts and within 3 percent of its optimum moisture content. Use of lighter compaction equipment may require placing material in thinner lifts, such as 4-inch thick loose lifts for small walk-behind plate compactors.

Structural fill, even when properly compacted may settle 1 to 2 percent of its volume. Therefore, there is potential for differential settlement between the rigid culvert lid (which will directly support the new pavement) and the adjacent ground surface that will be supported on structural fill. We recommend that paving around the culvert be performed as late in the project schedule as practical to allow as much settlement as possible to take place. Alternatively, approaches to the culvert could be constructed on rigid pavement slabs that are hinged to the culvert, similar to bridge abutment approach ramps.

4.4 EXCAVATION SUPPORT

4.4.1 General

We anticipate that the south half of the culvert will be constructed in a cut with depths less than about 10 feet. Excavations for the north half of the culvert, which incorporates the sediment trap, may be up to about 18 feet deep. Due to the anticipated closure of only one lane of SE 30th at a time, proximity to adjacent structures, and existing utilities, we anticipate that it will be necessary to brace and/or shore the excavations. Furthermore, due to a relatively shallow groundwater table, construction dewatering will be required.

For this site, driven sheeting may provide an economical temporary support system. However, due to multiple utility crossings through the area, it may not be practical to run continuous sheeting across the excavation face to achieve a relatively water tight shoring system.

4.4.2 Shoring Installation and Removal

Installation and removal of shoring will likely induce vibrations, and removal will leave minor voids, that will cause limited backfill settlement. We recommend that all shoring be removed and final subgrade compaction be performed before placing hot mix asphalt. This means that staged road closures should utilize gravel surfacing with final paving delayed until shoring is removed and subgrade can be re-compacted to meet structural fill requirements.

4.5 DEWATERING

Subsurface conditions encountered during this investigation suggest that groundwater control measures will be required to provide a dry and stable subgrade for construction of the culvert. The fine to coarse sand unit occurring below a depth of about 8 feet should be conducive to conventional dewatering methods. However, the proposed invert elevation in relation to the peat/organic silt interbeds and deeper silt unit may require supplemental sump pumping. Variations in the soil type and variable soil permeabilities along the culvert alignment could produce significant variations in the estimated flow volume and require more extensive dewatering methods. It is important that dewatering be continued through construction until the backfill has been installed to at least the level of backfill reaches the water level on the outside of the excavation.

Consideration will be need to given to the potential for loose sands to flow or run into dewatered excavations and potential of softening or disturbance of subgrade soils due to dewatering. Bottom instability could occur in culvert cuts due to heave of the silty sand soils if the hydraulic gradient is too steep where the water enters the bottom of the cut. For sandy soils, preventative measures consist of extending the sheeting to a safe distance below the bottom of the trench, and extending groundwater control measures to below the bottom of the cut. We estimate that for a 10-foot deep cut the sheeting should extend at least 6 to 8 feet below the bottom of the cut. For a 15-foot deep cut the sheeting should extend to at least 15 feet below the bottom of the cut.

To reduce disturbance at the bottom of the cut, and to provide a stable working base for the culvert foundation, we recommend installation of a stabilizing working blanket of free-draining granular fill at the bottom of the culvert cut. The free draining blanket should consist of at least 12 inches of imported material conforming to Section 9-03.9(3) Crushed Surfacing Base Course of the *WSDOT Standard Specifications*.

Groundwater draw downs due to dewatering may induce settlement in compressible soils such as soft silt or clay, or peat. The contractor should be required to submit a construction dewatering plan that addresses excavation base stability and potential draw down impacts. Kleinfelder can provide support in preparing shoring and construction dewatering specifications, if desired.

4.6 UNDERPINNING

Any structure, foundation, or utility that lies within a horizontal distance of H from the excavation, where H is the height of the cut or braced or shored excavation, should be underpinned and/or the shoring designed to carry the surcharge imposed by the structure. Underpinning may also be required due to dewatering-based settlement. The contractor should be responsible for protection of any existing nearby structures.

4.7 HOT MIX ASPHALT

Existing pavement encountered in our explorations ranged from 2 to 4½ inches of hot mix asphalt with little to no discernable base rock. We recommend that demolished pavements be replaced by a minimum of 4 inches of Hot Mix Asphalt in accordance with *WSDOT Standard Specifications* and be underlain by 4 inches of crushed surfacing base course.

CONTINUING SERVICES

We understand that Kleinfelder will be retained to provide construction observation services including subgrade verification, structural concrete testing and inspection, backfill testing and inspection, and asphalt testing and inspection. We recommend that Kleinfelder be retained to review shoring, dewatering and underpinning plans submitted by the contractor.

6.0 LIMITATIONS

Recommendations contained in this report are based on the field explorations and our understanding of the proposed project. The investigation was performed using a mutually agreed upon scope of services. It is our opinion that this study was a cost-effective method to explore the subject site and evaluate the potential geotechnical concerns.

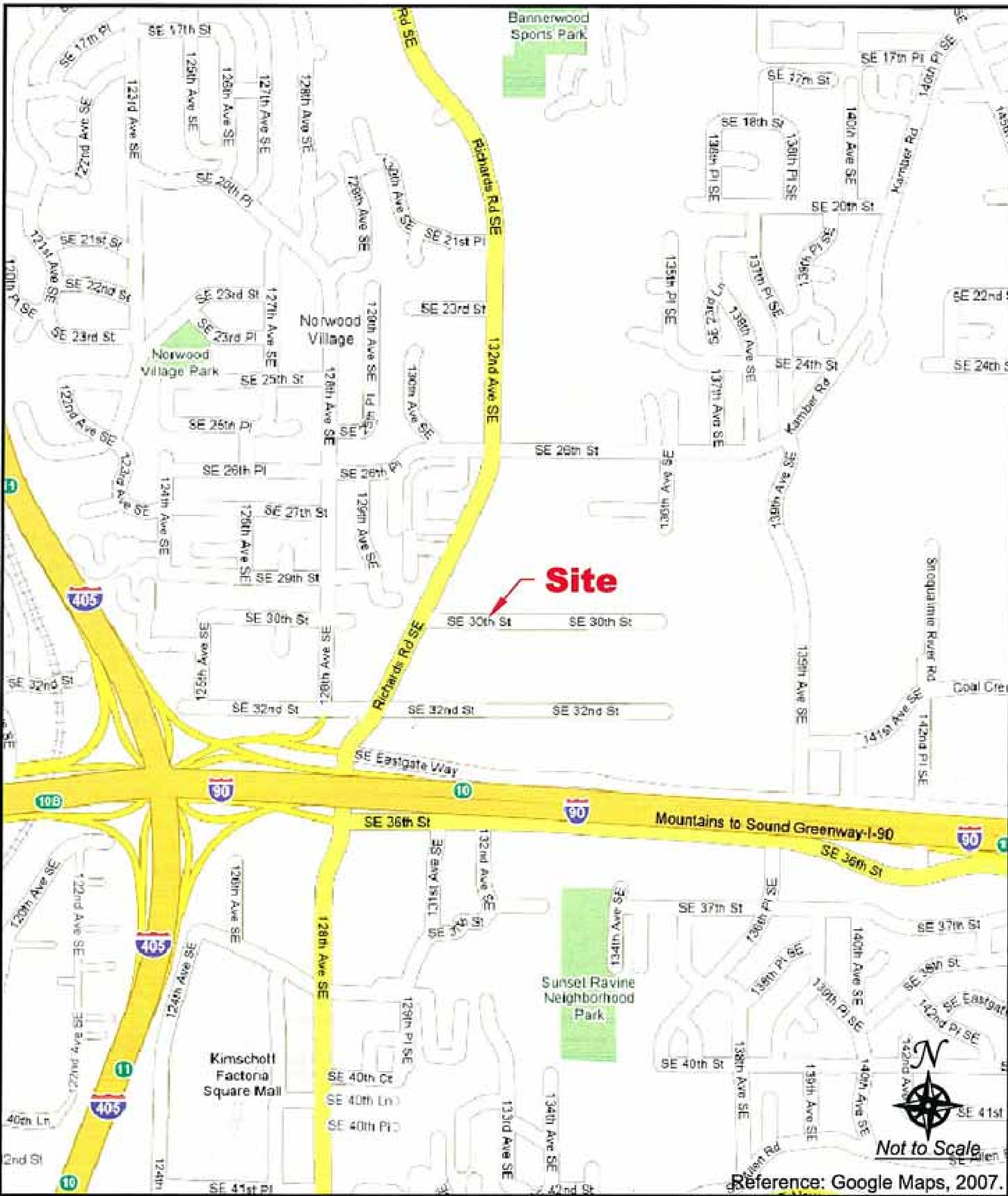
The soil data used in the preparation of this report were obtained from explorations completed for this study. It is possible that variations in soil and groundwater conditions exist between the points explored. The nature and extent of these variations may not be evident until construction occurs. If soil or groundwater conditions are encountered at this site that are different from those described in this report, our firm, and the design team, should be immediately notified so that we may make any necessary revisions to our recommendations. In addition, if the scope of the proposed project, locations of facilities, or design loads change from the descriptions given in this report, our firm, and the design team, should be notified.

The scope of our services does not include services related to construction safety precautions and our recommendations are not intended to direct the contractor's methods, techniques, sequences or procedures, except as specifically described in our report for consideration in design.

This report has been prepared for use in design and construction of the subject property for Herrera Environmental Consultants and their consultants in accordance with the generally accepted standards of practice at the time the report was written. No warranty, express or implied, is made.

This report may be used only by Herrera Environmental Consultants and their consultants and only for the purposes stated within a reasonable time from its issuance, but in no event later than one year from the date of the report. Land or facility use, on and off-site conditions, regulations, or other factors may change over time, and additional work may be required with the passage of time. Any party other than Herrera Environmental Consultants who wishes to use this report shall notify Kleinfelder of such intended use. Based on the intended use of the report, Kleinfelder may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party and client agrees to defend, indemnify, and hold harmless Kleinfelder from any claim or liability associated with such unauthorized use or non-compliance.

It is the responsibility of Herrera Environmental Consultants to see that all parties to the project including the designer, contractor, subcontractors, etc., are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk. Further guidelines and information on this geotechnical report can be found in Appendix C, in the ASFE publication entitled Important Information About Your Geotechnical Engineering Report.



KLEINFELDER

2405 140th Avenue NE, Suite A101
Bellevue, WA 98005-1877
PH: (425) 562-4200 FAX: (425) 562-4201
www.kleinfelder.com

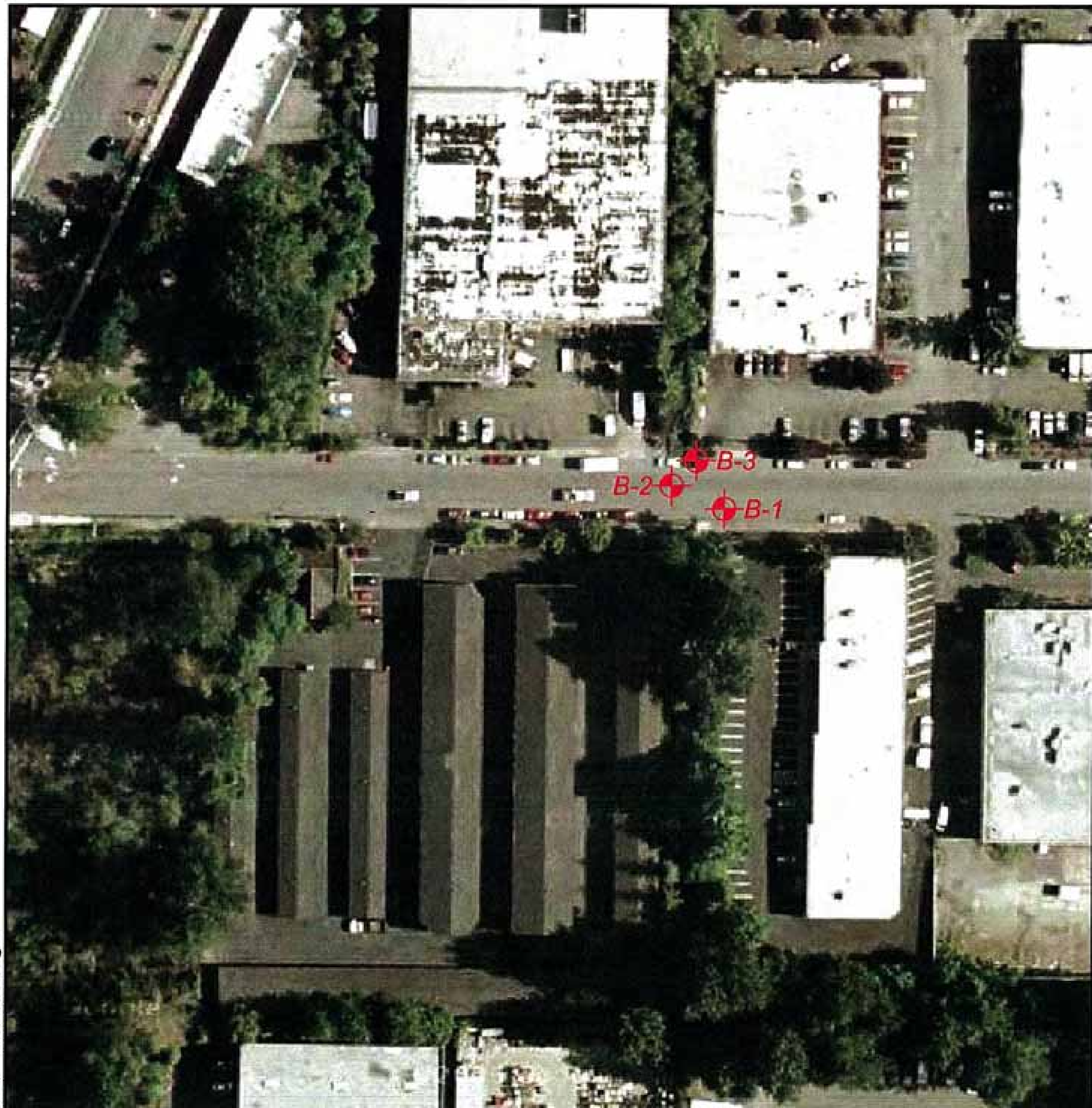
Vicinity Map

Sunset Creek Culvert Replacement
Bellevue, Washington

DRAWN BY:	J.S.
REVISED BY:	M.B.
CHECKED BY:	S.W.
FIGURE	A-1

DRAWN: October 2007 | APPROVED BY: S.W. | PROJECT NO. 82981 | FILE NAME: 82981 - Figures.dwg

ATTACHED IMAGES: Images: Site.tif Images: Vicinity.tif
ATTACHED XREFS: CAD FILE: G:\82981\ LAYOUT: Fig1



Legend

B-1 Boring Designation and Approximate Location

N

Not to Scale

Reference: Google Maps, 2007.

KLEINFELDER 2405 140th Avenue NE, Suite A101 Bellevue, WA 98005-1877 PH: (425) 562-4200 FAX: (425) 562-4201 www.kleinfelder.com	**Site Plan** Sunset Creek Culvert Replacement Bellevue, Washington	DRAWN BY: J.S. REVISED BY: M.B. CHECKED BY: S.W. FIGURE **A-2**
DRAWN: October 2007 APPROVED BY: S.W.	PROJECT NO. 82981 FILE NAME: 82981 - Figures.dwg	

ATTACHED IMAGES: Images: Site.tif Images: Vicinity.tif
ATTACHED XREFS: CAD FILE: G:\82981\ LAYOUT: Fig2

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOIL MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, 0% TO 15% FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, 0% TO 15% FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, SILTY GRAVEL-SAND MIXTURES
				GC	CLAYEY GRAVELS, CLAYEY GRAVEL-SAND MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, 0% TO 15% FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, 0% TO 15% FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SILTY SAND-GRAVEL MIXTURES
				SC	CLAYEY SANDS, CLAYEY SAND-GRAVEL MIXTURES
FINE GRAINED SOIL MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

KLEINFELDER Bright People. Right Solutions. www.kleinfelder.com	PROJECT NO. 82981 DRAWN: July 2008 DRAWN BY: J.S. CHECKED BY: I.L. FILE NAME: Soil Classification.dwg	**Soil Classification Legend** Sunset Creek Culvert Replacement Bellevue, Washington	APPENDIX **A-3**

PLOTTED: 28 Jul 2008, 11:45am, jstewart

CAD FILE: G:\82981\ LAYOUT: Layout1

ATTACHED IMAGES:
ATTACHED XREFS:
SEATTLE, WA

DEPTH (feet)	WELL/PIEZO CONSTRUCTION	WATER LEVEL	MOISTURE CONTENT(%)	PLASTIC LIMIT(%)	LIQUID LIMIT(%)	% PASSING No. 200 SIEVE	OTHER TESTS	PID (ppm)	BLOWS/6 inches** (uncorrected)	SAMPLER *	SAMPLE NUMBER	U.S.C.S. NAME	SOIL DESCRIPTION
0												SW-SM	Surface: Asphalt street 2" asphalt concrete WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM): light brown, moist, medium dense, fine to coarse sand, fine to coarse gravel.
									9, 10, 6	X	S-1		
5			14.9			10			2, 2, 3	X	S-2		
		▽							1, 1, 1	X	S-3	SM	SILTY SAND (SM): gray, moist to wet, loose to medium dense, fine to coarse sand.
10									3, 3, 4	X	S-4		
									3, 5, 7	X	S-5		
15			17.1			13			7, 6, 15	X	S-6	SM	SILTY SAND WITH GRAVEL (SM): gray, wet, medium dense, fine to coarse sand, fine gravel.
20									8, 7, 12	X	S-7		
25									12, 25, 25	X	S-8		
26.5													

Groundwater encountered at approximately 8 feet bgs during drilling as evidenced by wet soil/sampler. Backfilled with natural material and medium bentonite chips.

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

APPROV: ______

DATE DRILLED: 4-20-07	SURFACE ELEVATION (feet):	DRILLING METHOD: HSA
LOGGED BY: D. Divine	TOTAL DEPTH (feet): 26.5	DRILLER: Holocene
REVIEWED BY: M. Byers	DIAMETER OF BORING (in): 6-inch	CASING SIZE: NA

2002 STAN. INPUT/ALL OUTPUT 82981.GPJ 2000REV.GDT 10/23/07

KLEINFELDER
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
SOILS AND MATERIALS TESTING

PROJECT NUMBER: 82981

Sunset Creek Culvert
Bellevue, WA

BORING LOG
B1

A - 4

PAGE 1 of 1

BY: ______

DEPTH (feet)	WATER LEVEL	MOISTURE CONTENT(%)	% PASSING No. 200 SIEVE	BLOWS/6 inches** (uncorrected)	SAMPLE NUMBER	U.S.C.S. NAME	SOIL DESCRIPTION
0						SM	2" asphalt concrete SILTY SAND (SM): light gray, moist to wet, loose to medium dense, fine to medium sand.
				3, 6, 6	S-1	SM	SILTY SAND (SM): light brown, moist to wet, medium dense, fine to coarse sand, trace fine gravel.
5	▽			0, 1, 4	S-2	SM	SILTY SAND (SM): gray, wet, loose, fine to coarse sand, trace fine gravel
						ML	SANDY SILT (ML): gray-green, wet, soft, fine sand (non-plastic).
				0, 1, 4	S-3	SM	SILTY SAND (SM): gray, wet, loose, fine to medium sand.
10		19.8	42	4, 7, 8	S-4		
				2, 3, 4	S-5		
						SM	SILTY SAND (SM): gray, wet, medium dense, fine to coarse sand, trace fine to coarse gravel.
15				7, 8, 14	S-6		
						SM	SILTY SAND WITH GRAVEL (SM): gray, wet, very dense, fine to medium sand, some fine gravel. [TILL]
20		11.1	29	15, 28, 28	S-7		
						SM	SILTY SAND WITH GRAVEL (SM): light gray, moist to wet, very dense, fine to medium sand, fine to coarse gravel. [TILL]
25				12, 18, 25	S-8		
26.5							

Column headings also printed: WELL/PIEZO CONSTRUCTION; TESTING PROGRAM — LABORATORY: PLASTIC LIMIT(%), LIQUID LIMIT(%), OTHER TESTS; FIELD: PID (ppm); SAMPLER *; U.S.C.S. SYMBOL.

Surface: Asphalt street

Groundwater encountered at approximately 5 feet bgs during drilling as evidenced by wet soil/sampler. Backfilled with natural material and medium bentonite chips.

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

DATE DRILLED: 4-20-07
LOGGED BY: D. Divine
REVIEWED BY: M. Byers

SURFACE ELEVATION (feet):
TOTAL DEPTH (feet): 26.5
DIAMETER OF BORING (in): 6-inch

DRILLING METHOD: HSA
DRILLER: Holocene
CASING SIZE: NA

KLEINFELDER
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
SOILS AND MATERIALS TESTING

PROJECT NUMBER: 82981

Sunset Creek Culvert
Bellevue, WA

BORING LOG
B2

A - 5

PAGE 1 of 1

APPROV: ____ BY: ____

DEPTH (feet)	BLOWS/6 inches** (uncorrected)	SAMPLE NUMBER	U.S.C.S. NAME	SOIL DESCRIPTION
				Surface: Asphalt street
0			SM	4.5 inches Asphalt SILTY SAND with GRAVEL (SM): moist, brown, medium dense to loose, subrounded to rounded gravel.
	6, 7, 8	S-1		
5	3, 4, 4	S-2		
	1, 1, 5	S-3	SP-SM	SAND with SILT (SP-SM): wet, gray, very loose to loose, fine to coarse sand, trace gravel.
10	0, 1, 1	S-4		
	2, 3, 2	S-5		- 0.5 inch PEAT lense at 13.4 feet.
15	3, 5, 5	S-6		
20	1, 1, 2	S-7		- 8 inches of interbedded PEAT/ORGANIC SILT at 20.8 feet.
			MH	SILT (MH): wet, gray, soft, trace sand.
25	1, 2, 1	S-8		- 2 inch SAND seam at 26 feet.
			SP	SAND (SP): wet, gray, medium dense, fine to coarse sand, trace silt.
30				

Column headings: DEPTH (feet); WELL/PIEZO CONSTRUCTION; WATER LEVEL; TESTING PROGRAM – LABORATORY: MOISTURE CONTENT(%), PLASTIC LIMIT(%), LIQUID LIMIT(%), % PASSING No. 200 SIEVE, OTHER TESTS; FIELD: PID (ppm); BLOWS/6 inches** (uncorrected); SAMPLER *; SAMPLE NUMBER; U.S.C.S.: NAME, SYMBOL; SOIL DESCRIPTION

DATE DRILLED: 8-24-07
LOGGED BY: J. Washburn
REVIEWED BY: M. Byers

SURFACE ELEVATION (feet):
TOTAL DEPTH (feet): 36.5
DIAMETER OF BORING (in): 6-inch

DRILLING METHOD: HSA
DRILLER: Gregory
CASING SIZE: NA

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

APPROV: ______ BY: ______

KLEINFELDER
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
SOILS AND MATERIALS TESTING
PROJECT NUMBER: 82981

Sunset Creek Culvert
Bellevue, WA

BORING LOG
B3

A - 6a

DEPTH (feet)	WELL/PIEZO CONSTRUCTION	WATER LEVEL	MOISTURE CONTENT(%)	PLASTIC LIMIT(%)	LIQUID LIMIT(%)	% PASSING No. 200 SIEVE	OTHER TESTS	PID (ppm)	BLOWS/6 inches** (uncorrected)	SAMPLER *	SAMPLE NUMBER	U.S.C.S. NAME	U.S.C.S. SYMBOL	SOIL DESCRIPTION
30									9 17 18	SPT	S-9			
35									8 7 8	SPT	S-10			
36.5														

Groundwater encountered at approximately 7.5 feet bgs during drilling as evidenced by wet soil/sampler. Backfilled with natural material and medium bentonite chips.

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

* SAMPLER TYPE: Cal. (3"OD) Split Spoon; SPT (2" OD) Split Spoon; Core Sample; Shelby Tube; Grab; No Recovery

**HAMMER WEIGHT: 300 lbs (30" Drop); 140 lbs (30" Drop)

APPROV: ______ BY: ______

KLEINFELDER
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
SOILS AND MATERIALS TESTING

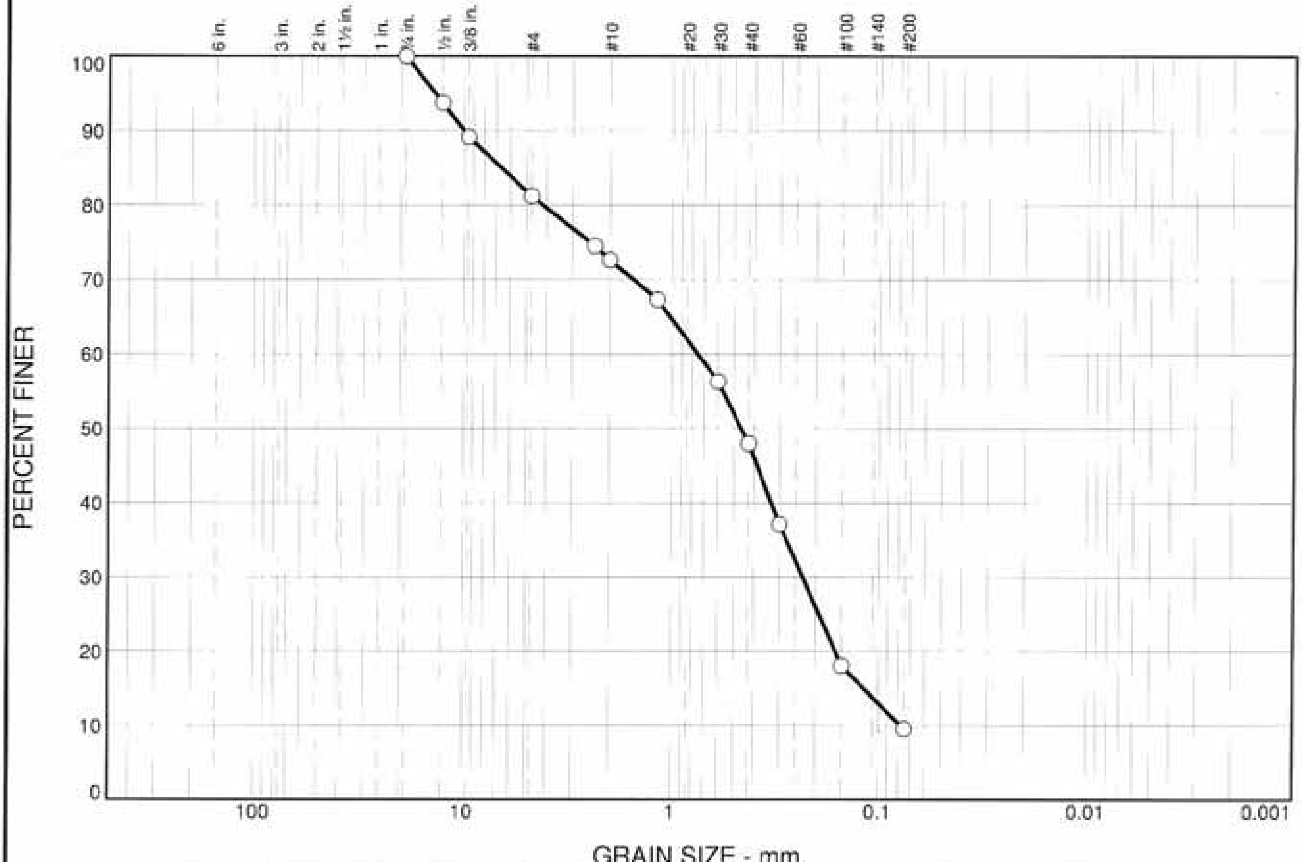
PROJECT NUMBER: 82981

Sunset Creek Culvert
Bellevue, WA

BORING LOG
B3

A - 6b

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	18.8	8.6	24.6	38.4	9.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	93.8		
3/8"	89.2		
#4	81.2		
#8	74.5		
#10	72.6		
#16	67.3		
#30	56.3		
#40	48.0		
#50	37.1		
#100	18.1		
#200	9.6		

* (no specification provided)

Material Description

Well-graded sand with silt and gravel
Laboratory No.: 7611A
Moisture Content:14.9%

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 6.6171 D_{60}= 0.7518 D_{50}= 0.4613
D_{30}= 0.2314 D_{15}= 0.1166 D_{10}= 0.0777
C_u= 9.68 C_c= 0.92

Classification

USCS= SW-SM AASHTO=

Remarks

Entered By: B. Kochanski

Sample Number: S-2
Source of Sample: B-1 **Depth:** 5' **Date:** 5-7-07

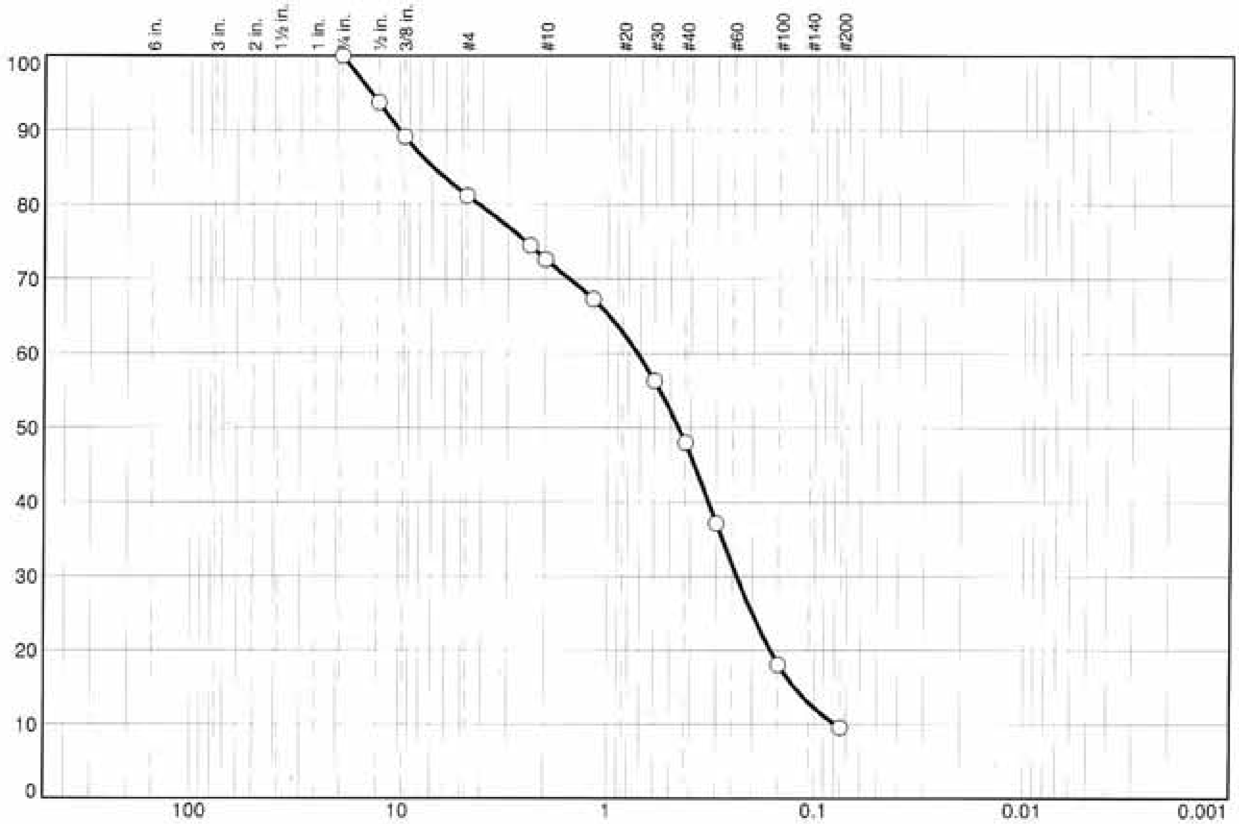
Kleinfelder, Inc.

Bellevue, WA

Client: Herrera
Project: Sunset Creek Culvert
Project No: 82981 **Figure** B-1

Tested By: B. Kochanski **Checked By:** J. Revard, CET

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	19	8	25	38	10	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100		
1/2"	94		
3/8"	89		
#4	81		
#8	75		
#10	73		
#16	67		
#30	56		
#40	48		
#50	37		
#100	18		
#200	10		

* (no specification provided)

Material Description

Well-graded sand with silt and gravel
Laboratory No.: 7611A
Moisture Content: 14.9%

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 6.9169 D_{60}= 0.7232 D_{50}= 0.4570
D_{30}= 0.2391 D_{15}= 0.1249 D_{10}= 0.0788
C_u= 9.17 C_c= 1.00

Classification

USCS= SW-SM AASHTO=

Remarks

Entered By: B. Kochanski

Sample Number: S-2
Source of Sample: B-1 **Depth:** 5' **Date:** 5-7-07

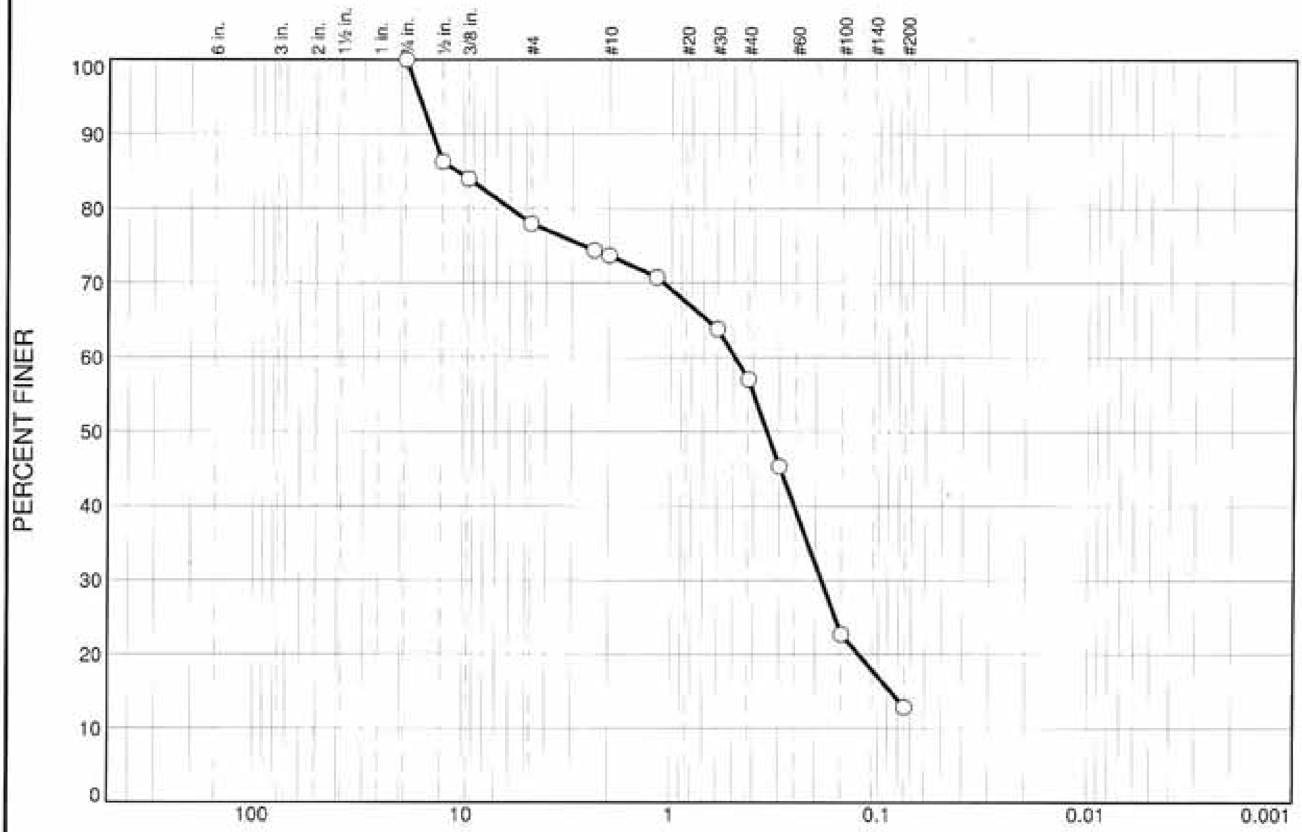
Kleinfelder, Inc.

Bellevue, WA

Client: Herrera
Project: Sunset Creek Culvert
Project No: 82981 **Figure**

Tested By: B. Kochanski **Checked By:** J. Revard, CET

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	22.0	4.3	16.6	44.2	12.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100.0		
1/2"	86.3		
3/8"	84.0		
#4	78.0		
#8	74.4		
#10	73.7		
#16	70.8		
#30	63.8		
#40	57.1		
#50	45.4		
#100	22.8		
#200	12.9		

* (no specification provided)

Material Description

Silty sand with gravel
Laboratory No.: 7611B
Moisture Content: 17.1%

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 10.7583 D_{60}= 0.4933 D_{50}= 0.3443
D_{30}= 0.1873 D_{15}= 0.0868 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

Entered By: B. Kochanski

Sample Number: S-6
Source of Sample: B-1 **Depth:** 15' **Date:** 5-7-07

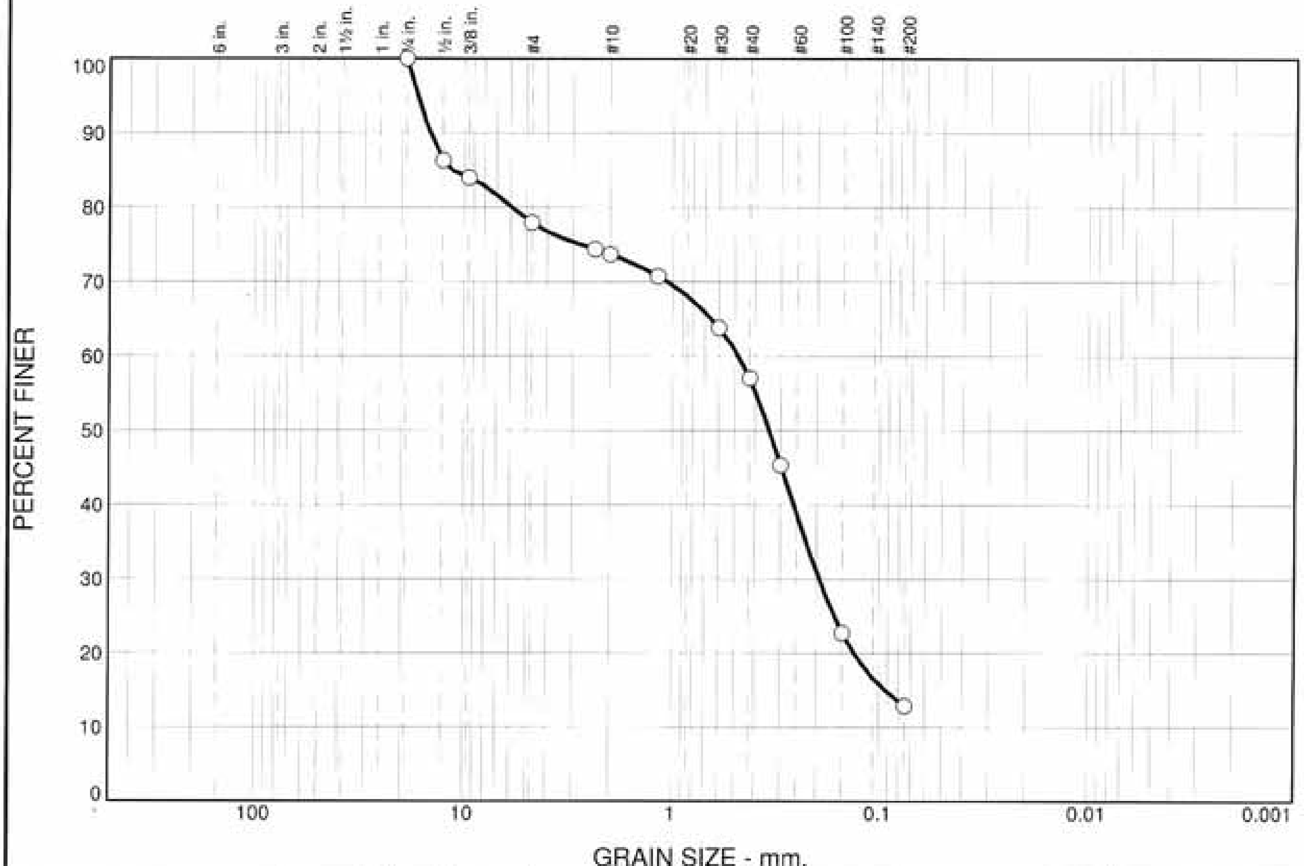
Kleinfelder, Inc.

Bellevue, WA

Client: Herrera
Project: Sunset Creek Culvert
Project No: 82981 **Figure** B-2

Tested By: B. Kochanski / R. Muir **Checked By:** J. Revard, CET

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	22	4	17	44	13	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4"	100		
1/2"	86		
3/8"	84		
#4	78		
#8	74		
#10	74		
#16	71		
#30	64		
#40	57		
#50	45		
#100	23		
#200	13		

* (no specification provided)

Material Description

Silty sand with gravel
Laboratory No.: 7611B
Moisture Content: 17.1%

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 11.4534 D_{60}= 0.4804 D_{50}= 0.3406
D_{30}= 0.1943 D_{15}= 0.0924 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

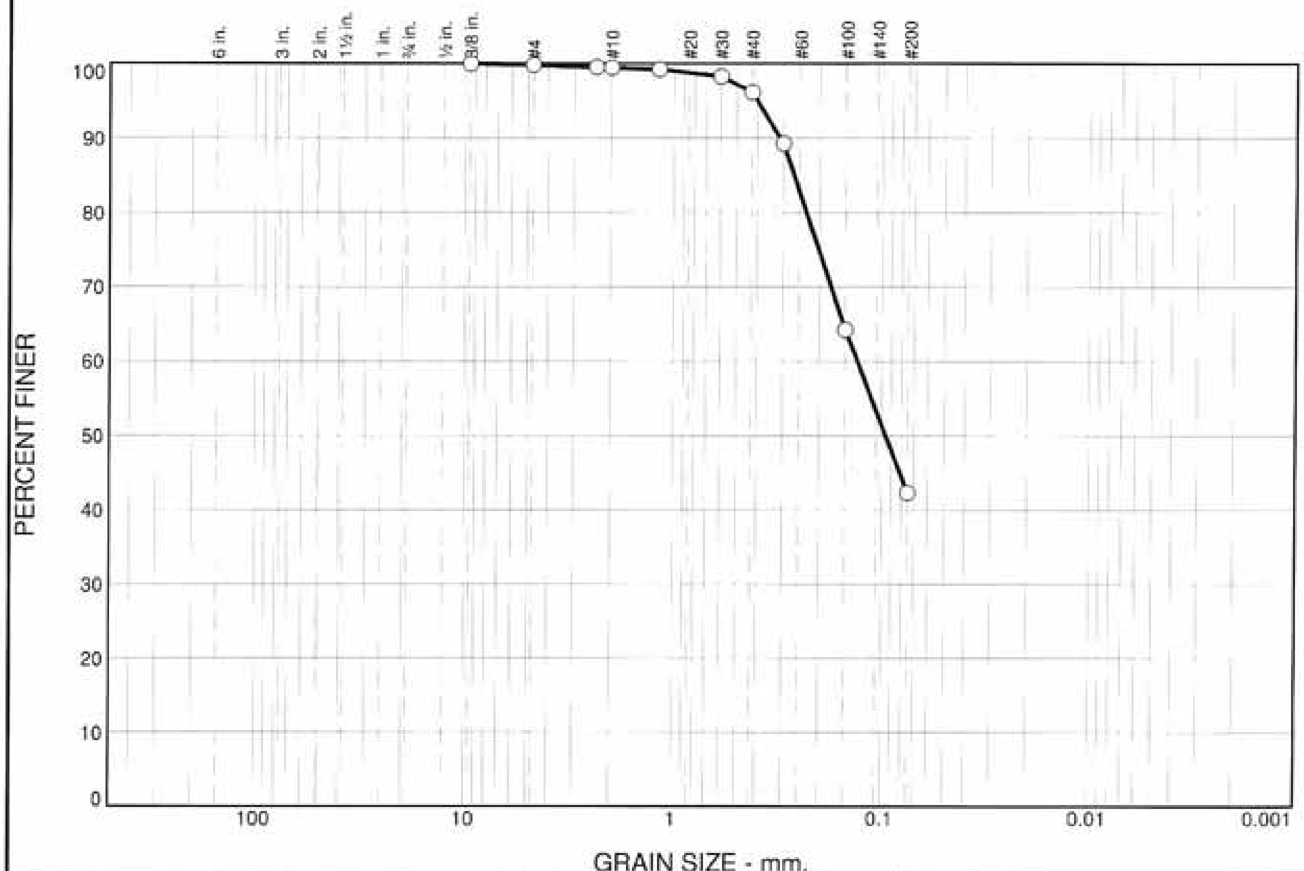
Entered By: B. Kochanski

Sample Number: S-6
Source of Sample: B-1 **Depth:** 15' **Date:** 5-7-07

Kleinfelder, Inc.	**Client:** Herrera
	Project: Sunset Creek Culvert
Bellevue, WA	**Project No:** 82981 **Figure**

Tested By: B. Kochanski / R. Muir **Checked By:** J. Revard, CET

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	0.3	3.3	53.9	42.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
#4	99.8		
#8	99.5		
#10	99.5		
#16	99.2		
#30	98.3		
#40	96.2		
#50	89.3		
#100	64.3		
#200	42.3		

* (no specification provided)

Material Description

Silty sand
Laboratory No.: 7611C
Moisture Content: 19.8%

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.2666 D_{60}= 0.1311 D_{50}= 0.0956
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

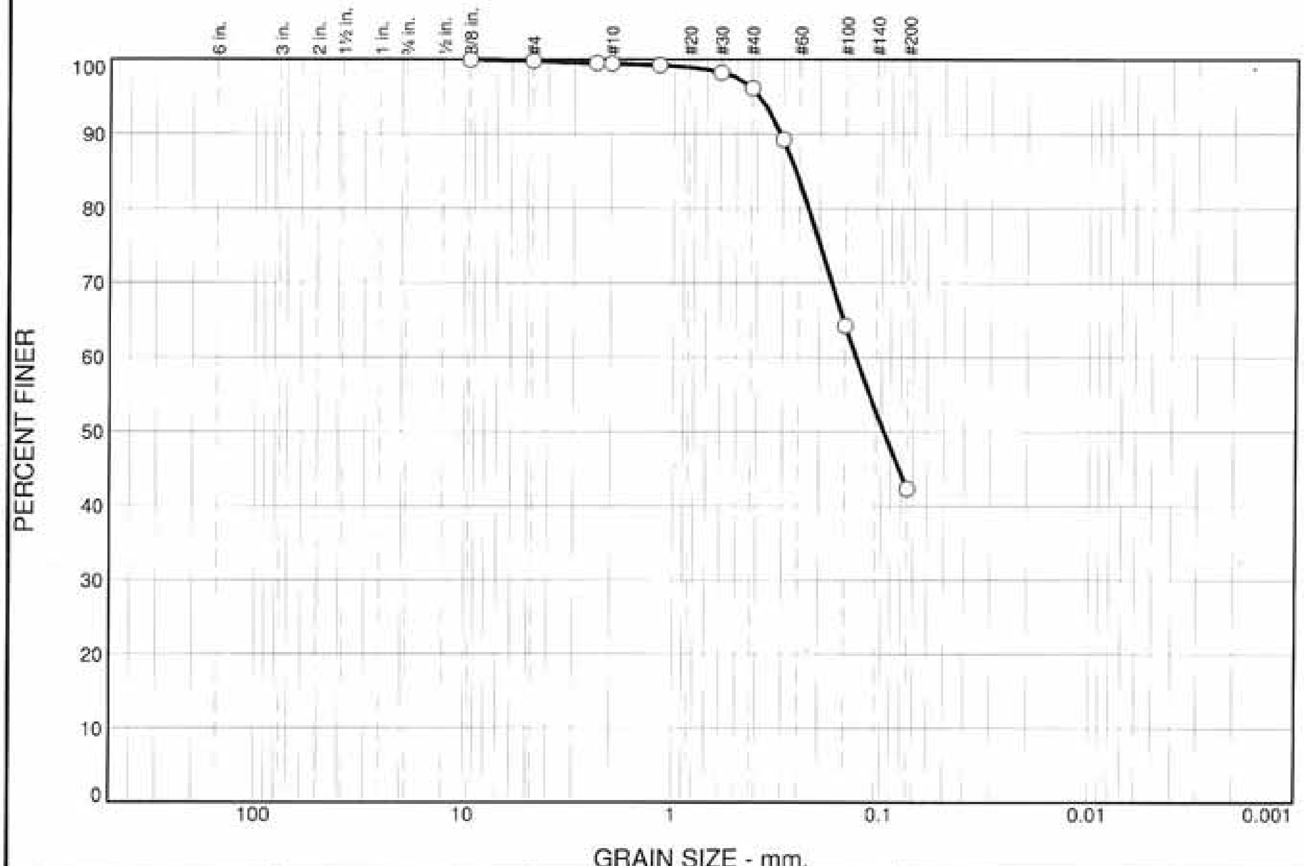
Entered By: B. Kochanski

Sample Number: S-4
Source of Sample: B-2 **Depth:** 10' **Date:** 5-7-07

Kleinfelder, Inc. Bellevue, WA	**Client:** Herrera **Project:** Sunset Creek Culvert **Project No:** 82981 **Figure** B-3

Tested By: R. Muir **Checked By:** J. Revard, CET

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	0	1	3	54	42	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100		
#4	100		
#8	100		
#10	99		
#16	99		
#30	98		
#40	96		
#50	89		
#100	64		
#200	42		

* (no specification provided)

Material Description

Silty sand
Laboratory No.: 7611C
Moisture Content: 19.8%

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.2612 D_{60}= 0.1329 D_{50}= 0.0972
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

Entered By: B. Kochanski

Sample Number: S-4
Source of Sample: B-2 **Depth:** 10' **Date:** 5-7-07

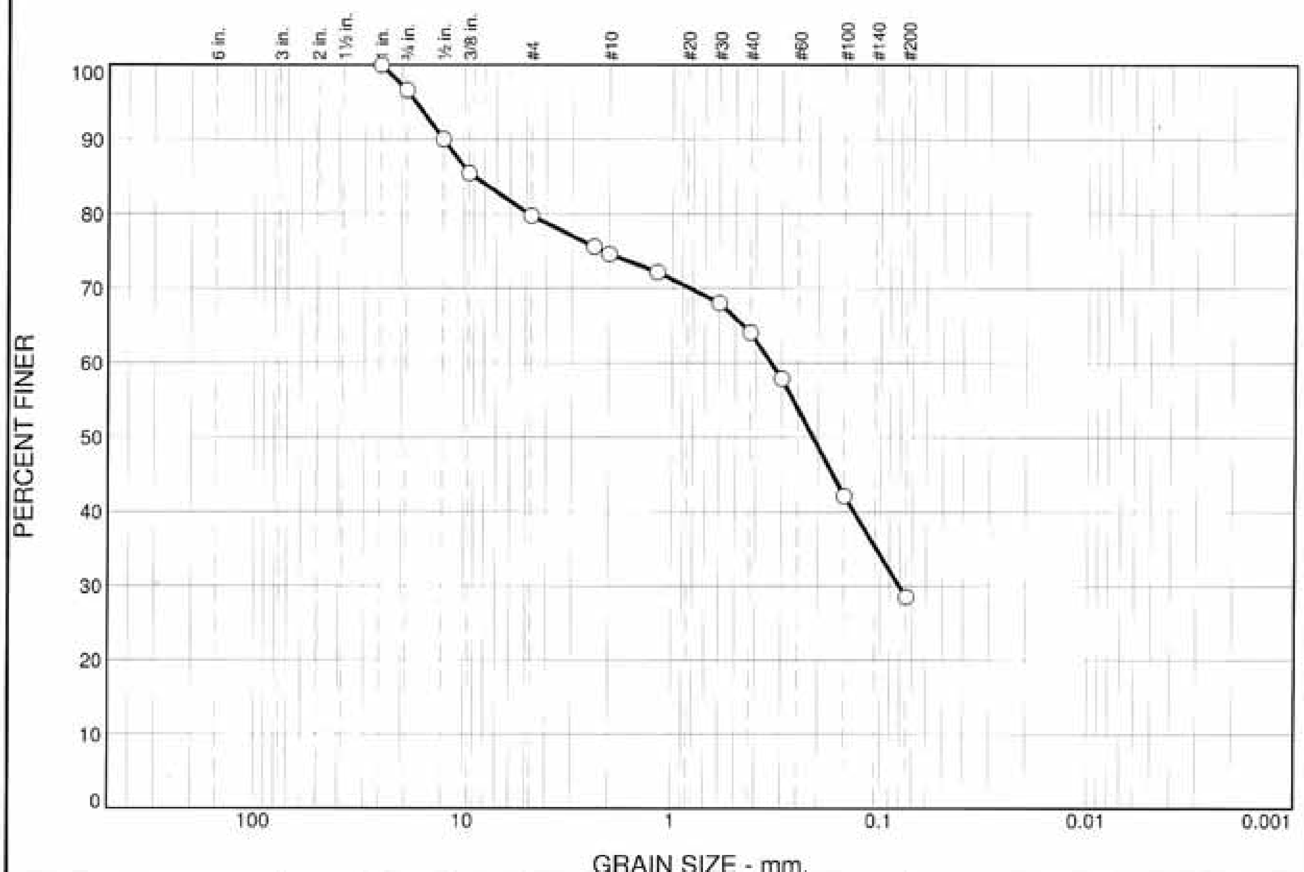
Kleinfelder, Inc.

Bellevue, WA

Client: Herrera
Project: Sunset Creek Culvert
Project No: 82981 **Figure**

Tested By: R. Muir **Checked By:** J. Revard, CET

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	3.3	16.9	5.2	10.5	35.6	28.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	96.7		
1/2"	90.0		
3/8"	85.5		
#4	79.8		
#8	75.6		
#10	74.6		
#16	72.2		
#30	68.1		
#40	64.1		
#50	57.9		
#100	42.1		
#200	28.5		

* (no specification provided)

Material Description

Silty sand with gravel
Laboratory No.: 7611D
Moisture Content: 11.1%

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 8.9911 D_{60}= 0.3380 D_{50}= 0.2121
D_{30}= 0.0809 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

Entered By: B. Kochanski

Sample Number: S-7
Source of Sample: B-2 **Depth:** 20' **Date:** 5-7-07

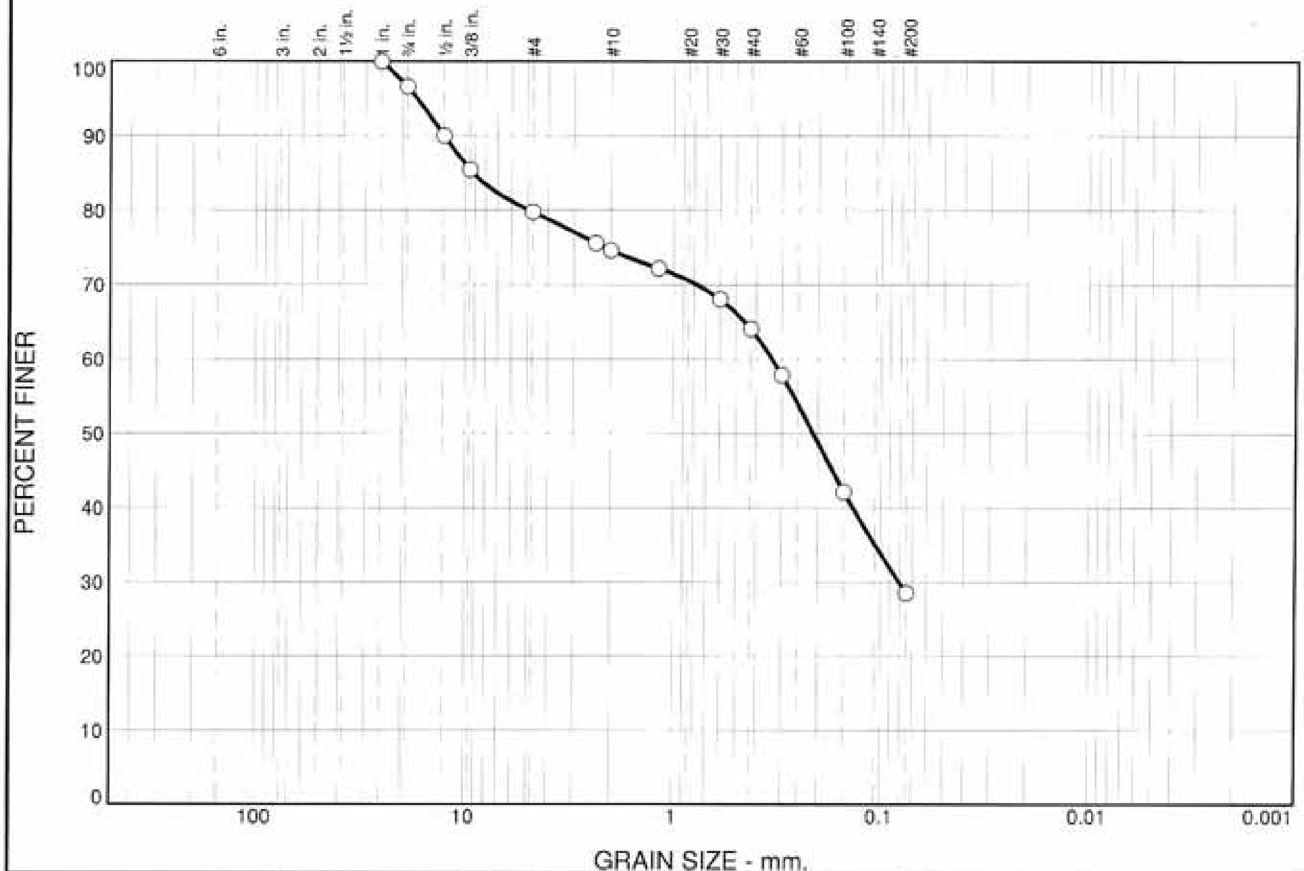
Kleinfelder, Inc.

Bellevue, WA

Client: Herrera
Project: Sunset Creek Culvert
Project No: 82981 **Figure** B-4

Tested By: R. Muir **Checked By:** J. Revard, CET

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	3	17	5	11	35	29	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100		
3/4"	97		
1/2"	90		
3/8"	85		
#4	80		
#8	76		
#10	75		
#16	72		
#30	68		
#40	64		
#50	58		
#100	42		
#200	29		

* (no specification provided)

Material Description

Silty sand with gravel
Laboratory No.: 7611D
Moisture Content: 11.1%

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 9.1888 D_{60}= 0.3339 D_{50}= 0.2112
D_{30}= 0.0813 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

Entered By: B. Kochanski

Sample Number: S-7
Source of Sample: B-2 **Depth:** 20' **Date:** 5-7-07

Kleinfelder, Inc.

Bellevue, WA

Client: Herrera
Project: Sunset Creek Culvert
Project No: 82981 **Figure**

Tested By: R. Muir **Checked By:** J. Revard, CET

Important Information About Your
Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

APPENDIX B

Analysis of Sunset Creek Culvert Replacement Options at SE 30th Street (Dustin's memo)

CivilTech Engineering

10800 NE 8th Street
Suite 820
Bellevue, WA 98004

Tel: 425.453.6488
Fax: 425.453.5848

May 3, 2007

Herrera Environmental Consultants
2200 Sixth Avenue, Suite 1100
Seattle, WA 98121

Attention: **Chase Barton**

Reference: **SE 30TH / Sunset Creek Improvements**

Subject: **SE 30TH St. Culvert Replacement Considerations**

Dear Chase,

As a part of the Sunset stream flow improvement project, a new culvert to replace the existing two 36" diameter corrugated metal pipes (CMP) crossing SE 30th Street was studied. The study included an evaluation of upsizing the existing stream opening and providing a sedimentation facility at the SE 30th Street location. Currently, the existing pipes are too small for a flood event plus the sediment deposit downstream of the culvert is exacerbating the problem. Therefore, a sedimentation facility will provide a trap to capture most of the fine soils in the stream and minimize continuous downstream migrations.

Several factors are important in selecting the size, type, and arrangement of the culvert structure. These factors include:

1. Maintaining the existing SE 30th Street profile
2. Maintaining the existing stream flow alignment and the up and downstream channel widths
3. Minimum impacts to the existing utilities, especially the 5' diameter Metro Sewer manhole, telephone vault, and fire department connection
4. Maintaining one lane traffic flow during construction
5. Providing a sedimentation facility for about 100 cubic yards of sediment soil
6. Minimum impacts to the adjacent properties and their businesses
7. Minimum disturbance to the existing rockeries along the stream banks

Based on these criteria, it was found that the existing 5' diameter manhole for the Metro Sewer at the east and the fire department connection at the west of the existing CMP constitute the most critical space restriction to the size of a new culvert. The preliminary study found that close to 12' in clear span and 15' in total depth for a new culvert can be considered. These limits apply only to the south area of the road close to the manhole. At other areas, the size of the culvert could be increased.

Low high rockeries at the upstream of the existing CMP pipes were found to have a plan opening of about 10' to 12'. At the downstream site, similar but slightly wider opening between the existing rockery banks was noted.

Precast structures are an economical and viable solution to facilitate and reduce project construction time. Three or four sided concrete box culverts can be applied depending on the foundation soils and the requirements from the sedimentation facility. The three or four sided precast culverts are typically fabricated to about 5' to 10' wide in segments. This size is relatively light and can be easily transported, lifted, and erected at the site using a light crane.

A new sedimentation facility was evaluated at the same culvert location. In order to avoid construction impacts to the existing Metro Sewer manhole and the connected sewer lines, it is recommended that this facility be located at the north portion of the street. This facility can be constructed and integrated into the new culvert structure. A general layout plan and sections are shown in the attached hand sketches Sheets 1 through 3.

The sedimentation capacity can be arranged based on various combinations of the horizontal length (W) and height (H) shown in the Sheet 2. Higher construction costs are expected when deeper and larger sedimentation capacity is required due to taller wall structures and more excavation or shoring system. Sections in the Sheet 1 show two culvert types that are available in the market: one with rectangular and one with arch type culverts.

Based on the culvert arrangement, it is suggested to fabricate all precast segments with same dimensions for the entire culvert length. At the south section of the culvert where the culvert walls are relatively low, the precast segments could be found directly on cast-in-place footings. At the north section of the culvert however, taller culvert walls are required. Cast-in-place pedestal walls can then be utilized to compensate the extra wall heights in addition to the precast segments. This approach provides an economical solution due to a simplification in designs and in casting and erecting precast segments.

Smaller utility lines such as gas, underground communication lines and water pipes could be embedded in the precast lid or located in the space between the sidewalks and precast lid. Penetrations for utilities located in the lid and/or inserts for utility supports can be cast into the precast units. The utility lines can then run through these penetrations after the culverts are erected at the site. As an alternate, they could be mounted to the exterior faces of the culvert or laid below the culvert footings. Larger size utilities that cannot be accommodated by the methods described above will need to be re-routed and re-located below the culvert footings.

If it is desirable, access holes for future cleaning of the soils deposited in the sediment facility can be located at the top of the precast culvert lid. City of Bellevue Maintenance Department will need to provide us with number of the access holes and its spacing for incorporation.

In order to maintain one lane traffic flow at all times, construction of the culvert will need to be executed in two phases. The 1st Phase could start at the south portion of the culvert for a length that is sufficient to accommodate one traffic lane, a sidewalk, and a temporary barrier. The 2nd phase would then continue the remaining culvert that involves taller walls, sedimentation facility, and others.

The findings above did not consider a bypass channel or pipe to facilitate the cleaning of the sediment facility; thus it is not shown on the sketches. If it is desirable, such a bypass system can be located west of the culvert, but the fire department connection will need to be relocated or be temporary supported during construction.

At this point in time, CivilTech understands that the followings parameters will be identified during the next phase of design.

- Culver opening
- Bypass opening
- Sediment storage capacity
- Down-slope and up-slope of storage facility
- Shallow foundation versus deep foundation
- Number and spacing of access holes

We hope that we have provided sufficient information for the City of Bellevue to evaluate their alternatives. Please let us know if we can further assist you.

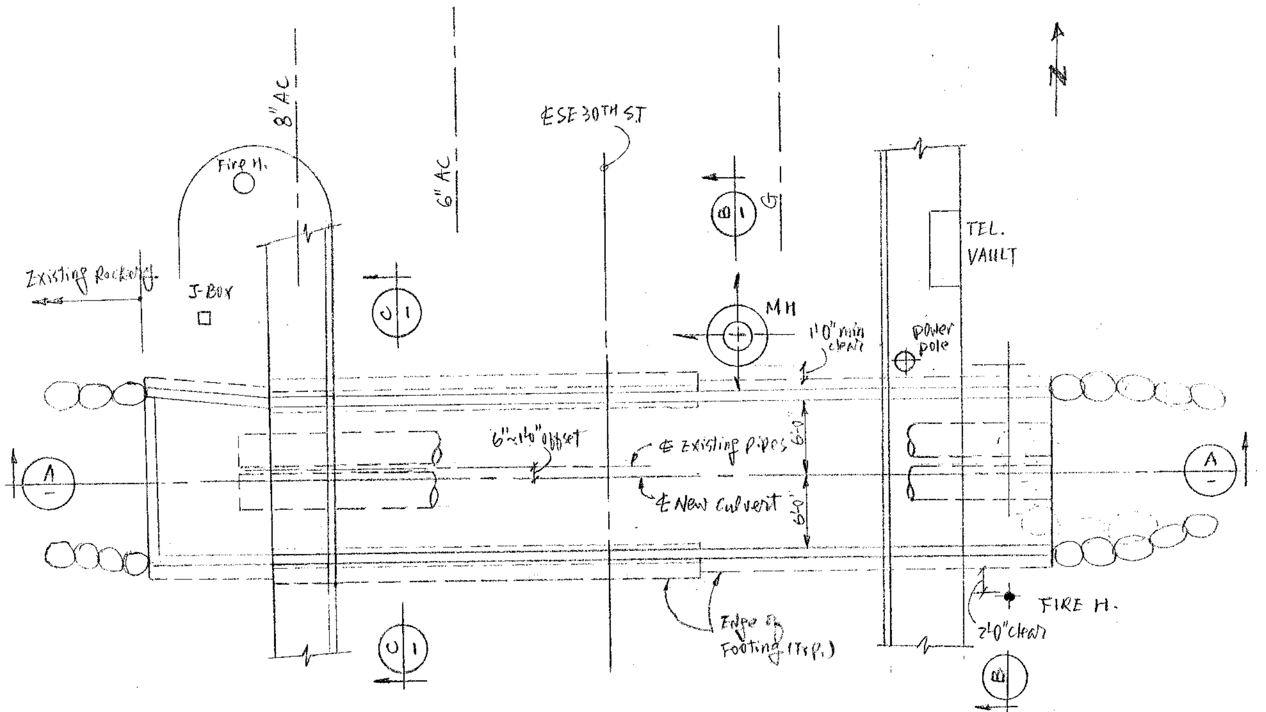
Respectfully Submitted,

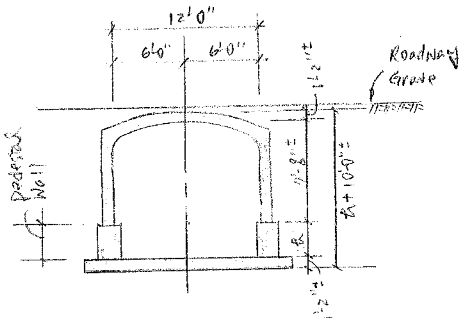
CivilTech Engineering

D. Chang Ong

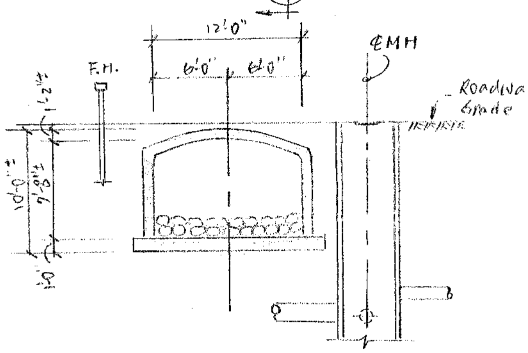
Dustin C. Ong, PE SE

Enclosures: Sketches 1 - 3

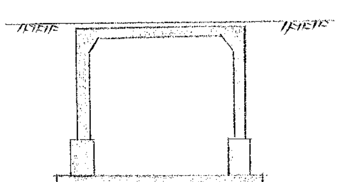




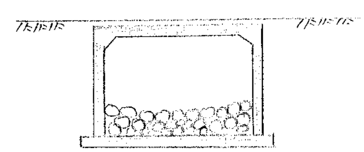
SECTION C



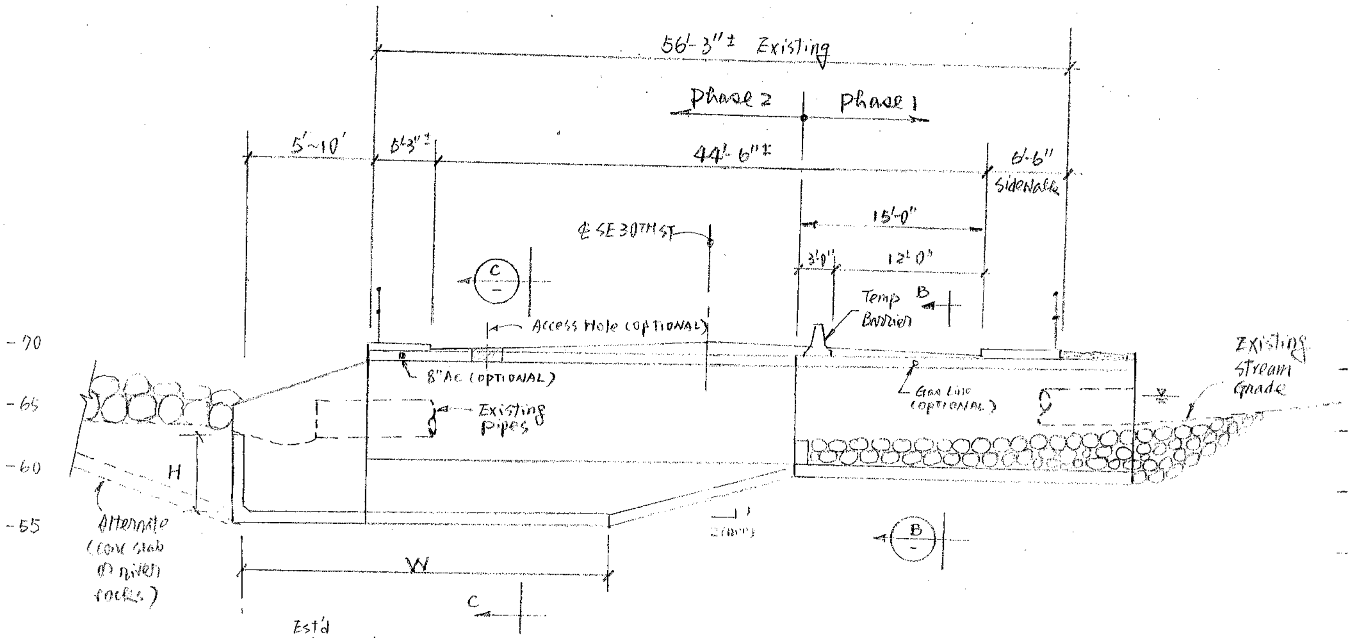
SECTION B



ALTERNATE



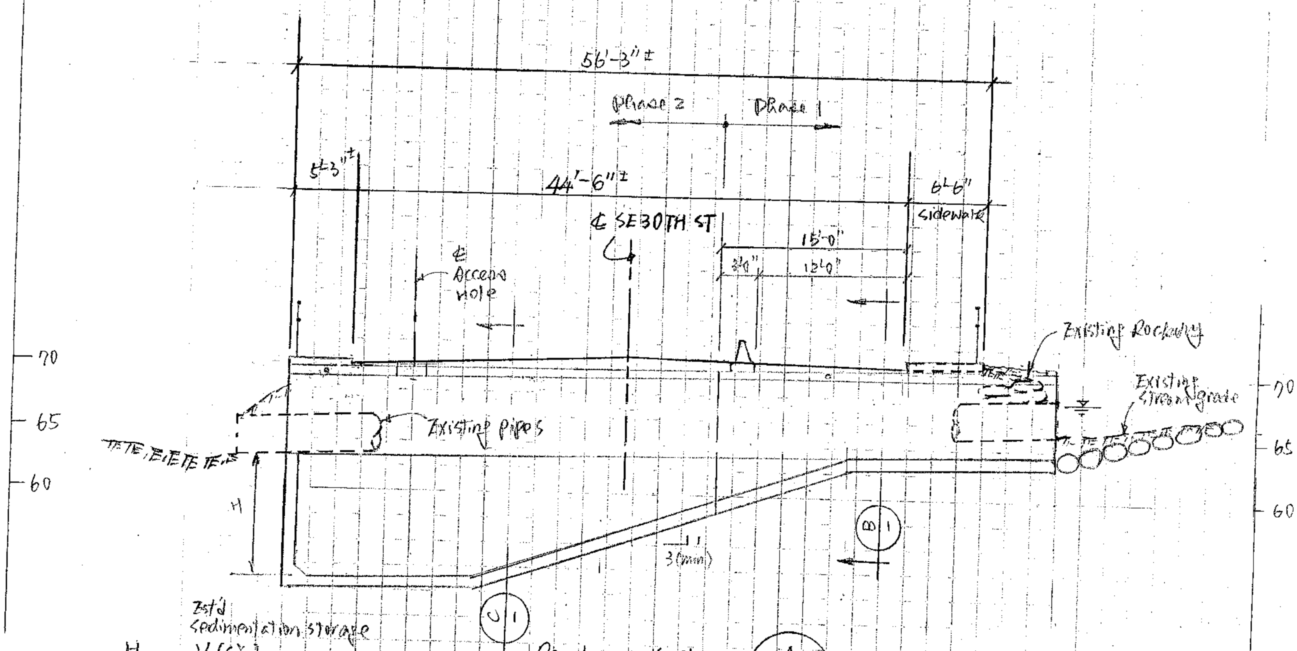
ALTERNATE



H	W	Est'd Sedimentation Storage (CY)
5'	30'	83
6'	30'	100
7'	30'	117
7'	20'	95

Roadway Section (A)
(ALT 1)

SHT 2



Roadway Section
(ALT 2)

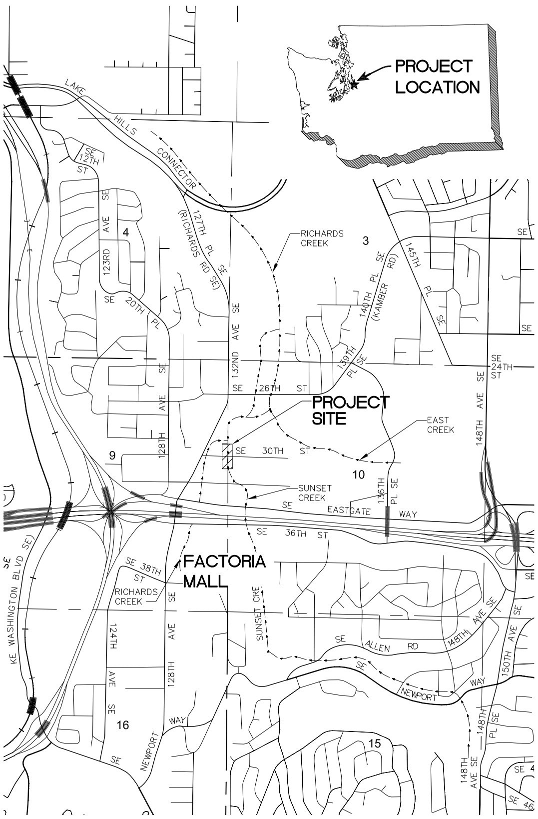
Est'd Sedimentation storage

H	V (CY)
8	96
9	114
10	133

SHT 3

APPENDIX C

Phase I 60% Design Plans



VICINITY MAP
SCALE: 1"=1000'

CITY OF BELLEVUE
SE 30TH STREET/SUNSET CREEK
CULVERT REPLACEMENT PROJECT

BELLEVUE, WASHINGTON

SHEET INDEX		
SHT NO.	DWG NO.	SHEET DESCRIPTION
1	G-1	TITLE SHEET, INDEX, AND VICINITY MAP
2	G-2	GENERAL NOTES
3	G-3	ABBREVIATIONS AND LEGEND
4	G-4	SITE PLAN
5	C-1	ROADWAY CORRIDOR DEMOLITION PLAN
6	C-2	ROADWAY PHASING PLAN AND NOTES
7	C-3	UTILITIES PLAN
8	C-4	UTILITIES DETAILS
9	C-5	ROADWAY PLAN AND SECTION
10	C-6	ROADWAY PLAN AND SECTION
11	C-7	CULVERT REPLACEMENT PLAN AND NOTES
12	C-8	CULVERT REPLACEMENT PROFILE AND NOTES
13	C-9	CULVERT REPLACEMENT DETAILS
14	C-10	STREAM CORRIDOR SITE PREPARATION PLAN
15	C-11	UPPER STREAM CHANNEL MODIFICATIONS PLAN AND PROFILE
16	C-12	LOWER STREAM CHANNEL MODIFICATIONS PLAN AND PROFILE
17	C-13	STREAM CHANNEL MODIFICATIONS DETAILS
18	ESC-1	TEMPORARY EROSION AND SEDIMENT CONTROL PLAN
19	ESC-2	TESC DETAILS
20	WM-1	FLOW DIVERSION AND FISH EXCLUSION DETAILS
21	P-1	PLANTING PLAN
22	P-2	PLANTING DETAILS
23	P-3	PLANT MATERIAL LIST

1 / C-3 — DETAIL REFERENCE NUMBER / DRAWING ON WHICH DETAIL IS SHOWN

DETAIL
SCALE: NTS
1 / C-1 — DETAIL REFERENCE NUMBER / DRAWING FROM WHICH DETAIL WAS TAKEN

A / C-4 — SECTION REFERENCE LETTER / DRAWING ON WHICH SECTION IS SHOWN

SECTION
SCALE: NTS
A / C-2 — SECTION REFERENCE LETTER / DRAWING FROM WHICH SECTION WAS TAKEN

"–" INDICATES THAT THE DETAIL/SECTION IS SHOWN ON THE SAME SHEET

"TYP" INDICATES THAT THE DETAIL/SECTION IS UNIFORMLY TYPICAL THROUGHOUT PROJECT EXCEPT WHERE OTHERWISE NOTED

"VAR" SPECIFIES THAT DETAIL/SECTION WAS TAKEN FROM SEVERAL DRAWINGS

NOTE AND DETAIL/SECTION REFERENCING

MARK EWBANK
STATE OF WASHINGTON
29434
CIVIL ENGINEER
PROFESSIONAL ENGINEER

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

811
Know what's below. Call before you dig.

60% DESIGN - NOT FOR CONSTRUCTION

NO	DATE	BY	APPR	REVISIONS
1	10/08	CB	ME	REVISIONS TO 60% DESIGN

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
Suite 1100
Seattle, Washington
98121-1820
206-441-9080
206-441-9108 FAX
http://www.herrerainc.com

SE 30TH STREET / SUNSET CREEK
CULVERT REPLACEMENT PROJECT

Approved By
DESIGN MANAGER — DATE
PROJECT MANAGER — DATE

C. BARTON 05/2008
DESIGNED BY — DATE
W. WESZCZECINSKI 06/2008
DRAWN BY — DATE
M. EWBANK 06/2008
CHECKED BY — DATE

CITY OF BELLEVUE WASHINGTON
City of Bellevue
UTILITIES

TITLE SHEET, INDEX, AND VICINITY MAP
DRAWING G-1
SHT 1 OF 23

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase II\G-1.dwg
Plot Date: 10/22/2008 1:30 PM
Cad User: Wojciech Wieszczecinski

GENERAL NOTES:

1. MATERIAL SHALL NOT BE STORED OUTSIDE OF IDENTIFIED STAGING AREAS, UNLESS APPROVED BY OWNER OR ENGINEER.
2. ALL EQUIPMENT SHALL USE ONLY BIODEGRADABLE HYDRAULIC FLUIDS.
3. CONTRACTOR SHALL LIMIT MACHINERY MOVEMENT TO PROJECT LIMITS DEFINED ON SITE PLAN OR IDENTIFIED AS ACCEPTABLE BY ENGINEER.
4. CLEARING LIMITS FOR TEMPORARY ACCESS ROAD AND PROPOSED STRUCTURES SHALL BE LIMITED TO THE AREA REQUIRED FOR SAFE EQUIPMENT OPERATION. CLEARING LIMITS SHALL BE STAKED BY CONTRACTOR AND APPROVED BY ENGINEER AT LEAST 3 DAYS PRIOR TO CLEARING ACTIVITIES. CLEARING LIMITS SHALL BE STAKED TO MINIMIZE THE AREA OF DISTURBANCE.
5. SEE SPECIFICATIONS FOR LOG TYPE (SPECIES), DIAMETER AND LENGTH. EXCAVATIONS SHALL BE INSPECTED BY ENGINEER PRIOR TO PLACEMENT OF ANY WOOD.
6. LOG PLACEMENTS SHALL BE INSPECTED BY ENGINEER PRIOR TO BACKFILLING.
7. CONTRACTOR SHALL PROVIDE 24 HOURS ADVANCE NOTICE TO THE ENGINEER PRIOR TO ANY REQUIRED INSPECTION. CONTRACTOR SHALL SUBMIT A CONSTRUCTION SEQUENCE PLAN FOR APPROVAL AT LEAST 5 DAYS PRIOR TO SITE WORK.
8. APPROVED CONSTRUCTION SEQUENCE PLAN SHALL NOT BE ALTERED UNLESS APPROVED BY ENGINEER.
9. EQUIPMENT USED FOR THIS PROJECT SHALL BE FREE OF EXTERNAL PETROLEUM-BASED PRODUCTS WHILE WORKING AROUND THE STREAM. ACCUMULATION OF SOILS OR DEBRIS SHALL BE REMOVED FROM THE DRIVE MECHANISMS (WHEELS, TRACKS, TIRES, ETC.) AND UNDERCARRIAGE OF EQUIPMENT PRIOR TO ITS WORKING WITHIN THE CHANNEL.
10. EQUIPMENT SHALL BE CHECKED DAILY FOR LEAKS, AND ANY NECESSARY REPAIRS SHALL BE COMPLETED PRIOR TO COMMENCING WORK ACTIVITIES.
11. THE CONTRACTOR IS RESPONSIBLE TO ENSURE THAT NO PETROLEUM PRODUCTS, HYDRAULIC FLUID, SEDIMENTS, SEDIMENT-LADEN WATER, CHEMICALS, OR ANY OTHER TOXIC OR DELETERIOUS MATERIALS ARE ALLOWED TO ENTER OR LEACH INTO THE STREAM.
12. IF AT ANY TIME, AS A RESULT OF PROJECT ACTIVITIES, FISH ARE OBSERVED IN DISTRESS, A FISH KILL OCCURS, OR WATER QUALITY PROBLEMS DEVELOP (INCLUDING EQUIPMENT LEAKS OR SPILLS), OPERATIONS SHALL CEASE AND THE ENGINEER SHALL BE NOTIFIED IMMEDIATELY. WASHINGTON DEPARTMENT OF FISH AND WILDLIFE AND WASHINGTON DEPARTMENT OF ECOLOGY SHALL BE CONTACTED IMMEDIATELY BY THE ENGINEER OR BY HIS/HER DESIGNEE. WORK SHALL NOT RESUME UNTIL FURTHER APPROVAL BY OWNER'S REPRESENTATIVE.
13. EROSION CONTROL METHODS SHALL BE USED TO PREVENT SILT-LADEN WATER FROM ENTERING THE CREEK. INITIAL EROSION CONTROL MEASURES ARE SHOWN ON DRAWINGS ESC-1 AND ESC-2. THE CONTRACTOR SHALL SUBMIT A TEMPORARY EROSION AND SEDIMENT CONTROL PLAN SHOWING ADDITIONAL SITE SPECIFIC EROSION AND SEDIMENT CONTROL TECHNIQUES AND METHODS.
14. IF HIGH FLOW CONDITIONS THAT MAY CAUSE SILTATION OR EROSION ARE ENCOUNTERED DURING CONSTRUCTION, WORK SHALL STOP UNTIL THE FLOW SUBSIDES.
15. CONTRACTOR IS RESPONSIBLE FOR CALLING "ONE CALL" FOR UTILITY LOCATES PRIOR TO CONSTRUCTION. 1(800)424-5555 OR 811
16. THE EXISTING FEATURES AS SHOWN ON THE EXISTING CONDITIONS PLAN WERE PROVIDED BY THE CITY OF BELLEVUE AND FROM SUPPLEMENTAL FIELD WORK PERFORMED BY APS.

LOG NOTES:

1. DECKED LOGS SHALL BE ACCESSIBLE FOR INSPECTION.
2. LOG TYPE IDENTIFICATION SHALL BE PAINTED ON ALL LOGS IN A PLACE VISIBLE FOR INSPECTION PRIOR TO PLACEMENT WITH LEAD-FREE, BLAZE-ORANGE SURVEY MARKING PAINT.

UTILITIES AND AGENCIES

CITY OF BELLEVUE

BRIAN WARD – PROJECT MANAGER

450 110TH AVENUE NE
BELLEVUE, WA 98004
(425) 452-5206
(425) 452-7856

EMAIL: BWARD@BELLEVUEWA.GOV

KING COUNTY DEPARTMENT OF NATURAL RESOURCES, WTD

ERIC DAVISON

201 S. JACKSON ST, MAIL STOP
KSC-NR-0508
SEATTLE, WA 98104-3855

(206) 684-1707
FAX: (206) 684-1710
ERIC.DAVISON@KINGCOUNTY.GOV

BELLEVUE WATER DISTRICT #1

KIPP FOCKLER – OPERATING & WATER MAINTENANCE
(425) 452-2923

GREG KNIGHT
(425) 452-4493

BELLEVUE FIRE DEPARTMENT

NON-EMERGENCY GENERAL
(425) 452-6892

FIRE PREVENTION PLAN REVIEW DESK
(425) 452-4122

BELLEVUE POLICE DEPARTMENT

(425) 452-6917

CITY OF BELLEVUE – TRANSPORTATION DEPARTMENT

JON REGALIA

450 110TH AVENUE NE
BELLEVUE, WA 98004
(425) 452-4599

EMAIL: JREGALIA@BELLEVUEWA.GOV

CITY OF BELLEVUE – PERMIT CENTER

TRAVIS RIPLEY
(425) 452-6042

PUGET SOUND ENERGY (PSE CONSTRUCTION)

JEANNE COLEMAN – MUNICIPAL CONSTRUCTION PLANNER

P.O. BOX 97034
MAIL STOP: EST-11W
BELLEVUE, WA 98009-9734

(425) 462-3488
EMAIL: JEANNE.COLEMAN@PSE.COM

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JILL LOOK

1525 75TH ST. SW, SUITE 200
EVERETT, WA 98203

(425) 263-5346
FAX: (425) 263-5352
MOBILE: (206) 396-6032
EMAIL: JILL_LOOK@CABLE.COMCAST.COM

QWEST (US WEST COMMUNICATIONS)

DAN RESSLER

1550 NEWPORT WAY NW, ROOM #2
ISSAQUAH, WA 98027

(206) 345-3809
EMAIL: JOSEPH.RESSLER@QWEST.COM

ONE CALL

UTILITY LOCATION
(800) 424-5555 OR 811

Know what's below. Call before you dig.

MARK EWBANK
STATE OF WASHINGTON
29434
CIVIL ENGINEER
PROFESSIONAL ENGINEER

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

60% DESIGN - NOT FOR CONSTRUCTION

NO	DATE	BY	APPR	REVISIONS
1	10/08	CB	ME	REVISIONS TO 60% DESIGN

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
Suite 1100
Seattle, Washington
98121-1820
206-441-9080
206-441-9108 FAX
http://www.herrerainc.com

SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER DATE
PROJECT MANAGER DATE

C. BARTON	05/2008
DESIGNED BY	DATE
W. WIESZCZECINSKI	06/2008
DRAWN BY	DATE
M. EWBANK	06/2008
CHECKED BY	DATE

City of Bellevue
UTILITIES

GENERAL NOTES

DRAWING G-2

SHT 2 OF 23

ABBREVIATIONS:

APPROX	APPROXIMATE(LY)
CB	CATCH BASIN
DBH	DIAMETER BREAST HEIGHT
DIA	DIAMETER
DWG	DRAWING
ESC	EROSION AND SEDIMENT CONTROL
EX	EXISTING
FAC	FACULTATIVE
FACU	FACULTATIVE UPLAND
FACW	FACULTATIVE WETLAND
FT	FEET
IN	INCHES
LWD	LARGE WOODY DEBRIS
MIN	MINIMUM
NI	NO INDICATOR
OHP	OVERHEAD POWER LINE
OHWM	ORDINARY HIGH WATER MARK
PSE	PUGET SOUND ENERGY
SDMH	STORM DRAIN MANHOLE
TEL	TELEPHONE
TYP	TYPICAL
UGP	UNDERGROUND POWER LINE
UGT	UNDERGROUND TELEPHONE LINE
UPL	OBLIGATE UPLAND

LEGEND:

EXISTING BUILDING
EXISTING CURB
72 EXISTING CONTOURS
EXISTING BANK SLOPE
OHP EXISTING OVERHEAD POWER LINE
UGP EXISTING UNDERGROUND POWER LINE
W EXISTING WATER LINE
G EXISTING GAS LINE
EXISTING MANHOLE
EXISTING CATCH BASIN
EXISTING STORM DRAIN MANHOLE
T EXISTING TELEPHONE J-BOX
P EXISTING POWER VAULT
EXISTING FIRE DEPT CONNECTION
EXISTING POWER POLE
EXISTING POWER TRANSFORMER

CREEK FLOW LINE
HIGH VISIBILITY FENCE
x SILT FENCE
EXCAVATION LIMITS
EXISTING GRADE
DIVERTED FLOW LINE
PROPOSED AVERAGE GRADE
LIMITED DISTURBANCE AREA
CLEAR AND GRUB AREA
STREAMBED GRAVEL
PLUNGE POOL
STREAMBED COBBLE
EXISTING GROUND
TEMPORARY STREAM ACCESS
EXCAVATED ALLUVIUM
STAGING AREA
ECOLOGY BLOCKS
BULK BAGS

BOULDERS
LOGS WITH ROOTWAD
LOGS WITHOUT ROOTWAD
LOGS WITH ROOTWAD BURIED
LOGS WITHOUT ROOTWAD BURIED
LOG SECTION
VEGETATION
LOG IDENTIFICATION
LOG CONTROL POINT
1+00 STREAM PROFILE STATIONING (FT)

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase II\G-3.dwg
Plot Date: 10/22/2008 1:53 PM Cad User: Wojciech Wieszczecinski

811 Know what's below. Call before you dig.

60% DESIGN - NOT FOR CONSTRUCTION

NO	DATE	BY	APPR	REVISIONS
1	10/08	CB	ME	REVISIONS TO 60% DESIGN

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
Suite 1100
Seattle, Washington
98121-1820
206-441-9080
206-441-9108 FAX
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MARK EWBANK STATE OF WASHINGTON 29634 CIVIL ENGINEER PROFESSIONAL ENGINEER

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

CITY OF BELLEVUE WASHINGTON
City of Bellevue
UTILITIES

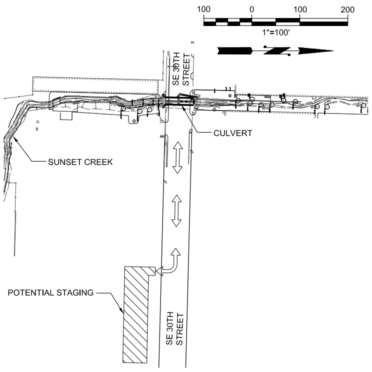
ABBREVIATIONS AND LEGEND

DRAWING G-3

SHT 3 OF 23

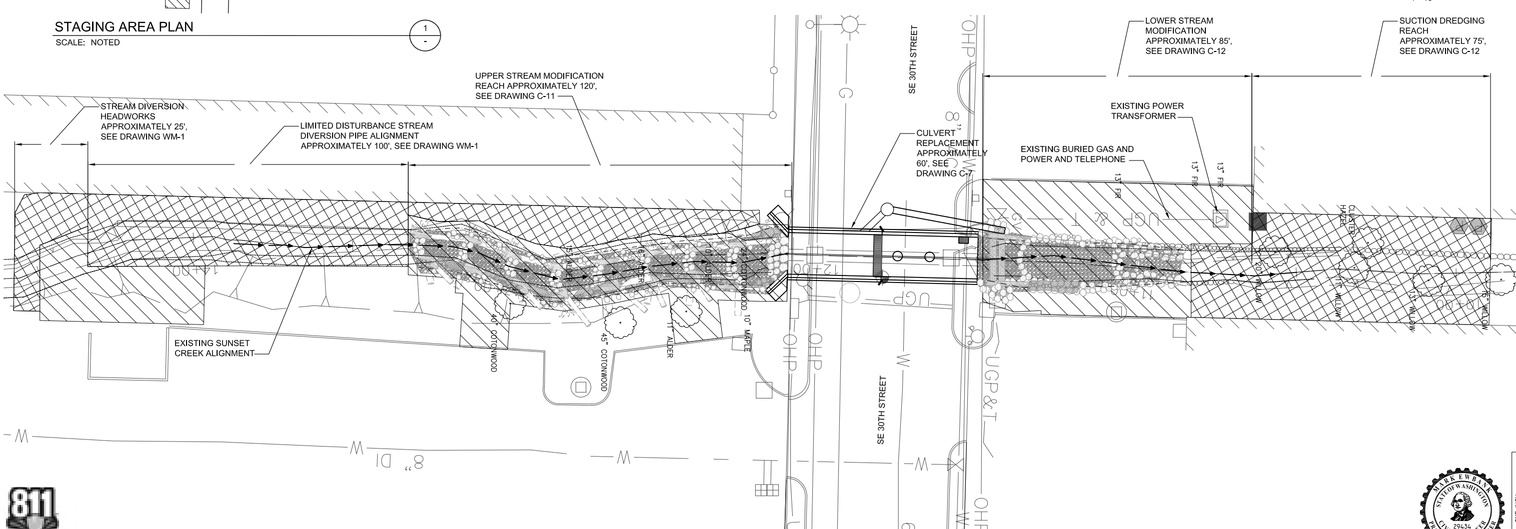
GENERAL NOTES:

1. FOR STREAM CORRIDOR SITE PREP DETAILS SEE DRAWING C-10
2. FOR SITE STAGING AREA SEE DETAIL 1 ON THIS SHEET



STAGING AREA PLAN

SCALE: NOTED



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1	10/08	CB	ME	REVISIONS TO 60% DESIGN

HERRERA ENVIRONMENTAL CONSULTANTS

CIVILTECH ENGINEERING
10800 NE 8th Street Suite 820
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Phone: 425.453.6488
Fax: 425.453.5848

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City of Bellevue UTILITIES

SITE PLAN

DRAWING G-4 SHT 4 OF 23

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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REMOVAL NOTES:

1. REMOVE CONC CURB AND SIDEWALK
2. SAW CUTTING PAVEMENT
3. REMOVE ASPHALT CONC PAVEMENT
4. REMOVE CATCH BASIN
5. EXCAVATE AND REMOVE CMP CULVERTS
6. REMOVE SAFETY RAILING
7. REMOVE ROCKERY WALL AS NECESSARY TO FACILITATE CULVERT INSTALLATION. KEEP ROCK FOR CHANNEL MODIFICATIONS.

GENERAL NOTES:

1.) FOR REMOVAL, RELOCATION, AND ADJUSTMENT OF WATER VALVES, FIRE HYDRANTS, WATER METERS, AND OTHER FEATURES RELATED TO WATER MAIN, SEE UTILITY PLAN, SHEETS C3 AND C4.

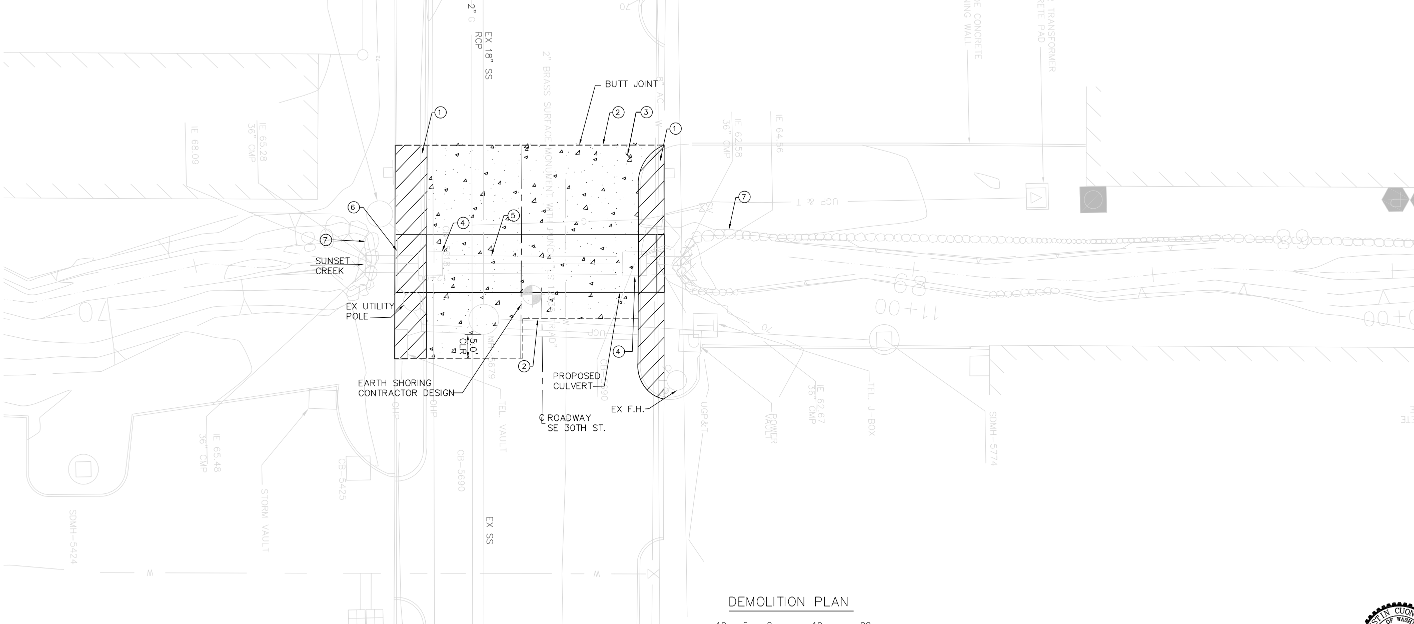
2.) FOR REMOVAL OR RELOCATION OF POWER POLE AND TELEPHONE POLE, SEE UTILITY PLAN, SHEETS C3 AND C4.

3.) FOR REMOVAL, RELOCATION, AND ADJUSTMENT OF OTHER EXISTING UTILITIES, SEE SHEETS C3 AND C4.

LEGEND

CURB & SIDEWALK REMOVAL

FULL DEPTH PAVEMENT REMOVAL



DEMOLITION PLAN

10 5 0 10 20

SCALE IN FEET

VERTICAL DATUM:
CITY OF BELLEVUE #140 NAVD'88 ELEV.=210.42
TOP NE CORNER 3'x3' CONCRETE FOOTING FOR 2'x2' BRICK PILLAR AT SW CORNER 128TH AVENUE SE AND SE 26TH PLACE.

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NORTH 1/2, SEC. 10, TWP. 24 N., RGE 5 E., W.M.

NO	DATE	BY	APPR	REVISIONS

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J. ROBERTS	04/2008
DRAWN BY	DATE
D.C. ONG	04/2008
CHECKED BY	DATE

City of Bellevue UTILITIES

ROADWAY CORRIDOR DEMOLITION PLAN

DRAWING C-1

SHT 5 OF 24

EXPIRES

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

Path: P:\Structural\2007\27015 - SE 30 & Sunset Cr (Herrera)\Cad\Drawing\C-1.dwg
Plot Date: 6/10/2008 2:31 PM Cad User: Jeff Roberts

STAGE 1

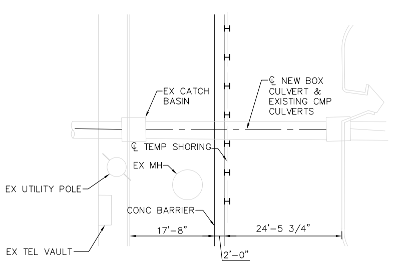
1. PREPARE ROAD CLOSURE AND PLACE CLOSURE SIGNS
2. REMOVE STRUCTURES AND OBSTRUCTIONS
3. INSTALL TEMPORARY SHORING (SOLDIER PILE SHOWN) AT LOCATIONS SHOWN.
4. INSTALL TEMPORARY TRAFFIC BARRIER

STAGE 2

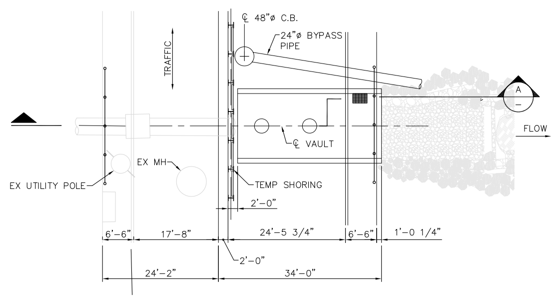
1. CLOSE NORTH LANES. MAINTAIN ONE LANE OPEN AT ALL TIMES, ON SOUTH SIDE OF STREET.
2. INSTALL TEMPORARY PIPE TO DIVERT STREAM FLOW (NOT SHOWN)
3. START EXCAVATION AND REMOVE EXISTING ROCKERIES AND CMP CULVERT.
4. PREPARE FOUNDATION SOILS
5. INSTALL 3-SIDED BOXES, 48"ø TYPE 2 CB, AND 24"ø BYPASS PIPE
6. CONSTRUCT BAFFLE WALLS, REMOVABLE LIDS, AND LADDERS
7. CONSTRUCT DOWNSTREAM CHANNEL MODIFICATIONS

STAGE 3

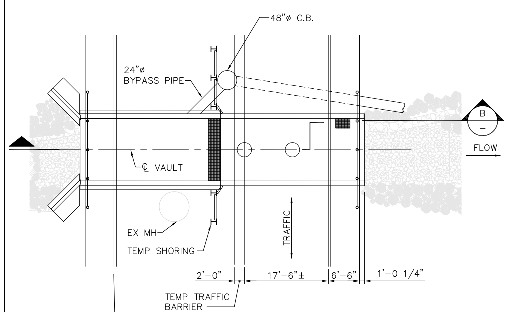
1. RELOCATE TEMPORARY TRAFFIC BARRIER AT THE LOCATION SHOWN
2. OPEN NORTH LANE TO TRAFFIC, CLOSE SOUTH SIDE OF STREET
3. BEGIN EXCAVATION AND REMOVE EXISTING ROCKERIES AND REMAINING CMP CULVERT. REMOVE SOLDIER PILES THAT INTERFERE WITH NEW VAULT STRUCTURE. PROTECT EXISTING 5'ø MANHOLE DURING EXCAVATION.
4. PREPARE FOUNDATION SOILS
5. INSTALL 4-SIDED BOXES AND WING WALLS. CONSTRUCT 24"ø BYPASS CONNECTION TO 48"ø C.B., PIPE, AND BAFFLES
6. CONSTRUCT UPSTREAM CHANNEL MODIFICATIONS
7. CONSTRUCT SIDEWALKS AND CURBS, PLACE ROADWAY CONCRETE SURFACE OVER CULVERT, AND INSTALL HANDRAILS



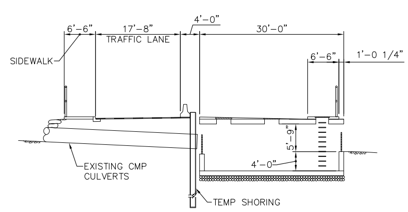
STAGE 1 (PLAN)
SCALE: 1"=10'



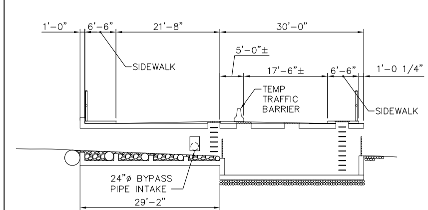
STAGE 2 (PLAN)
SCALE: 1"=10'



STAGE 3 (PLAN)
SCALE: 1"=10'



SECTION A
SCALE: 1"=10'



SECTION B
SCALE: 1"=10'

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Path: P:\Structural\2007\27015 - SE 30 & Sunset Cr (Herrera)\Cad\Drawing\C-2.dwg
Plot Date: 10/21/2008 11:12 AM Cad User: Jeff Roberts

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NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS

CIVILTECH ENGINEERING
10800 NE 8th Street Suite 820
Bellevue, WA 98004
Phone: 425.453.6488
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D.C. ONG	04/2008
CHECKED BY	DATE

CITY OF BELLEVUE WASHINGTON

City of Bellevue
UTILITIES

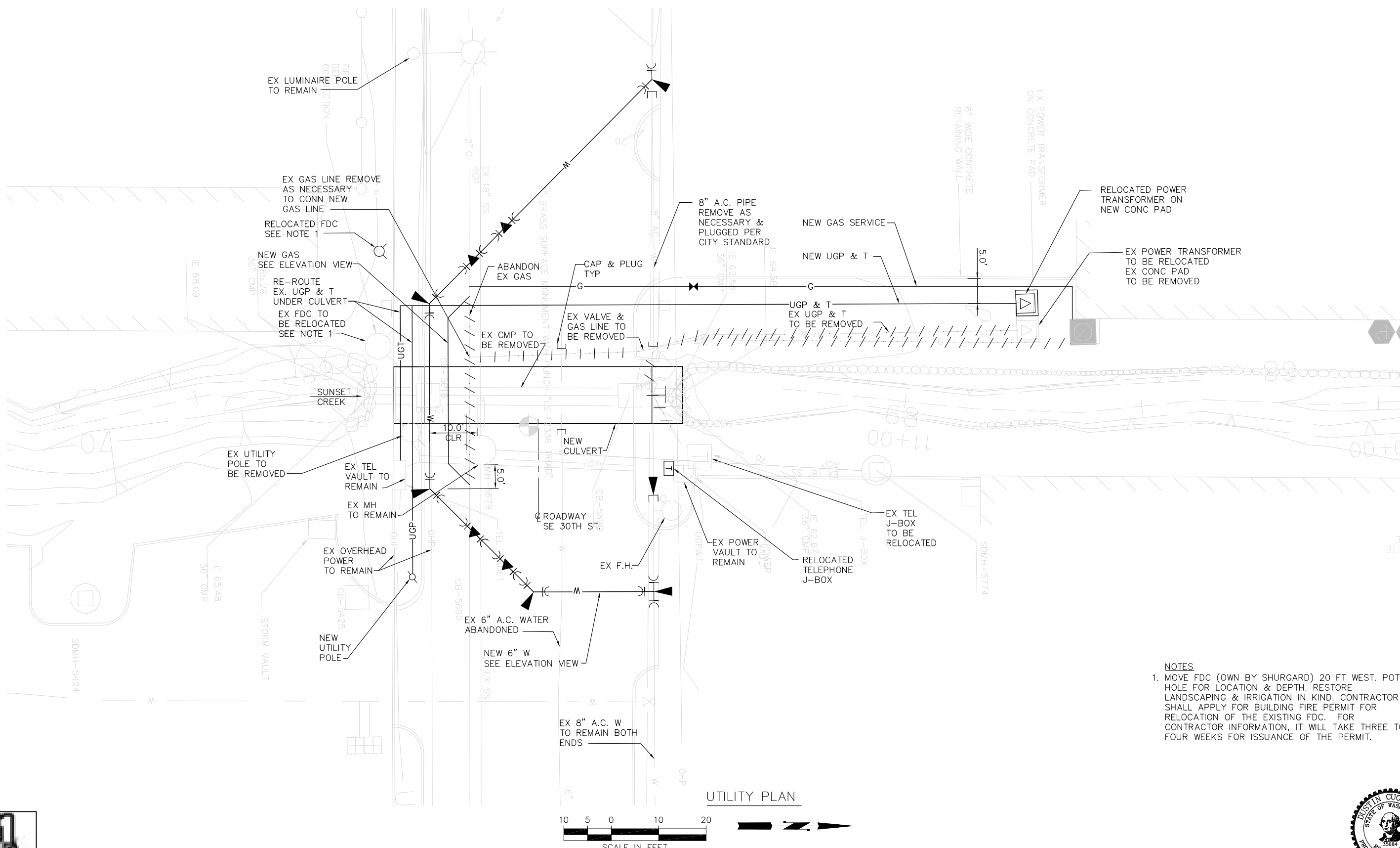
ROADWAY PHASING PLAN AND NOTES

DRAWING C-2

SHT 6 OF 24

DUSTIN CUONG ONG
STATE OF WASHINGTON
35684
REGISTERED PROFESSIONAL ENGINEER
EXPIRES

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY



NOTES
1. MOVE FDC (OWN BY SHURGARD) 20 FT WEST. POT HOLE FOR LOCATION & DEPTH. RESTORE LANDSCAPING & IRRIGATION IN KIND. CONTRACTOR SHALL APPLY FOR BUILDING FIRE PERMIT FOR RELOCATION OF THE EXISTING FDC. FOR CONTRACTOR INFORMATION, IT WILL TAKE THREE TO FOUR WEEKS FOR ISSUANCE OF THE PERMIT.

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NORTH 1/2, SEC. 10, TWP. 24 N., RGE 5 E., W.M.

EXPIRES

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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CHECKED BY DATE

City of Bellevue
UTILITIES

UTILITIES PLAN

DRAWING C-3

SHT 7 OF 24

Path: P:\Structural\2007\27015 - SE 30 & Sunset Cr (Herrera)\Cad\Drawing\C-3.dwg
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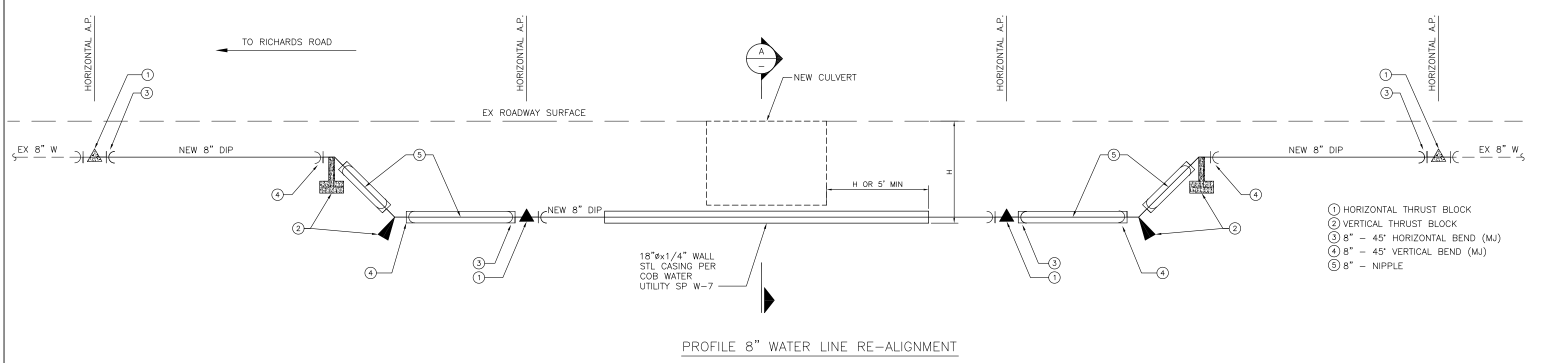
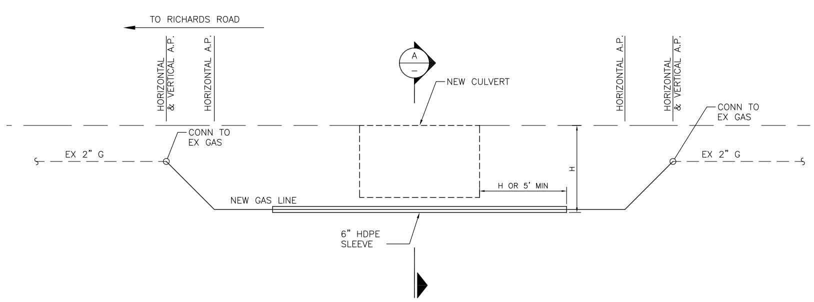
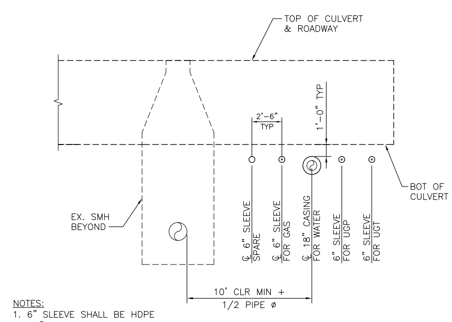


PROFILE 8" WATER LINE RE-ALIGNMENT



PROFILE GAS LINE RE-ALIGNMENT



NOTES:
1. 6" SLEEVE SHALL BE HDPE
2. 12" SLEEVE SHALL BE ASTM A53 GRADE B

SLEEVE DETAIL (A)
SCALE: NTS

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

EXPIRES

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D.C. ONG 04/2008
CHECKED BY DATE

City of Bellevue
UTILITIES

UTILITIES DETAILS

DRAWING C-4

SHT 8 OF 24

Path: P:\Structural\2007\27015 - SE 30 & Sunset Cr (Herrera)\Cad\Drawing\C4.dwg
Plot Date: 6/10/2008 2:40 PM Cad User: Jeff Roberts

ⓧ ROADWAY CONSTRUCTION NOTES:

1. CONSTRUCT CEMENT CONCRETE TRAFFIC CURB AND GUTTER PER CITY OF BELLEVUE STANDARD DETAIL TE-10.
2. CONSTRUCT CURBSIDE SIDEWALK PER CITY OF BELLEVUE STANDARD DETAIL TE-11.
3. CONSTRUCT DRIVEWAY APPROACH PER CITY OF BELLEVUE STANDARD DETAIL DEV-5.
4. PAVEMENT THICKNESS WILL BE 4 INCHES OF HOT MIX ASPHALT CLASS 1/2" PG 64-22
5. REPLACE CULVERT, SEE SHEET C-7.
6. INSTALL METAL SAFETY RAILING PER CITY OF BELLEVUE STANDARD DETAIL TE-34.
7. 4" CRUSHED SURFACING TOP COURSE.
8. COMPACT GRAVEL BORROW OR NATIVE SOIL TO 95% DRY DENSITY.
9. 6 INCHES OF COMMERCIAL HOT MIX ASPHALT CLASS 1" PG 64-22

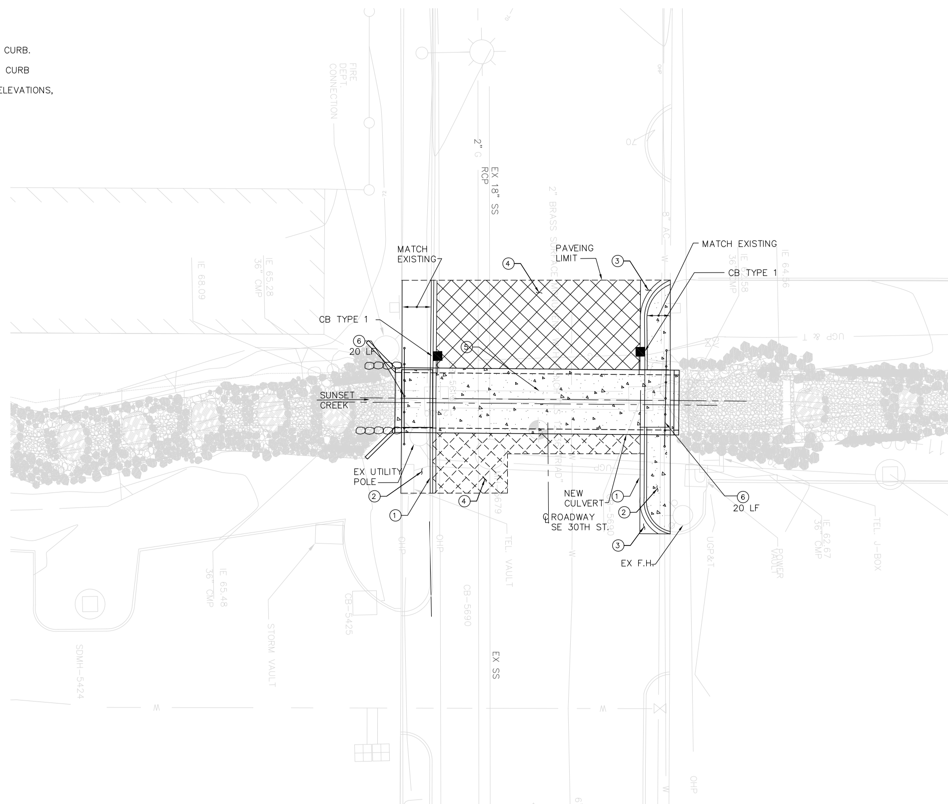
GENERAL NOTES:

1. ROADWAY DIMENSIONS ARE TO FACE OF CURB.
2. SIDEWALK DIMENSIONS ARE TO BACK OF CURB
3. FOR TOP OF CURB RETURN DATA AND ELEVATIONS, MATCH EXISTING

LEGEND

FULL DEPTH PAVEMENT

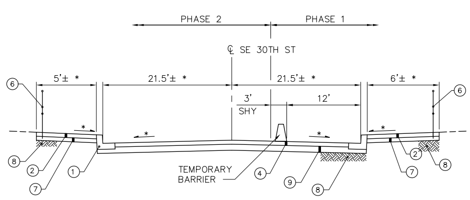
CEMENT CONCRETE



PAVING PLAN

10 5 0 10 20

SCALE IN FEET



TYPICAL ROADWAY SECTION

* VERIFY IN FIELD & MATCH EXISTING CONDITION FOR FIT-UP

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City of Bellevue UTILITIES

ROADWAY PLAN AND SECTION

DRAWING C-5

SHT 9 OF 24

EXPIRES

ONE INCH — AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

Path: P:\Structural\2007\27015 - SE 30 & Sunset Cr (Herrera)\Cad\Drawing\C-5.dwg
Plot Date: 6/10/2008 2:41 PM Cad User: Jeff Roberts

BLANK SHEET

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D.C. ONG 04/2008
CHECKED BY DATE

City of Bellevue
UTILITIES

ROADWAY SECTION

DRAWING C-6

SHT 10 OF 24

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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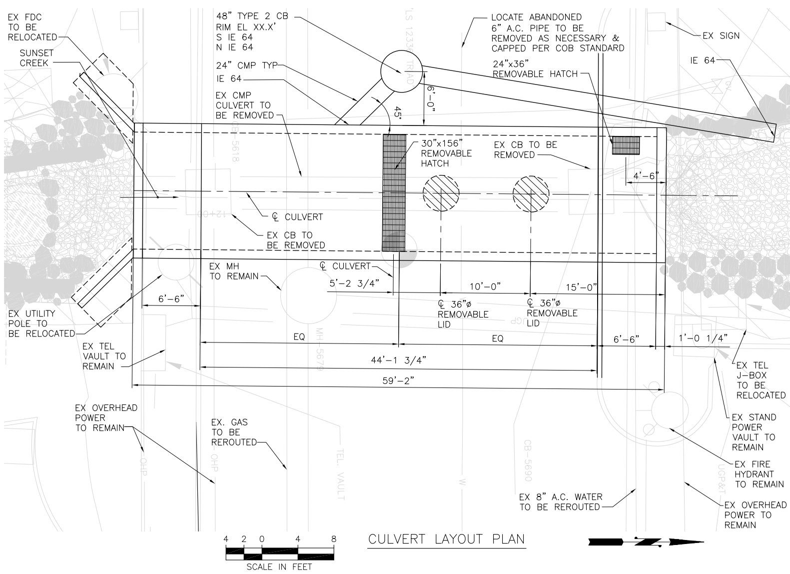
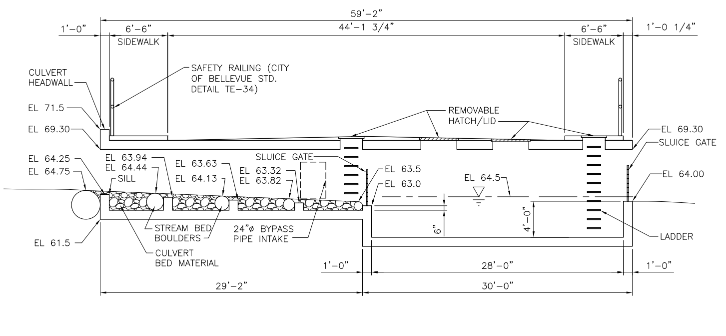
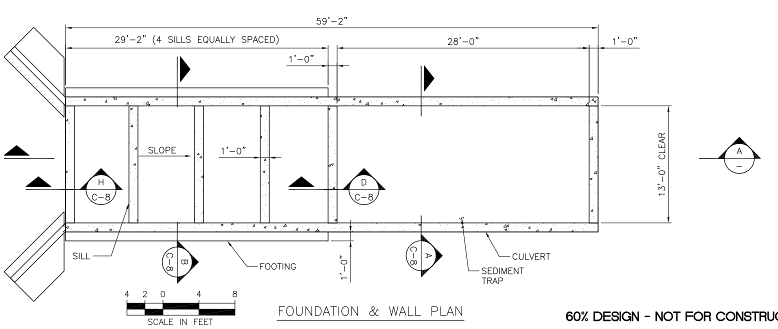


CULVERT LAYOUT PLAN



PROFILE-SECTION (A)
SCALE: 3/8"=1'-0"



FOUNDATION & WALL PLAN

60% DESIGN - NOT FOR CONSTRUCTION

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1	10/08	JR	DCO	REVISIONS TO 60% DESIGN

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J. ROBERTS 04/2008 DRAWN BY DATE
D.C. ONG 04/2008 CHECKED BY DATE

City of Bellevue UTILITIES

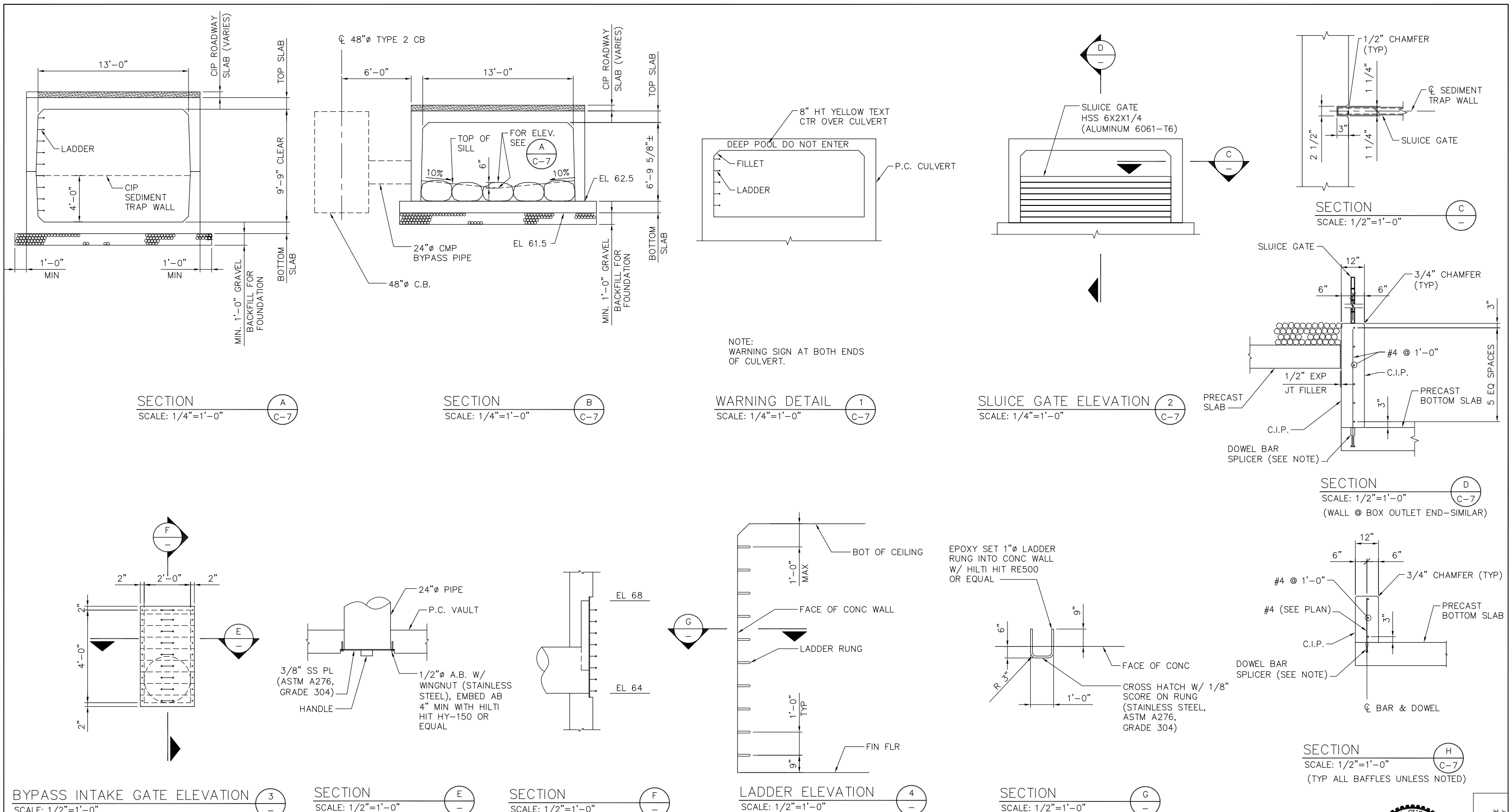
CULVERT REPLACEMENT PLAN AND NOTES

DRAWING C-7 SHT 11 OF 24

EXPIRES

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

Path: P:\Structural\2007\27015 - SE 30 & Sunset Cr (Herrera)\Cad\Drawing\C-7.dwg
Plot Date: 10/21/2008 11:11 AM Cad User: Jeff Roberts



NOTES
1. ALL BARS & DOWEL BAR SPLICERS SHALL BE EPOXY COATED
2. f'c= 4000 PSI (MIN) fy = 60 KSI (ASTM A615)
3. DOWEL BAR SPLICERS SHALL BE DAYTON SUPERIOR D-108-A HEADED OR D-102-A 90° HOOKED OR OTHER EQUIVALENT.

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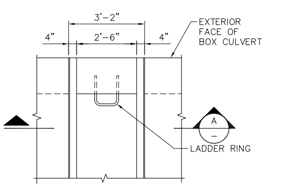
City of Bellevue UTILITIES

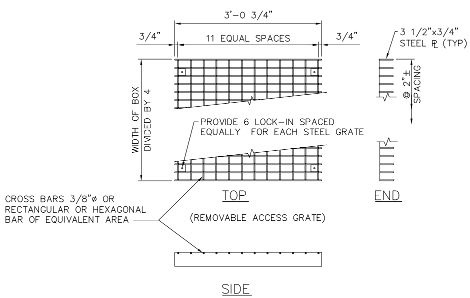
CULVERT REPLACEMENT PROFILE AND NOTES

DRAWING C-8 SHT 12 OF 24

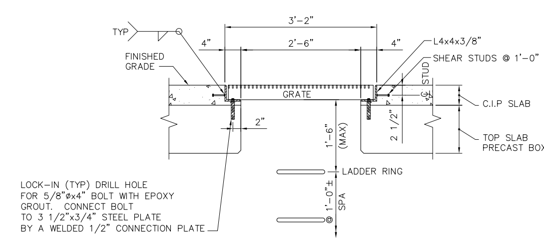
Path: P:\Structural\2007\27015 - SE 30 & Sunset Cr (Herrera)\Cad\Drawing\C-8.dwg
Plot Date: 10/21/2008 11:10 AM Cad User: Jeff Roberts



PLAN
SCALE: 1/2" = 1'-0"
(30"x WIDTH OF CULVERT REMOVABLE LID)
(STEEL GRATE, LOCK-IN BOLT & SHEAR STUDS NOT SHOWN)



REMOVABLE ACCESS GRATE 1
SCALE: 1"=1'-0"



SECTION A
SCALE: 1"=1'-0"

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HERRERA ENVIRONMENTAL CONSULTANTS

CIVILTECH ENGINEERING
10800 NE 8th Street Suite 820
Bellevue, WA 98004
Phone: 425.453.6488
Fax: 425.453.5848

SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER DATE
PROJECT MANAGER DATE

D.C. ONG 04/2008
DESIGNED BY DATE
J. ROBERTS 04/2008
DRAWN BY DATE
D.C. ONG 04/2008
CHECKED BY DATE

City of Bellevue
UTILITIES

SECTIONS AND DETAILS

DRAWING C-9 SHT 13 OF 24

EXPIRES

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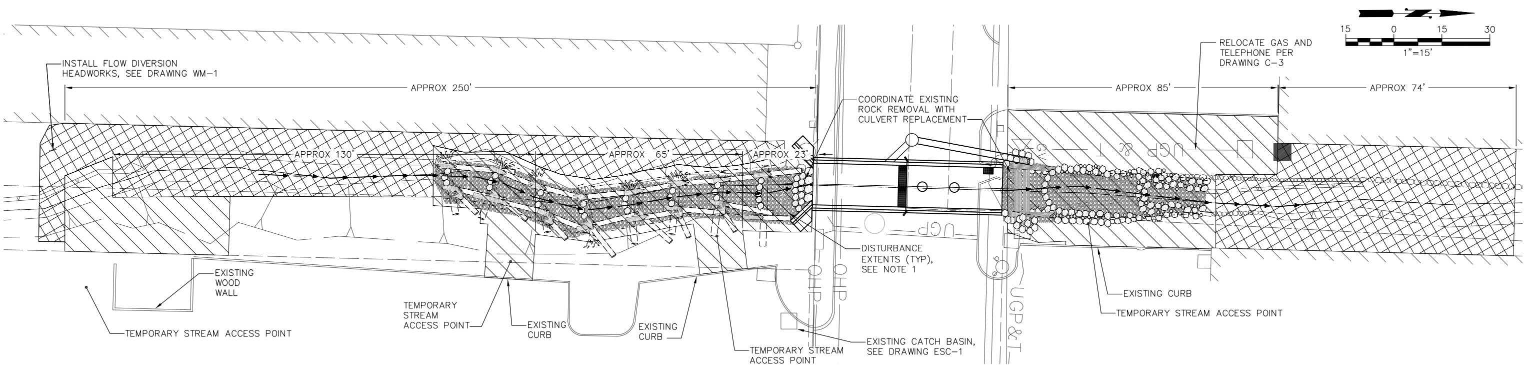
Plot Date: 6/10/2008 2:43 PM Cad User: Jeff Roberts

GENERAL NOTES:

1. CONTRACTOR SHALL FENCE THE PERIMETER OF THE CONSTRUCTION ZONE WITH A MINIMUM OF 6' TALL CHAINLINK FENCING PRIOR TO COMMENCEMENT OF ANY CONSTRUCTION ACTIVITIES.
2. PRIOR TO ANY CLEARING OR GRUBBING THE CONTRACTOR SHALL INSTALL TREE PROTECTION FOR ALL TREES DESIGNATED/FLAGGED BY THE CITY OF BELLEVUE TO REMAIN. TREE PROTECTION SHALL CONSIST OF ¾" 4'X'4 PLYWOOD BOXES CENTERED ON THE TRUNK OF THE TREE OR APPROVED EQUAL.
3. EXISTING PARKING LOT CURBS AND PAVEMENT USED FOR ACCESS SHALL BE PROTECTED FROM DAMAGE BY THE CONTRACTOR. DAMAGE INCURRED DURING CONSTRUCTION TO ADJACENT PROPERTY SHALL BE THE SOLE RESPONSIBILITY OF THE CONTRACTOR.



STREAM CORRIDOR SITE PREPARATION PLAN 1/C-1
SCALE: NOTED

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Cad User: Wojciech Wieszczeckinski

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http://www.herrerainc.com

SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER DATE

PROJECT MANAGER DATE

C. BARTON 05/2008
DESIGNED BY DATE
W. WESZCZECINSKI 06/2008
DRAWN BY DATE
M. EWBANK 06/2008
CHECKED BY DATE

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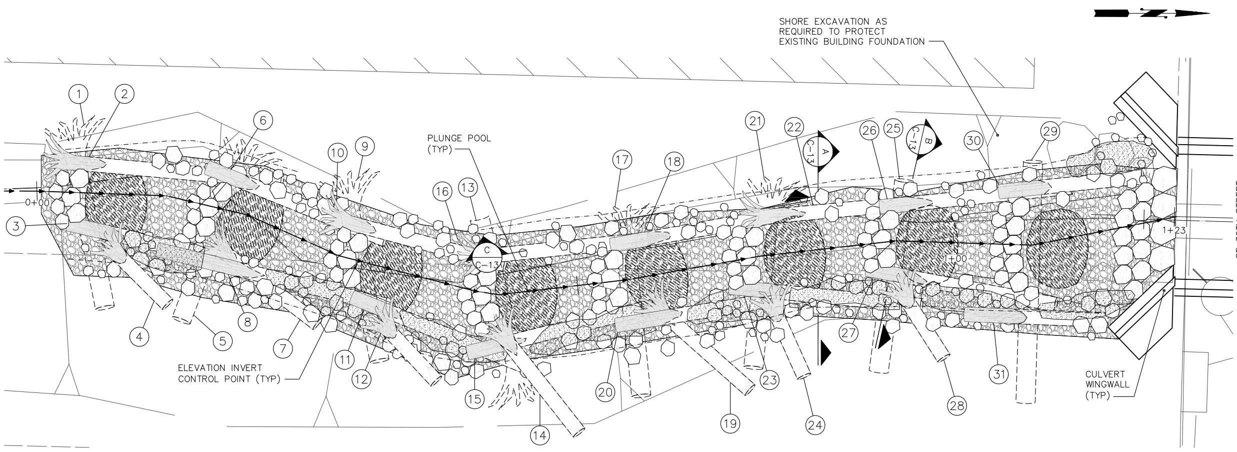
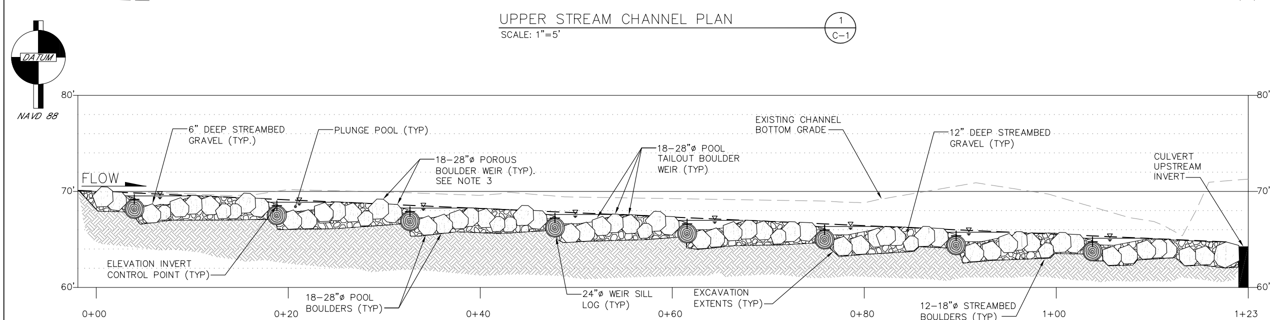
STREAM CORRIDOR SITE PREPARATION PLAN

DRAWING C-10

SHT 14 OF 23



UPPER STREAM CHANNEL PLAN
SCALE: 1"=5'
1 / C-1



UPPER STREAM CHANNEL PROFILE
SCALE: 1"=5'
A / –

GENERAL NOTES:

1. FILL ALL VOIDS DURING BACKFILLING AND CONSOLIDATE FILL USING WYCO 992A–FI–10 10 CONCRETE VIBRATOR OR APPROVED EQUAL.
2. LOG IDENTIFICATION NUMBERS REFLECT POTENTIAL CONSTRUCTION SEQUENCING AND LOG PLACEMENT SEQUENCING. SEE DRAWING C–13 FOR LOG SCHEDULE.
3. CONTACT POINTS BETWEEN BOULDERS SHALL BE MAINTAINED 4" ABOVE PLUNGE POOL WATER SURFACE.

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M. EWBANK 06/2008
CHECKED BY DATE

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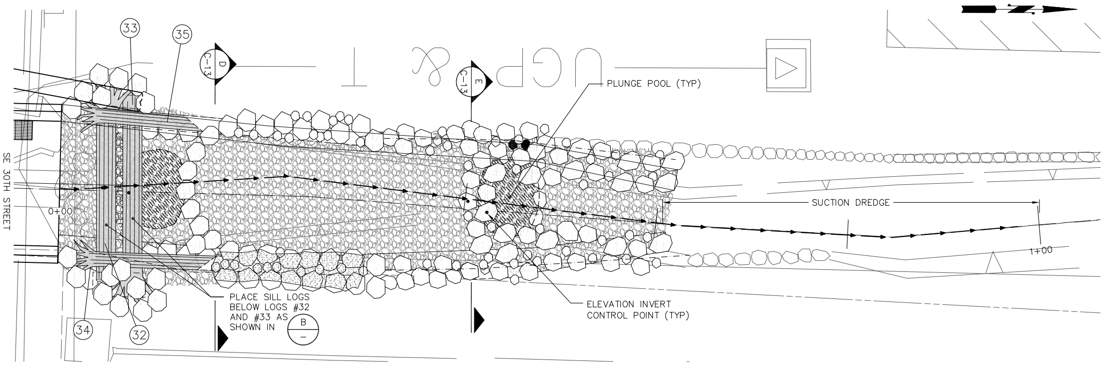
UPPER STREAM CHANNEL MODIFICATIONS PLAN AND PROFILE

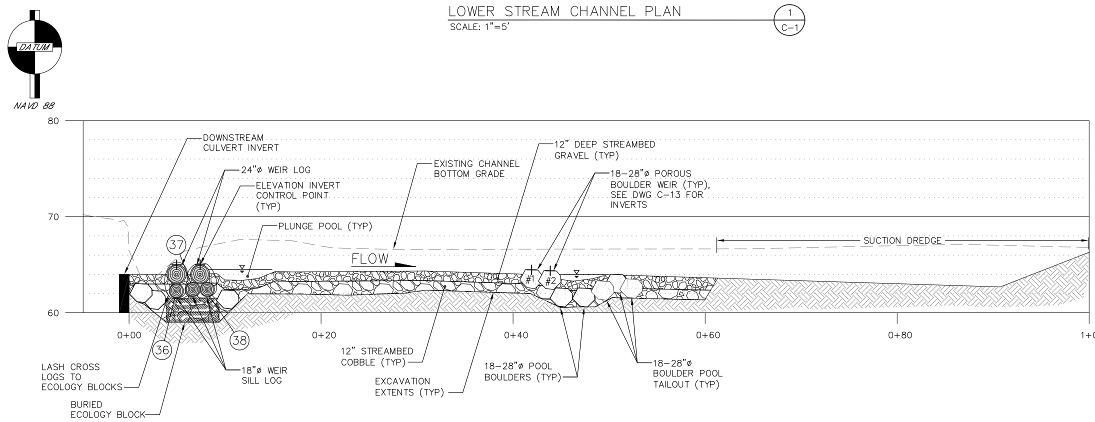
DRAWING C-11
SHT 15 OF 23



LOWER STREAM CHANNEL PLAN

SCALE: 1"=5'

1
C-1



LOWER STREAM CHANNEL PROFILE

SCALE: 1"=5'

B
–

GENERAL NOTES:

1. FILL ALL VOIDS DURING BACKFILLING AND CONSOLIDATE FILL USING WYCO 992A-FI-10 10 CONCRETE VIBRATOR OR APPROVED EQUAL.
2. LOG IDENTIFICATION NUMBERS REFLECT POTENTIAL CONSTRUCTION SEQUENCING AND LOG PLACEMENT SEQUENCING. SEE DRAWING C-13 FOR LOG SCHEDULE.

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SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER — DATE

PROJECT MANAGER — DATE

C. BARTON	05/2008
DESIGNED BY	DATE
W. WIESZCZECINSKI	06/2008
DRAWN BY	DATE
M. EWBANK	06/2008
CHECKED BY	DATE

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LOWER STREAM CHANNEL MODIFICATIONS PLAN AND PROFILE

DRAWING C-12

SHT 16 OF 23

Path: C:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase II\C-12.dwg
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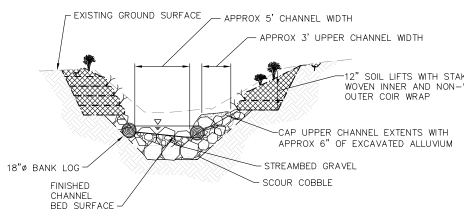
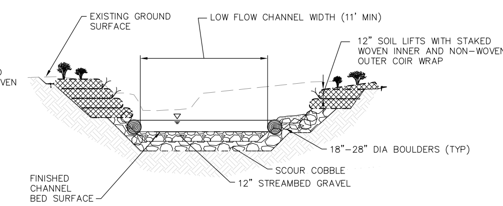
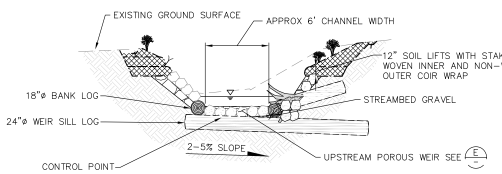
Cad User: Wojciech Wieszczecinski



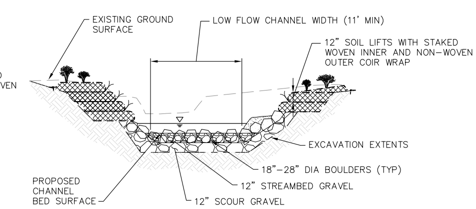
SECTION–TYPICAL UPSTREAM CHANNEL (A / C-11)
SCALE: 1"=5'



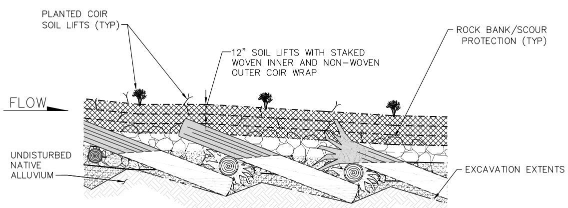
SECTION–TYPICAL DOWNSTREAM CHANNEL (D / C-12)
SCALE: 1"=5'



SECTION–TYPICAL UPSTREAM LOG GRADE CONTROL (B / C-11)
SCALE: 1"=5'



SECTION–TYPICAL DOWNSTREAM CHANNEL AT BOULDER WEIR (E / C-12)
SCALE: 1"=5'



SECTION–TYPICAL UPSTREAM CHANNEL BANK (C / C-11)
SCALE: 1"=5'

TABLE – DOWNSTREAM BOULDER INVERTS:

BOULDER #	INVERT ELEVATION	APPROX STATION
#1	64.47	0+40
#2	64.38	0+42

TABLE – DOWNSTREAM LOG SCHEDULE:

LOG #	DIA. (IN)	LENGTH (FT)	ROOTWAD	INVERT ELEVATION	APPROX STATION
32	24	22	YES	65.0	0+05
33	24	22	YES	65.0	0+07
34	18–22	30	YES	–	
35	18–22	30	YES	–	
36	18–22	22	NO	–	0+04
37	18–22	22	NO	–	0+06
38	18–22	22	NO	–	0+08

TABLE – UPSTREAM LOG SCHEDULE:

LOG #	DIA. (IN)	LENGTH (FT)	ROOTWAD	INVERT ELEVATION	APPROX STATION	DOWN SLOPE DIRECTION
1	24	20	YES	69.2	0+04	EAST
2	18–22	25	YES	–		
3	18–22	20	NO	–		
4	18–22	10	YES	–		
5	24	20	YES	68.5	0+21	WEST
6	18–22	15	NO	–		
7	18–22	18	YES	–		
8	18–22	25	NO	–		
9	24	20	YES	67.9	0+37	EAST
10	18–22	20	YES	–		
11	18–22	20	NO	–		
12	18–22	10	YES	–		
13	24	20	YES	67.2	0+52	WEST
14	18–22	15	YES	–		
15	18–22	20	NO	–		
16	18–22	20	YES	–		
17	24	20	YES	66.6	1+01	EAST
18	18–22	20	NO	–		
19	18–22	18	NO	–		
20	18–22	20	NO	–		
21	24	20	NO	66.0	1+15	WEST
22	18–22	18	NO	–		
23	18–22	20	NO	–		
24	18–22	20	NO	–		
25	24	20	NO	65.4	1+30	EAST
26	18–22	20	NO	–		
27	18–22	20	NO	–		
28	18–22	10	YES	–		
29	24	25	NO	64.8	1+44	WEST
30	18–22	15	NO	–		
31	18–22	15	NO	–		

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SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By
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PROJECT MANAGER DATE

C. BARTON 05/2008 DESIGNED BY DATE
W. WESZCZEONSKI 06/2008 DRAWN BY DATE
M. EWBANK 06/2008 CHECKED BY DATE

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STREAM CHANNEL MODIFICATIONS DETAILS

DRAWING C-13

SHT 17 OF 23

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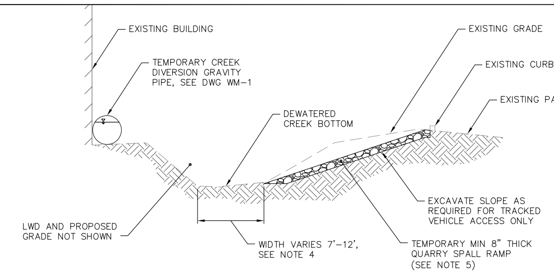
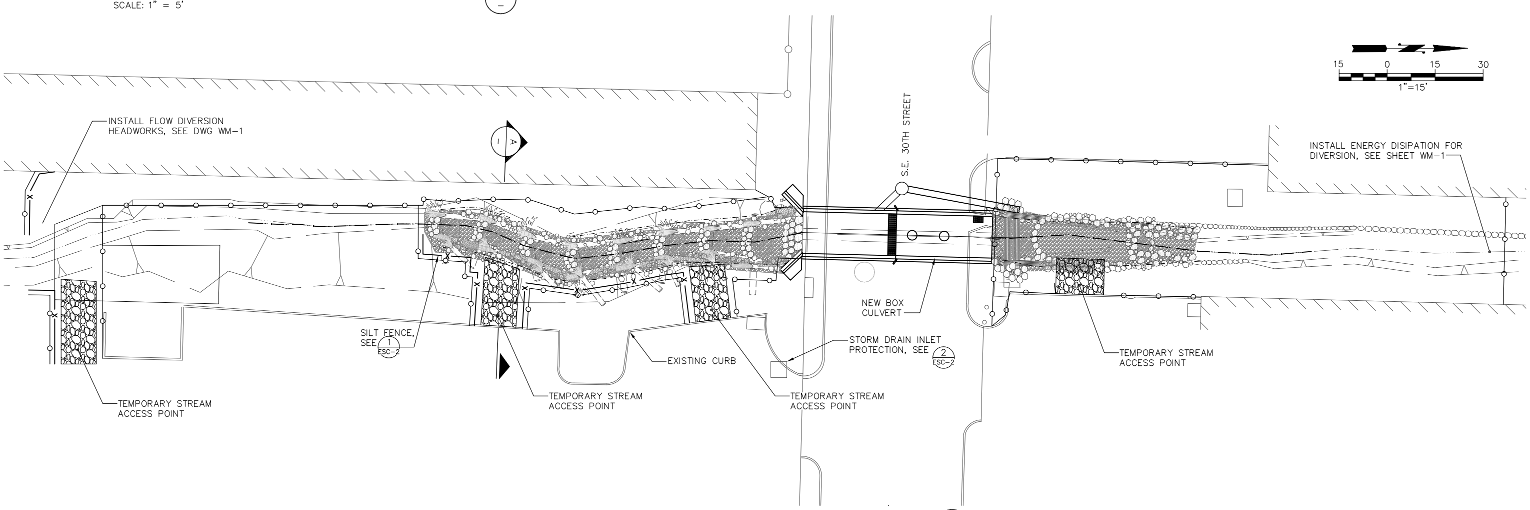


TEMPORARY STREAM ACCESS SECTION (TYP.) A / –

SCALE: 1" = 5'

GENERAL NOTES:

1. NO MECHANIZED EQUIPMENT SHALL BE STORED WITHIN 100' OF CREEK.
2. HIGH VISIBILITY FENCE AND SILT FENCE SHALL BE INSTALLED PRIOR TO COMMENCING CLEARING AND GRUBBING. A MINIMUM OF 2 DAYS NOTICE WILL BE GIVEN TO THE ENGINEER TO ALLOW FOR APPROVAL OF CLEARING LIMITS PRIOR TO ANY CLEARING OR GRUBBING ACTIVITIES.
3. CONTRACTOR SHALL MAINTAIN SAFE ACCESS TO PARKING LOT FOR PRIVATE PROPERTY OWNERS DURING CONSTRUCTION.
4. TEMPORARY ACCESS FOR TRACKED EQUIPMENT ON CHANNEL ALIGNMENT MAY REQUIRE TEMPORARY GRADING OF CHANNEL BOTTOM.
5. QUARRY SPALLS FOR TEMPORARY STREAM ACCESS SHALL BE REMOVED WHEN NO LONGER NEEDED.



TESC PLAN 1 / C-1

SCALE: NOTED

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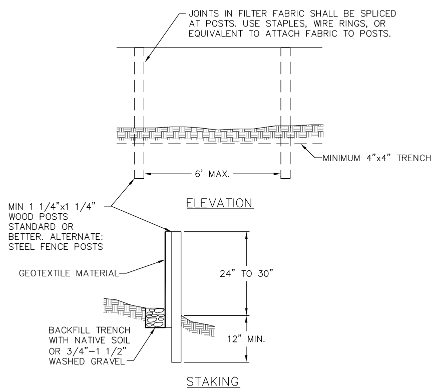
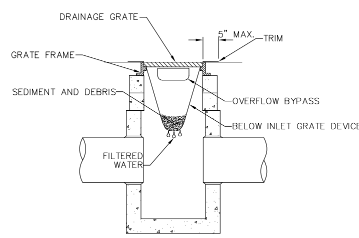
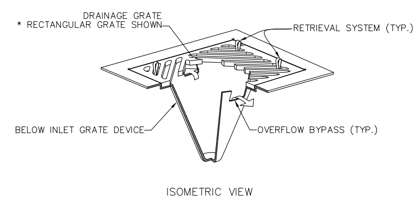
TEMPORARY EROSION AND SEDIMENT CONTROL PLAN

DRAWING ESC-1 SHT 18 OF 23



SILT FENCE DETAIL 1 / ESC-1
SCALE: NTS





STORM DRAIN INLET PROTECTION 2 / ESC-1
SCALE: NTS

NOTES:

1. SIZE THE BELOW INLET GRATE DEVICE (BIGD) FOR THE STORM WATER STRUCTURE IT WILL SERVICE.
2. THE BIGD SHALL HAVE A BUILT-IN HIGH-FLOW RELIEF SYSTEM (OVERFLOW BYPASS).
3. THE RETRIEVAL SYSTEM MUST ALLOW REMOVAL OF THE BIGD WITHOUT SPILLING THE COLLECTED MATERIAL.
4. PERFORM MAINTENANCE IN ACCORDANCE WITH STANDARD SPECIFICATION 8-01.3(15).

NOTES:

1. THE FILTER FABRIC (CONSTRUCTION GEOTEXTILE FOR TEMPORARY SILT FENCE) SHALL BE PURCHASED IN A CONTINUOUS ROLL, 5FT WIDE, CUT TO THE LENGTH OF THE BARRIER TO AVOID USE OF JOINTS. WHEN JOINTS ARE NECESSARY, THE FILTER FABRIC SHALL BE SPLICED TOGETHER ONLY AT A SUPPORT POST, WITH A MINIMUM 6 INCH OVERLAP, AND SECURELY FASTENED TO THE POST.
2. THE FENCE POSTS SHALL BE SPACED A MAXIMUM OF 6 FEET APART AND DRIVEN SECURELY INTO THE GROUND A MINIMUM OF 12 INCHES.
3. A TRENCH SHALL BE EXCAVATED A MINIMUM OF 4 INCHES WIDE BY 4 INCHES DEEP, UPSLOPE AND ADJACENT TO THE POST TO ALLOW THE FILTER FABRIC TO BE BURIED.
4. THE FILTER FABRIC SHALL BE STAPLED OR WIRED TO THE POSTS, AND 12 INCHES OF THE FABRIC SHALL BE EXTENDED INTO THE TRENCH. THE FABRIC SHALL NOT EXTEND MORE THAN 30 INCHES ABOVE THE ORIGINAL GROUND SURFACE. FILTER FABRIC SHALL NOT BE STAPLED TO TREES.
5. THE TRENCH SHALL BE BACKFILLED WITH NATIVE SOIL OR WITH 3/4"-1 1/2" WASHED GRAVEL.
6. SILT FENCES SHALL BE REMOVED AT DIRECTION OF ENGINEER, BUT NOT BEFORE THE UPSLOPE AREA HAS BEEN PERMANENTLY STABILIZED.
7. SILT FENCES SHALL BE INSPECTED IMMEDIATELY AFTER EACH RAINFALL EVENT AND AT LEAST DAILY DURING PROLONGED RAINFALL. ANY REQUIRED REPAIRS SHALL BE MADE IMMEDIATELY.
8. SILT FENCE PERFORMANCE SHALL BE EVALUATED AND SILT FENCE LOCATIONS SHALL BE EVALUATED AND ADJUSTED AS DIRECTED OR APPROVED BY THE ENGINEER AND THE PERMITTING AUTHORITY.
9. SILT FENCE SHALL BE INSTALLED AS SHOWN ON DRAWINGS.
10. ANY DEVIATION OR CHANGE TO SILT FENCE DETAILS MUST BE APPROVED BY THE OWNERS REPRESENTATIVE.
11. THE CONTRACTOR SHALL MAINTAIN A COPY OF THE MANUFACTURER'S SPECIFICATIONS FOR FILTER FABRIC ON SITE.
12. MAINTENANCE STANDARDS:
    A. ANY DAMAGE SHALL BE REPAIRED IMMEDIATELY.
    B. IF CONCENTRATED FLOWS ARE EVIDENT UPHILL OF THE SILT FENCE, THEY MUST BE INTERCEPTED AND CONVEYED TO A SEDIMENT TRAP OR POND, OR OTHERWISE DIVERTED TO A LOCATION THAT DOES NOT RESULT IN TURBID DISCHARGES TO SURFACE WATERS.
    C. THE UPHILL SIDE OF THE SILT FENCE SHALL BE CHECKED FOR SIGNS OF THE SILT FENCE CLOGGING, ACTING AS A BARRIER TO FLOW, AND CAUSING CHANNELIZATION OF FLOWS PARALLEL TO THE FENCE. IF SUCH CHANNELIZATION OCCURS, THE CONTRACTOR SHALL REPLACE THE FENCE OR REMOVE THE TRAPPED SEDIMENT.
    D. SEDIMENT SHALL BE REMOVED AND PROPERLY DISPOSED OF WHEN THE SEDIMENT IS 6 INCHES HIGH.
    E. IF THE FILTER FABRIC HAS DETERIORATED DUE TO ULTRAVIOLET BREAKDOWN, IT SHALL BE REPLACED.

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CITY OF BELLEVUE WASHINGTON
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UTILITIES

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TESC DETAILS

DRAWING ESC-2 | SHT 19 OF 23

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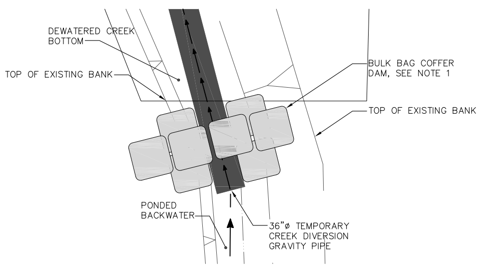
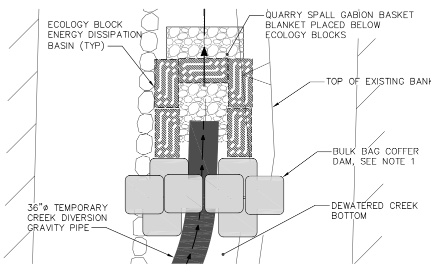


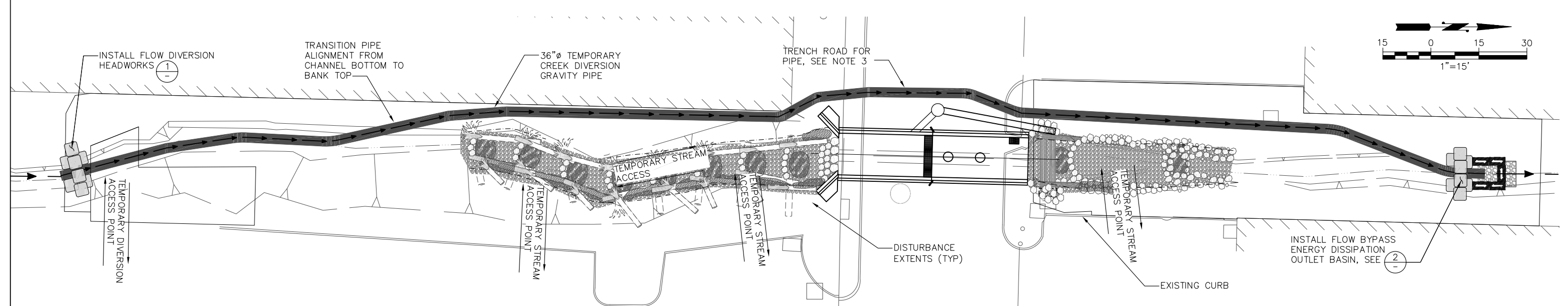
UPSTREAM COFFER DAM DETAIL 1
SCALE: 1" = 5'



DOWNSTREAM OUTLET STRUCTURE DETAIL 2
SCALE: 1" = 5'

GENERAL NOTES:

1. BULK BAGS SHALL BE FILLED WITH CLEAN WASHED ROUNDED GRAVEL.
2. TEMPORARY PUMPING OF CREEK DURING GRAVITY PIPE, UPSTREAM COFFERDAM, AND DOWNSTREAM OUTFALL DISSIPATION INSTALLATION AND REMOVAL WILL BE REQUIRED.
3. COORDINATE TEMPORARY DIVERSION PIPE TRENCH WITH CULVERT SHORING REQUIREMENTS AND UTILITY RELOCATION.
4. COORDINATE FISH EXCLUSION WITH CREEK DIVERSION.



STREAM CHANNEL DIVERSION PLAN 1 C-1
SCALE: NOTED

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CITY OF BELLEVUE WASHINGTON

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FLOW DIVERSION AND FISH EXCLUSION DETAILS

DRAWING WM-1 SHT 20 OF 23

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase II\WM-1.dwg
Plot Date: 10/22/2008 1:40 PM Cad User: Wojciech Wieszczecinski

PLANT SCHEDULE

RIPARIAN LOW LIGHT 1 (RLL1)	SPECIES ABBRV	SCIENTIFIC NAME
	ALRU	ALNUS RUBRA
	THPL	THUJA PLICATA
	ACCI	ACER CIRCINATUM
	COCO	CORYLUS CORNUTA
	RUPA	RUBUS PARVIFLORUS
	SYAL	SYMPHORICARPOS ALBUS
	POMU	POLYSTICHUM MUNTIUM

RIPARIAN LOW LIGHT 2 (RLL2)	SPECIES ABBRV	SCIENTIFIC NAME
	ALRU	ALNUS RUBRA
	PSME	PSEUDOTSUGA MENZIESII
	ACCI	ACER CIRCINATUM
	COCO	CORYLUS CORNUTA
	MAAQ	MAHONIA AQUIFOLIUM
	RONU	ROSA NUTKANA
	RUPA	RUBUS PARVIFLORUS
	SYAL	SYMPHORICARPOS ALBUS

RIPARIAN HIGH LIGHT 1&2 (RHL)	SPECIES ABBRV	SCIENTIFIC NAME
	ALRU	ALNUS RUBRA
	PSME	PSEUDOTSUGA MENZIESII
	HODI	HOLODISCUS DISCOLOR
	MAAQ	MAHONIA AQUIFOLIUM
	RONU	ROSA NUTKANA
	POBA	POPULUS BALSAMIFERA
	SYAL	SYMPHORICARPOS ALBUS

LIVE STAKES (LS)	SPECIES ABBRV	SCIENTIFIC NAME
	COSE	CORNUS SERICEA
	SALU	SALIX LUCIDA SSP. LASIANDRA
	SASC	SALIX SCOULERIANA
	SASI	SALIX SITCHENSIS

LEGEND:

EXISTING CREEK FLOW LINE

PLANTING KEY LEGEND:

PLANTING MIX. SEE PLANTING LEGEND

PLANTING AREA NUMBER

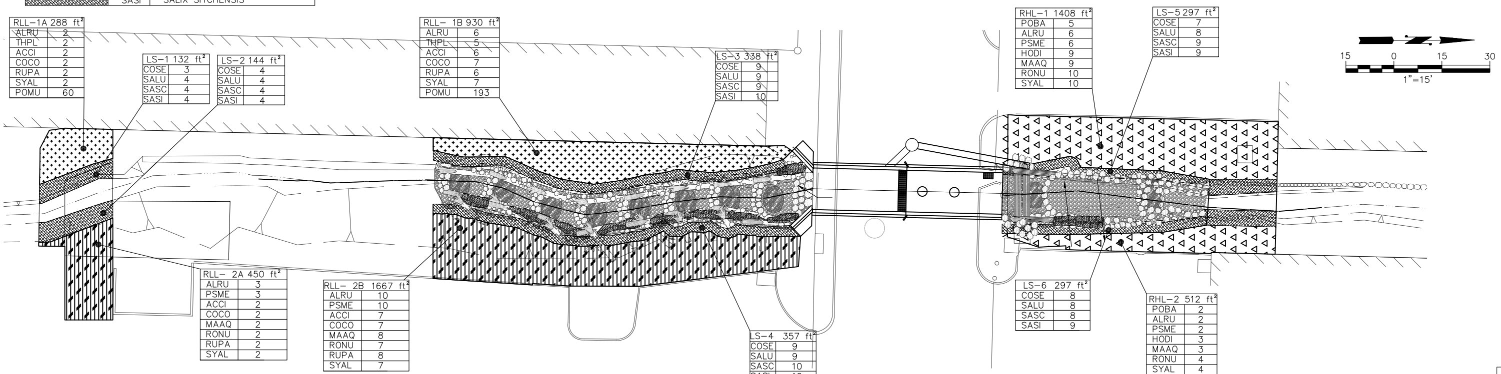
RLL-1B 649 ft²	
ALRU	4
THPL	4
ACCI	3
COCO	4
RUPA	4
SYAL	4
POMU	133

PLANTING ABBREV. SEE PLANTING LEGEND

QUANTITY OF PLANTS IN AREA

GENERAL NOTES:

1. NOXIOUS WEEDS SHALL BE REMOVED PRIOR TO COMMENCING CONSTRUCTION. WEEDS SHALL BE REMOVED BY SELECTIVE CLEARING METHODS WITHIN THE RIPARIAN ENHANCEMENT ZONES. THE WORK SITE SHALL BE MAINTAINED IN A WEED FREE CONDITION THROUGHOUT CONSTRUCTION UNTIL THE CLOSE OF THE CONTRACT. AT A MINIMUM, HIMALAYAN BLACKBERRY, REED CANARYGRASS, JAPANESE KNOTWEED AND ENGLISH IVY SHALL BE COMPLETELY REMOVED FROM THE PROJECT SITE.
2. SELECTIVE CLEARING METHODS CONSIST OF LIGHTWEIGHT HAND OR HAND-HELD EQUIPMENT TO PREVENT DAMAGE TO ROOTS OF EXISTING VEGETATION, COMPACTION OF SOIL, AND DISPERSAL OF SEEDS OR POLLEN FROM INVASIVE PLANTS.
3. NATIVE SEED MIX SHALL BE APPLIED TO ALL DISTURBED AREAS TO STABILIZED SOILS & TO PROVIDE HERBACEOUS COVER. SEEDING SHALL OCCUR AFTER SOIL PREPARATION AND GRADING HAS BEEN APPROVED BY ENGINEER. NATIVE SEED MIX SHALL BE APPLIED BY HAND TO FACES OF SOIL LIFTS PRIOR TO WRAPPING WITH WOVEN GEOTEXTILE. ALL OTHER AREAS WILL BE HYDROSEEDED.
4. ALL PLANTS, EXCEPT AS NOTED, SHALL BE NURSERY CONTAINER GROWN A MINIMUM OF ONE YEAR AND CONTAINERIZED PER ANSI STANDARDS. PLANT MATERIAL IS TO BE SUPPLIED BY COMMERCIAL NURSERIES THAT SPECIALIZE IN NATIVE PLANTS. PLANT SUBSTITUTIONS ARE SUBJECT TO APPROVAL BY THE ENGINEER.
5. SPECIFICATIONS FOR SIZE AND CONDITION ON DWG P-3 ARE MINIMUM.
6. PLANT SPECIES SELECTIONS FOR EACH PLANTING AREA ARE BASED ON PREDICTED LIGHT AND WATER AVAILABILITY. PLANTS SHALL BE RANDOMLY MIXED THROUGHOUT EACH PLANTING ZONE. VERIFICATION OF APPROPRIATE ENVIRONMENTAL CONDITIONS PER SPECIES REQUIREMENTS WILL BE NECESSARY TO ACHIEVE MAXIMUM PLANT SURVIVAL. LAYOUT OF ALL PLANT MATERIAL AND SEEDING TO BE APPROVED BY THE ENGINEER PRIOR TO INSTALLATION. PLANTING PLAN MAY REQUIRE MODIFICATION FOLLOWING ASSESSMENT OF AS-BUILT CONDITIONS: USE PLAN FOR QUANTITIES – FINAL LOCATIONS OF PLANTS SUBJECT TO CHANGE.
7. SHRUBS, TREES AND, LIVE STAKES SHALL BE INSTALLED ACCORDING TO DETAILS ON DWG. P-2.
8. DISCREPANCIES BETWEEN PLANS AND SITE CONDITIONS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER PRIOR TO PROCEEDING.
9. ENGINEER TO APPROVE GRADING PRIOR TO PLANTING.
10. KEEP ALL PLANT MATERIAL WELL-WATERED AND SHADED UNTIL THE ACTUAL TIME OF PLANTING: DO NOT ALLOW PLANT MATERIAL TO BE EXPOSED TO SUNLIGHT OR OTHER DRYING CONDITIONS PRIOR TO PLANTING.
11. ALL SHRUB AND TREE PLANTING SHALL OCCUR DURING THE DORMANT SEASON (NOVEMBER THROUGH FEBRUARY).
12. THOROUGHLY WATER ALL PLANTED AREAS IMMEDIATELY AFTER PLANTING AND WATER FOR OPTIMUM HEALTH DURING DRY PERIODS DURING THE PLANT ESTABLISHMENT PERIOD.
13. EXISTING AREAS DISTURBED BY CONSTRUCTION ACTIVITIES AND NOT SHOWN TO BE RE-LANDSCAPED ON THESE PLANS SHALL BE RESTORED AND SEEDED AS DIRECTED BY THE ENGINEER.
14. SEE SPECIFICATIONS FOR ADDITIONAL SEEDING, PLANTING, AND SOIL PREPARATION NOTES.
15. ALL TREE OR SHRUB PLANTINGS SHALL BE SETBACK A MINIMUM OF 5 FEET FROM ALL PAVEMENT EDGES, AND ALL TREE PLANTINGS SHALL BE SETBACK A MINIMUM OF 10 FEET FROM BUILDINGS.



STREAM CHANNEL SITE PREP PLAN

SCALE: NOTED

1 / C-1

ONE INCH

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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1	10/08	CB	ME	REVISIONS TO 60% DESIGN

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98121-1820
206-441-9080
206-441-9108 FAX
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SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER DATE

PROJECT MANAGER DATE

C. ELLIOT 05/2008 DESIGNED BY DATE
W. WESZCZEONSKI 06/2008 DRAWN BY DATE
K. LEPINE 06/2008 CHECKED BY DATE

City of Bellevue UTILITIES

PLANTING PLAN

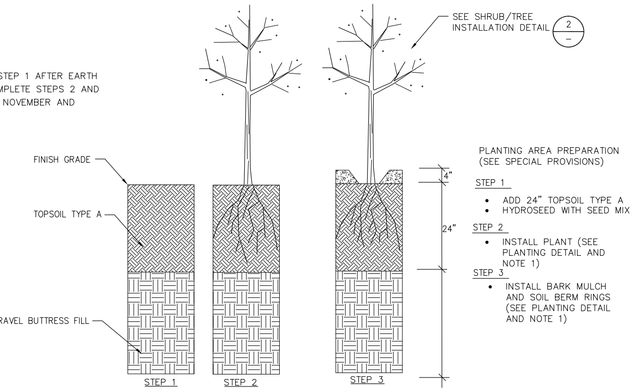
DRAWING P-1

SHT 21 OF 23

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase II\P-1.dwg Plot Date: 10/22/2008 1:40 PM Cad User: Wojciech Wieszczeonski

NOTE:

1. COMPLETE STEP 1 AFTER EARTH WORK. COMPLETE STEPS 2 AND 3 BETWEEN NOVEMBER AND FEBRUARY



PLANTING AREA PREPARATION (SEE SPECIAL PROVISIONS)

STEP 1
- ADD 24" TOPSOIL TYPE A
- HYDROSEED WITH SEED MIX

STEP 2
- INSTALL PLANT (SEE PLANTING DETAIL AND NOTE 1)

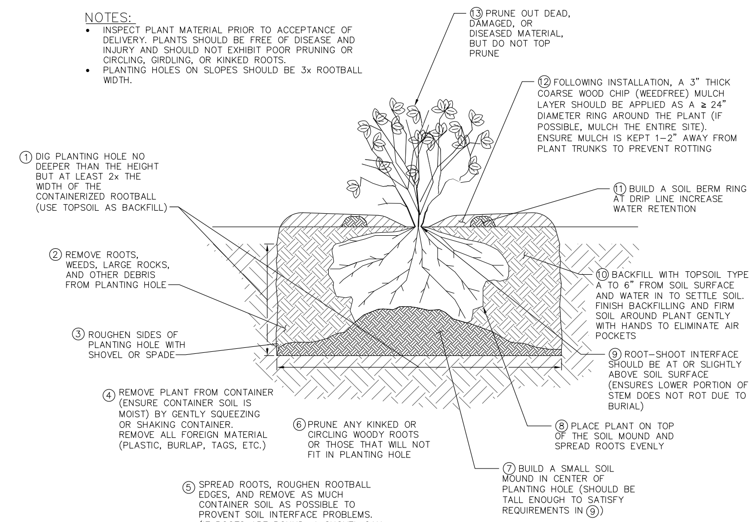
STEP 3
- INSTALL BARK MULCH AND SOIL BERM RINGS (SEE PLANTING DETAIL AND NOTE 1)

TOPSOIL TYPE A AMENDMENT AND PLANTING SEQUENCE OF WORK (1 –)

SCALE: NTS

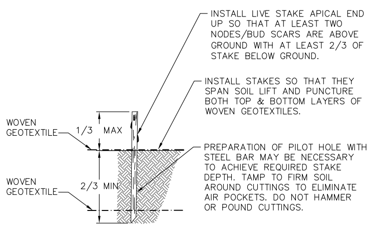
NOTES:

- INSPECT PLANT MATERIAL PRIOR TO ACCEPTANCE OF DELIVERY. PLANTS SHOULD BE FREE OF DISEASE AND INJURY AND SHOULD NOT EXHIBIT POOR PRUNING OR CIRCLING, GIRDLING, OR KINKED ROOTS.
- PLANTING HOLES ON SLOPES SHOULD BE 3x ROOTBALL WIDTH.



CONTAINERIZED TREE/SHRUB INSTALLATION SEQUENCE (2 –)

SCALE: NTS



NOTES:

1. BASAL END OF LIVE STAKES SHOULD BE 0.5–1.5 INCHES IN DIAMETER AND AT LEAST 36 INCHES IN LENGTH.
2. KEEP LIVE STAKES COVERED, COOL, AND MOIST AT ALL TIMES PRIOR TO PLANTING. AT NO TIME SHOULD LIVE STAKES BE EXPOSED AND ALLOWED TO DRY OUT.
3. WHEN PLANTING ON STREAM BANKS, ANGLE STAKES SLIGHTLY DOWNSTREAM.

LIVE STAKE INSTALLATION (3 –)

SCALE: NTS

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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1	10/08	CB	ME	REVISIONS TO 60% DESIGN

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206-441-9108 FAX
https://www.herrerainc.com

SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER — DATE

PROJECT MANAGER — DATE

C. ELLIOT 05/2008 DESIGNED BY DATE
W. WESZCZEONSKI 06/2008 DRAWN BY DATE
K. LEPINE 06/2008 CHECKED BY DATE

City of Bellevue UTILITIES

PLANTING DETAILS

DRAWING P-2

SHT 22 OF 23

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase II\P-2.dwg
Plot Date: 10/22/2008 1:41 PM Cad User: Wojciech Wieszczeonski

STRUCTURAL CLASS	SPECIES ABBRV	QUANTITY	SCIENTIFIC NAME	COMMON NAME	WETLAND INDICATOR	MATERIAL TYPE & SIZE	SPACING ON CENTER (FEET)	NOTES
TREES								
	POBA	7	POPULUS BALSAMIFERA	BLACK COTTONWOOD	FAC	1 GAL CONT. 12" HEIGHT	9	
	ALRU	29	ALNUS RUBRA	RED ALDER	FAC	1 GAL CONT. 12" HEIGHT	9	
	PSME	23	PSEUDOTSUGA MENZIESII	DOUGLAS FIR	FACU	2 GAL CONT. 24" HEIGHT	9	
	SALU	42	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW	NI	LIVE STAKE 36" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	INSTALL AT OHWM AND BELOW
	THPL	6	THUJA PLICATA	WESTERN RED CEDAR	FAC	2 GAL CONT. 24" HEIGHT	9	
SHRUBS								
	ACCI	17	ACER CIRCINATUM	VINE MAPLE	FAC–	1 GAL CONT. 12" HEIGHT	5	
	COSE	40	CORNUS SERICEA	RED OSIER DOGWOOD	FACW	LIVE STAKE 36" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	INSTALL AT OHWM AND BELOW
	COCO	18	CORYLUS CORNUTA	BEAKED HAZELNUT	FACU	1 GAL CONT. 12" HEIGHT	5	
	HODI	12	HOLODISCUS DISCOLOR	OCEANSPRAY	UPL	1 GAL CONT. 12" HEIGHT	5	
	MAAQ	23	MAHONIA AQUIFOLIUM	TALL OREGON GRAPE	UPL	1 GAL CONT. 12" HEIGHT	5	
	RONU	25	ROSA NUTKANA	NOOTKA ROSE	FAC	1 GAL CONT. 12" HEIGHT	5	
	RUPA	17	RUBUS PARVIFLORUS	THIMBLEBERRY	FAC–	1 GAL CONT. 12" HEIGHT	5	
	SYAL	31	SYMPHORICARPOS ALBUS	SNOWBERRY	FACU	1 GAL CONT. 12" HEIGHT	5	
	SASC	44	SALIX SCOULERIANA	SCOULER'S WILLOW	FAC	LIVE STAKE 36" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	INSTALL AT OHWM AND ABOVE
	SASI	46	SALIX SITCHENSIS	SITKA WILLOW	FACW	LIVE STAKE 36" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	INSTALL AT OHWM AND BELOW
HERBS								
	POMU	196	POLYSTICHUM MUNITUM	SWORD FERN	FACU	1 GAL CONT.	2	

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase II\P-3.dwg Cad User: Wojciech Wieszczecinski
Plot Date: 10/22/2008 1:42 PM

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C. ELLIOT 05/2008 DESIGNED BY DATE
W. WIESZCZECINSKI 06/2008 DRAWN BY DATE
K. LEPINE 06/2008 CHECKED BY DATE

City of Bellevue UTILITIES

PLANT MATERIAL LIST

DRAWING P-3

SHT 23 OF 23

APPENDIX D

Hydraulic Modeling Documentation and Results

Hydraulic Model Analysis Documentation

This appendix describes and documents the modeling approach, the data inputs, and the calibration procedure used to develop and validate the hydraulic model used for the analysis of flood control and sediment management alternatives for Sunset Creek.

Methods of Hydraulic Model Analysis

The hydraulic analysis was performed using version 4.0.0 Beta of the *Hydrologic Engineering Center - River Analysis System* (HEC-RAS) model. HEC-RAS is a one-dimensional, stepped, backwater numerical software model developed by the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC) for river analysis and simulation. It is commonly used as a flood hazard mapping tool by the Federal Emergency Management Agency (FEMA) and state and local agencies throughout the country for the development of Flood Insurance Rate Maps (FIRMs). HEC-RAS can simulate steady and unsteady, gradually varied flow. The computational procedure of the one-dimensional HEC-RAS model is based on the solution of the energy equation and energy losses between successive channel/floodplain cross-sections. The model calculates the water surface elevation in a step-wise manner from one cross section to the next based on the hydraulic roughness of the channel and floodplain and on cross sectional area of flow.

The HEC-RAS model created for the Sunset Creek project was developed as a steady flow model. Steady flow models include a fixed flow input, and the flow depths and velocities do not vary over time. Steady flow input information was derived from the Richards Creek Basin Plan (Entranco 2000). Cross-sectional geometry and channel information for the Sunset Creek, Richards Creek, and East Creek channel network in the vicinity of SE 30th Street and Kamber Road was developed from cross-sectional surveys completed between 2006 and 2007 (Bellevue 2007). Because the primary project area is along Sunset Creek and the SE 30th Street crossing of Sunset Creek, the steady HEC-RAS model is referred to in this report as the “Sunset Creek model”.

Sunset Creek Model Analysis Approach

The approach for the Sunset Creek model analysis was as follows:

- Perform a hydraulic analysis of existing conditions to estimate and evaluate flow depths, velocities, and shear stresses under existing conditions and to understand existing flooding and sedimentation challenges in the project area.
- Iteratively modify the geometry in the existing conditions model to simulate Phase I proposed conditions in order to both significantly increase flow conveyance with a replacement SE 30th Street culvert, as well as to maintain adequate shear stress to the sediment trap within the culvert.

- Perform a hydraulic analysis of conditions resulting from project Phases I, II, and III by adding the channel and bank roughness structures, the replacement culvert and sediment trap, a two-stage channel, and grade control structures to the Sunset Creek model.
- Compare the results under existing conditions with those resulting from project Phases I, II, and III to assess the extent of changes in water surface elevation, shear stress, and velocity.
- Adjust the design/size/location of the structures and channel modifications to assess changes in upstream or downstream water surface elevation or velocity, optimize design, and extract design information to support channel stability, berm location and design, and flood reduction.

Five model plans were developed to carry out this approach and to meet the modeling objectives described in the introduction of this report. Each of these model plans represents a unique combination of steady flow and channel geometry information specific to the existing conditions, or Phase I, II, or III alternative conditions. Table D-1 below outlines each model plan, the specific steady flow and model geometry files referenced, and describes the model scenario that each plan was designed to represent and analyze.

Existing Conditions Model Results and Calibration

The proposed culvert and channel improvements will reduce the impacts of flooding, sedimentation, and sediment removal activities around SE 30th Street and in downstream areas. To achieve these objectives, the project must not induce channel erosion, bank instability, and flood risks in the project area that are greater than existing conditions. Therefore, a characterization of the existing hydraulic conditions was necessary to provide a basis for comparison.

Model Extents

The length of the Sunset Creek and Richards Creek channel network simulated with the Sunset Creek model extends along Sunset Creek from 625 feet upstream of SE 30th Street to the confluence with Richards Creek, located downstream of SE 30th Street. The Richards Creek channel then continues downstream to a flow split with the historical Richards Creek alignment, past the confluence with East Creek and the Kamber Road crossing, down to the lower Richards Creek channel. The Richards Creek channel upstream of the confluence with Sunset Creek and the East Creek channel upstream of the confluence with the Richards Creek flow-split channel were not included in the Sunset Creek model evaluated for this project. Figures 2 and 6 of this report depict the entire channel network included in the Sunset Creek hydraulic model. Figures D-1 through Figure D-5 provide a detailed view of the channel network simulated within the HEC-RAS model, from upstream to downstream. Table D-2 lists the stream reach segments as they were developed within the Sunset Creek model.

Table D-1. Summary of HEC-RAS model plans used for the Sunset Creek hydraulic analysis.

Plan Name	Steady Flows	Model Geometry	Description
Final Existing Conditions	Final Steady Flood Flows	Existing_geometry_Final_1	Representation of existing conditions, prior to the culvert replacement and implementation of any proposed design alternatives. Existing cross-sectional geometry derived from cross-section surveys; Manning's *n* values based on observations and Cowan method; steady flow information from Richards Creek Basin Plan report (Entranco 2000).
Phase I Oct2008	Final Steady Flood Flows	Alternative_1_Phase_1	Representation of conditions after construction of the proposed Phase I improvements. Existing cross-sectional geometry altered to include the replacement culvert and sediment trap as well as root wads, weirs, and upstream and downstream channel grading changes; Manning's *n* values based on proposed changes to channel roughness, derived using Cowan method; steady flow information from Richards Creek Basin Plan report (Entranco 2000).
Phase II Oct2008	Final Steady Flood Flows	Alternative_2a_Phase_2_1.01bench	Representation of conditions after construction of the proposed Phase I and Phase II alternatives. Geometry includes Phase I alterations, and Phase II alterations to represent additional channel re-grading downstream of the replacement culvert; steady flow information from Richards Creek Basin Plan report (Entranco 2000).
Phase III Alt 3 Oct2008	Final Steady Flood Flows	Alternative_3_Phase_3_1.01bench	Representation of conditions after construction of the proposed Phase I, II, and III alternatives, assuming a continued downstream boundary condition controlled by the backwater induced by the beaver dam. Geometry includes both Phase I and Phase II alterations as well as Phase III channel re-grading of the East Creek and flow-split channels; steady flow information from Richards Creek Basin Plan report (Entranco 2000).
Phase III Alt 4 No Beavers Oct2008	Final Steady Flood Flows no beavers	Alternative_4_Phase_3_1.01bench	Representation of conditions after construction of the proposed Phase I, II, and III alternatives, assuming a downstream boundary condition consistent with no beaver dam present. Geometry includes Phase I, Phase II, and Phase III alterations; steady flow information from Richards Creek Basin Plan report (Entranco 2000) adjusted to set the downstream boundary condition relevant to a water surface slope when no beaver dam is present.

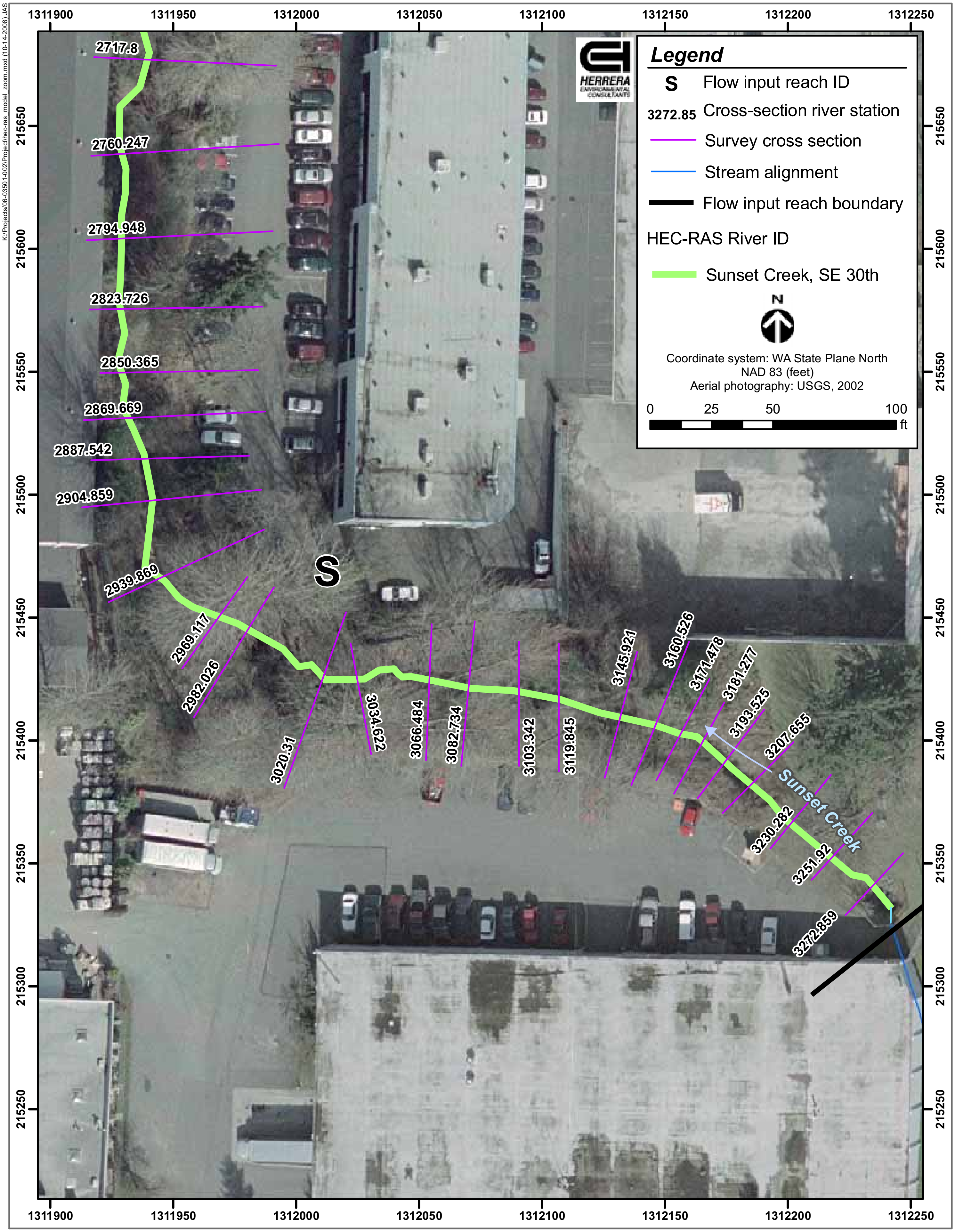

Figure D-1. Sunset Creek HEC-RAS model geometry for cross sections 3272.859 to 2717.8.

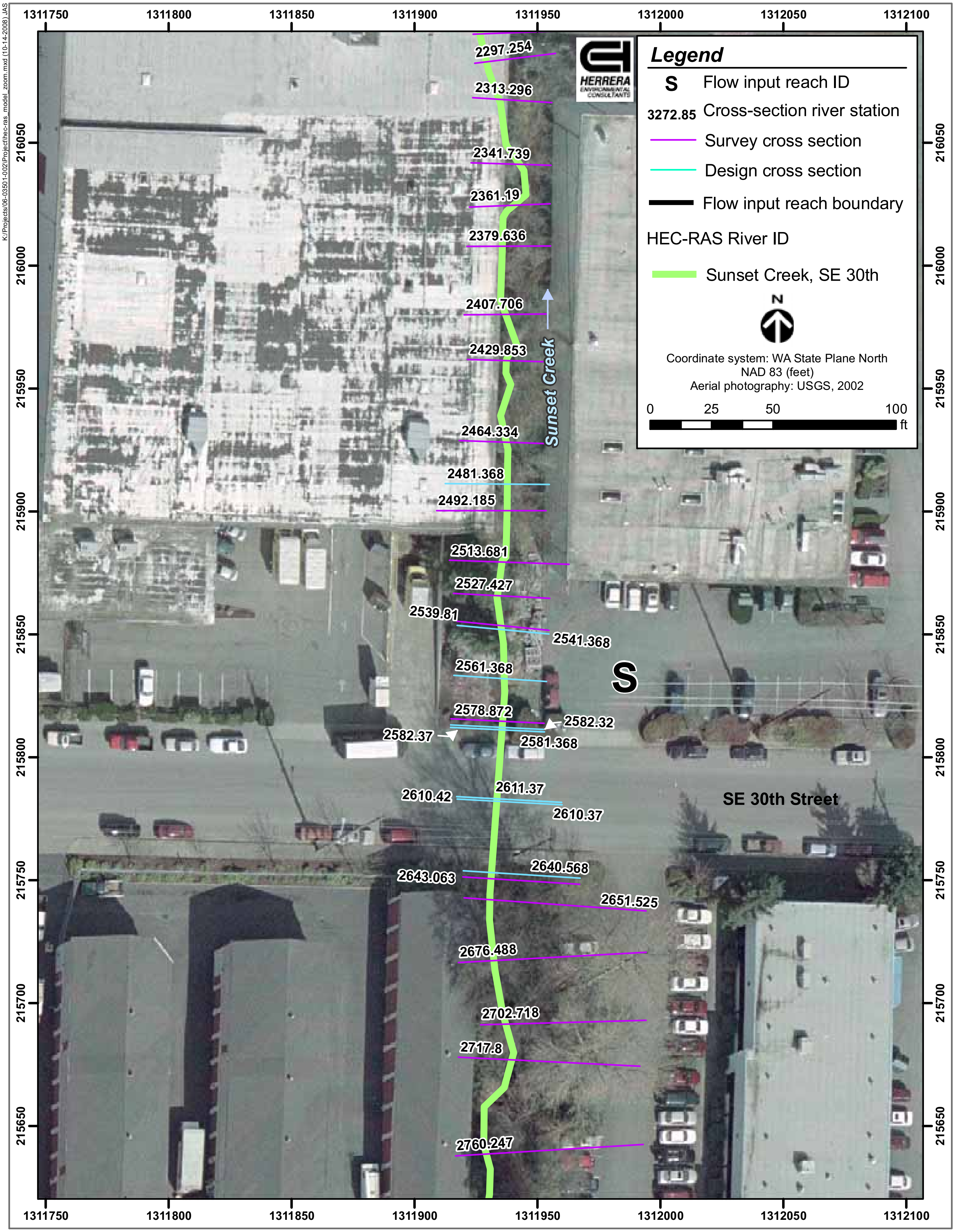

Figure D-2. Sunset Creek HEC-RAS model geometry for cross sections 2760.247 to 2297.254.

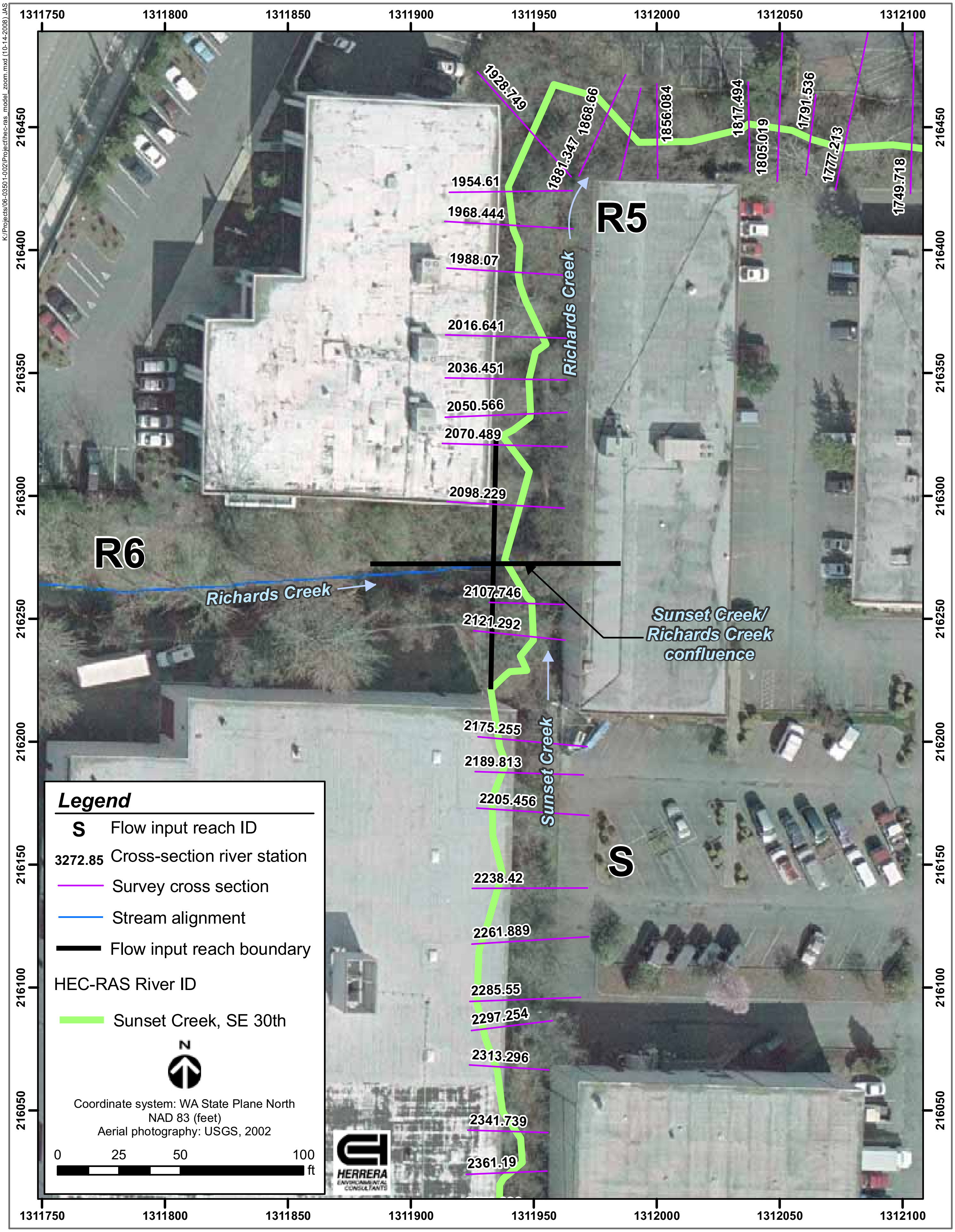

Figure D-3. Sunset Creek HEC-RAS model geometry for cross sections 2361.19 to 1749.718

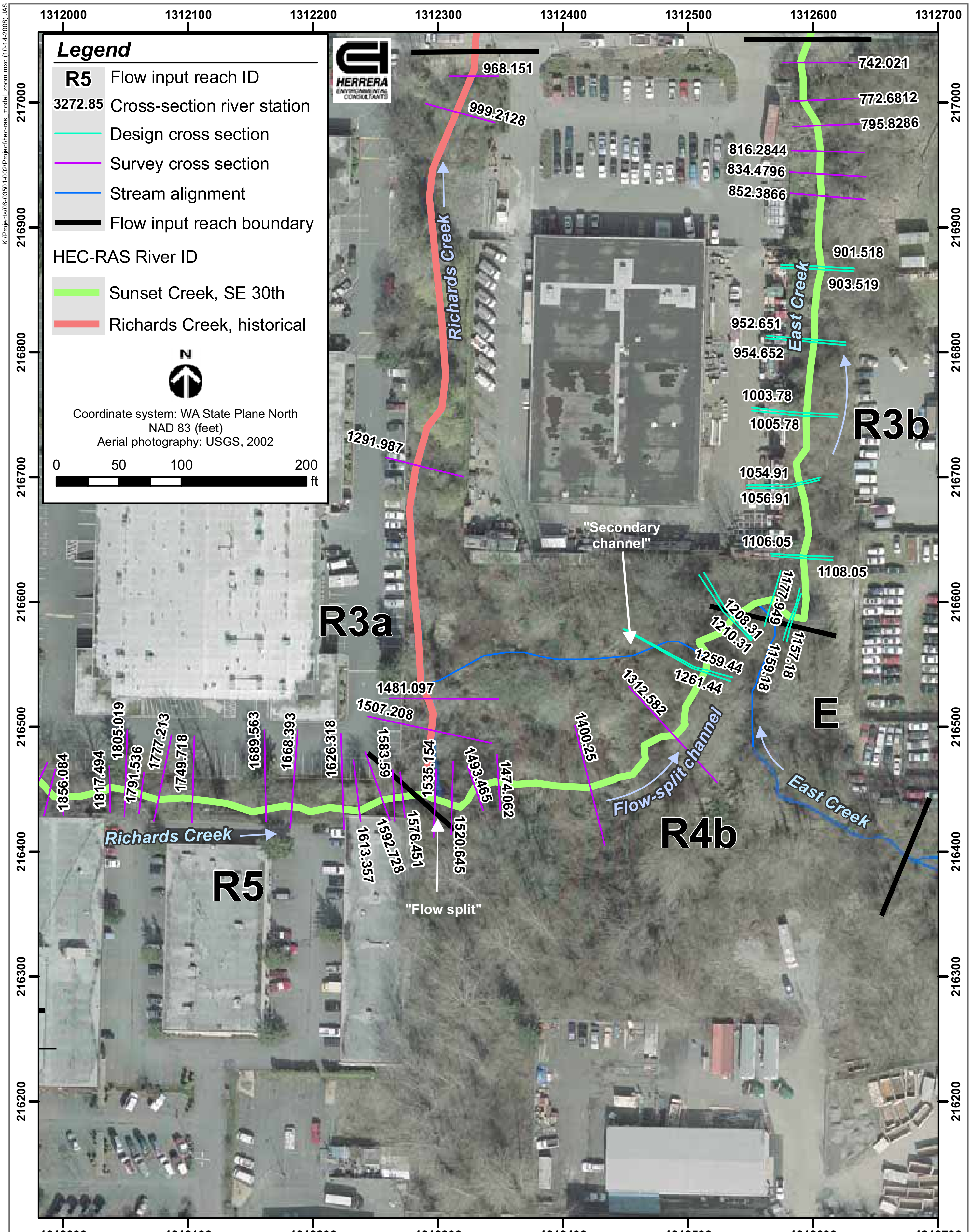

Figure D-4. Sunset Creek HEC-RAS model geometry for cross sections 1791.536 to 742.021 and Richards Creek, historical alignment cross sections 1507.208 to 968.151.

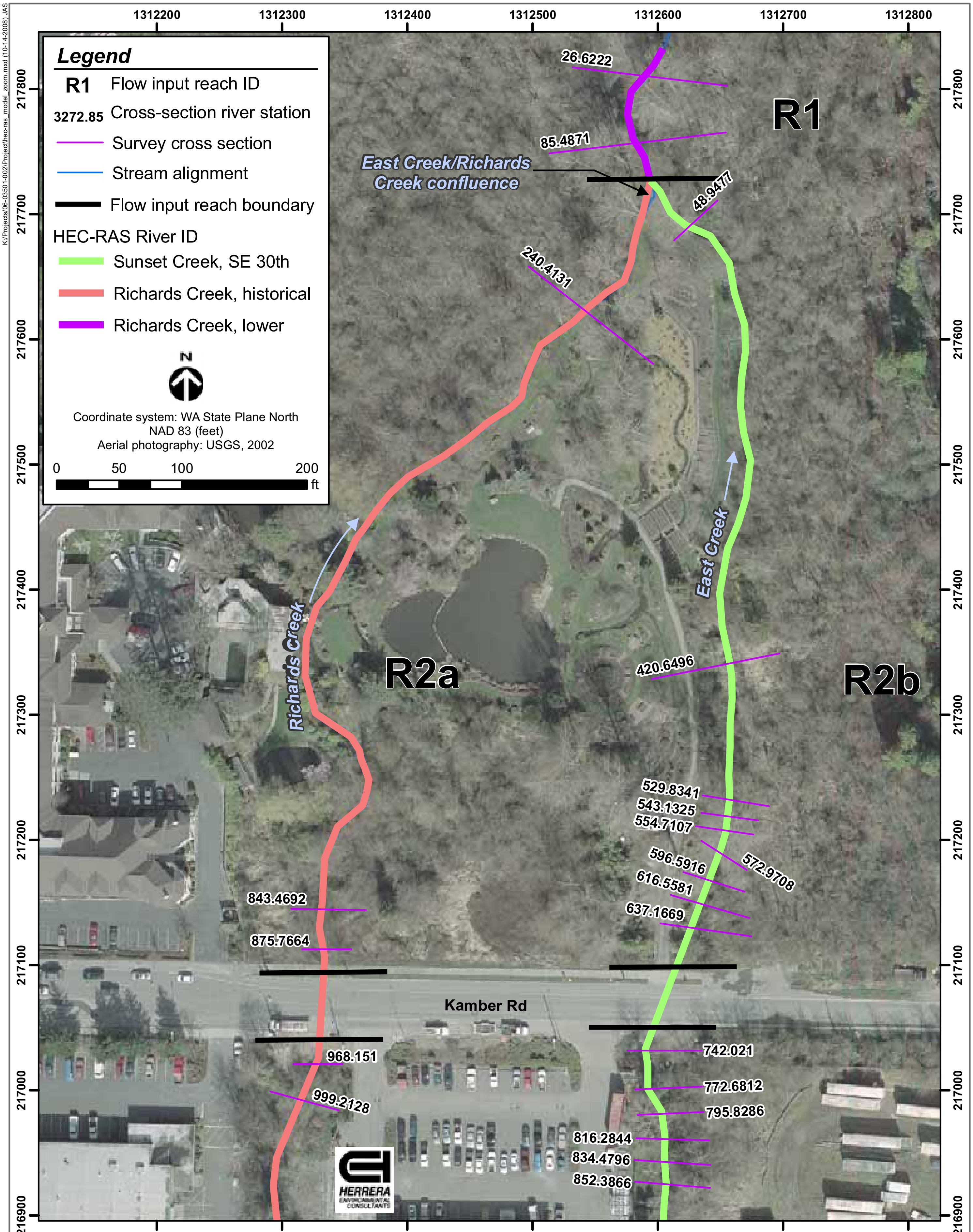

Figure D-5. Sunset Creek HEC-RAS model geometry for cross sections 852.3866 to 48.9477, Richards Creek, historical alignment cross sections 999.2128 to 240.4131, and Richards Creek, lower cross sections 85.4871 to 26.6222.

Table D-2. Sunset Creek stream reach segments.

HEC-RAS River ID	HEC-RAS Reach ID	Downstream River Station (ft)	Upstream River Station (ft)	Corresponding Flow Input Reach	Description
Sunset Creek	SE 30th	48.9477	3272.859	S, R5, R4b, R3b, R2b	Incorporates the Sunset Creek channel from 625 feet upstream of SE 30th Street to the confluence with Richards Creek and includes Richards Creek to the flow split, the flow-split channel, and the East Creek channel from the confluence of the flow-split channel and East Creek down to the confluence with the historical Richards Creek channel
Richards Creek	Historical	240.4131	1507.208	R3a, R2a	Historical Richards Creek channel from flow split to confluence with East Creek downstream of Kamber Road
Richards Creek	Lower	26.62222	85.48712	R1	Richards Creek from confluence of East Creek with historical Richards Creek channel downstream to Bannerwood Park

Cross-Section Data

Topographic and cross-section survey data for constructing the Sunset Creek hydraulic model geometry were provided by the City of Bellevue and include the following:

- Entranco HEC-RAS model geometry (Entranco 2000)
- 2006 City of Bellevue survey (Bellevue 2007)
- 2006 Peterson survey (Bellevue 2007)
- 2007 City of Bellevue survey (Bellevue 2007)
- 2000 Puget Sound Lidar Consortium (PSLC) light detection and ranging (LiDAR) data (PSLC 2000).

Model cross-sections derived from digital elevation models were based either on the City of Bellevue survey data from 2005, 2006, and 2007 or from the Peterson Survey from 2006 (Bellevue 2007). The 2000 PSLC LiDAR data (PSLC 2000) were used to extend cross-sections where the survey extent in floodplain areas was not sufficient. The topographic data source for each cross-section used for the Sunset Creek model is presented in the title of each cross section in the model, and also indicated for each figure showing the cross-sectional geometry later in this appendix. Table D-3 provides a summary of each cross section used within the Sunset Creek model for the existing conditions analysis and cites the original data source.

Table D-3. Cross section data sources for the Sunset Creek model of existing conditions.

HEC-RAS River ID	HEC-RAS Reach ID	River Station (ft)	Source	Cross Section Survey Year and Description
Sunset Creek	SE 30th	3272.859	Bellevue 2007	2006 #75
Sunset Creek	SE 30th	3251.92	Bellevue 2007	2006 #74
Sunset Creek	SE 30th	3230.282	Bellevue 2007	2006 #73
Sunset Creek	SE 30th	3207.655	Bellevue 2007	2006 #72
Sunset Creek	SE 30th	3193.525	Bellevue 2007	2006 #71
Sunset Creek	SE 30th	3181.277	Bellevue 2007	2006 #70
Sunset Creek	SE 30th	3171.478	Bellevue 2007	2006 #69
Sunset Creek	SE 30th	3160.526	Bellevue 2007	2006 #68
Sunset Creek	SE 30th	3145.921	Bellevue 2007	2006 #67
Sunset Creek	SE 30th	3119.845	Bellevue 2007	2006 #66
Sunset Creek	SE 30th	3103.342	Bellevue 2007	2006 #65
Sunset Creek	SE 30th	3082.734	Bellevue 2007	2006 #64
Sunset Creek	SE 30th	3066.484	Bellevue 2007	2006 #63
Sunset Creek	SE 30th	3034.622	Bellevue 2007	2006 #62
Sunset Creek	SE 30th	3020.31	Bellevue 2007	2006 #61
Sunset Creek	SE 30th	2982.026	Bellevue 2007	2006 #59
Sunset Creek	SE 30th	2969.117	Bellevue 2007	2006 #58
Sunset Creek	SE 30th	2939.869	Bellevue 2007	2006 #57
Sunset Creek	SE 30th	2904.859	Bellevue 2007	2006 #56
Sunset Creek	SE 30th	2887.542	Bellevue 2007	2006 #55
Sunset Creek	SE 30th	2869.669	Bellevue 2007	2006 #54
Sunset Creek	SE 30th	2850.365	Bellevue 2007	2006 #53
Sunset Creek	SE 30th	2823.726	Bellevue 2007	2006 #52
Sunset Creek	SE 30th	2794.948	Bellevue 2007	2006 #51
Sunset Creek	SE 30th	2760.247	Bellevue 2007	2006 #50
Sunset Creek	SE 30th	2717.8	Bellevue 2007	2006 #49
Sunset Creek	SE 30th	2702.718	Bellevue 2007	2006 #48
Sunset Creek	SE 30th	2676.488	Bellevue 2007	2006 #47
Sunset Creek	SE 30th	2651.525	Bellevue 2007	2006 #46
Sunset Creek	SE 30th	2643.063	Bellevue 2007	2006B #12
Sunset Creek	SE 30th	2608.794	Bellevue 2007	2-42" CMP @ SE 30th St.
Sunset Creek	SE 30th	2578.872	Bellevue 2007	2006B #11

HEC-RAS River ID	HEC-RAS Reach ID	River Station (ft)	Source	Cross Section Survey Year and Description
Sunset Creek	SE 30th	2539.81	Bellevue 2007	2006 #44
Sunset Creek	SE 30th	2527.427	Bellevue 2007	2007 #35
Sunset Creek	SE 30th	2513.681	Bellevue 2007	2006 #43
Sunset Creek	SE 30th	2492.185	Bellevue 2007	2006 #42
Sunset Creek	SE 30th	2464.334	Bellevue 2007	2006 #41
Sunset Creek	SE 30th	2429.853	Bellevue 2007	2007 #32
Sunset Creek	SE 30th	2407.706	Bellevue 2007	2006 #39
Sunset Creek	SE 30th	2379.636	Bellevue 2007	2006 #38
Sunset Creek	SE 30th	2361.19	Bellevue 2007	2006 #37
Sunset Creek	SE 30th	2341.739	Bellevue 2007	2006 #36
Sunset Creek	SE 30th	2313.296	Bellevue 2007	2006 #35
Sunset Creek	SE 30th	2297.254	Bellevue 2007	2006 #34
Sunset Creek	SE 30th	2285.55	Bellevue 2007	2006 #33
Sunset Creek	SE 30th	2261.889	Bellevue 2007	2006 #32
Sunset Creek	SE 30th	2238.42	Bellevue 2007	2006 #31
Sunset Creek	SE 30th	2205.456	Bellevue 2007	2006 #30
Sunset Creek	SE 30th	2189.813	Bellevue 2007	2006B #7
Sunset Creek	SE 30th	2175.255	Bellevue 2007	2006 #29
Sunset Creek	SE 30th	2121.292	Bellevue 2007	2006 #28
Sunset Creek	SE 30th	2107.746	Bellevue 2007	2007 #31
Sunset Creek	SE 30th	2098.229	Bellevue 2007	2007 #30
Sunset Creek	SE 30th	2070.489	Bellevue 2007	2006 #25
Sunset Creek	SE 30th	2050.566	Bellevue 2007	2007 #29
Sunset Creek	SE 30th	2036.451	Bellevue 2007	2006 #24
Sunset Creek	SE 30th	2016.641	Bellevue 2007	2006 #23
Sunset Creek	SE 30th	1988.07	Bellevue 2007	2006 #22
Sunset Creek	SE 30th	1968.444	Bellevue 2007	2006 #21 (channel & right bank)/2006B #4 (left bank)
Sunset Creek	SE 30th	1954.61	Bellevue 2007	2006 #20
Sunset Creek	SE 30th	1928.749	Bellevue 2007	2006 #19 (channel & right bank)/2006B #3 (left bank point)
Sunset Creek	SE 30th	1881.347	Bellevue 2007	2006 #18
Sunset Creek	SE 30th	1868.66	Bellevue 2007	2006 #17

HEC-RAS River ID	HEC-RAS Reach ID	River Station (ft)	Source	Cross Section Survey Year and Description
Sunset Creek	SE 30th	1856.084	Bellevue 2007	2006 #16
Sunset Creek	SE 30th	1817.494	Bellevue 2007	2007 #28
Sunset Creek	SE 30th	1805.019	Bellevue 2007	2006 #14(overbank)/2007 #27(channel)
Sunset Creek	SE 30th	1791.536	Bellevue 2007	2007 #26
Sunset Creek	SE 30th	1777.213	Bellevue 2007	2006 #13
Sunset Creek	SE 30th	1749.718	Bellevue 2007	2006 #12
Sunset Creek	SE 30th	1689.563	Bellevue 2007	2006 #10
Sunset Creek	SE 30th	1668.393	Bellevue 2007	2006 #9
Sunset Creek	SE 30th	1626.318	Bellevue 2007	2006 #8
Sunset Creek	SE 30th	1613.357	Bellevue 2007	2006 #7
Sunset Creek	SE 30th	1592.728	Bellevue 2007	2006 #6
Sunset Creek	SE 30th	1583.59	Bellevue 2007	2006B #1
Sunset Creek	SE 30th	1583.5	Bellevue 2007	Flow Split to historical Richards Creek alignment
Sunset Creek	SE 30th	1576.451	Bellevue 2007	2006 #5
Sunset Creek	SE 30th	1535.154	Bellevue 2007	2006 #4
Sunset Creek	SE 30th	1520.645	Bellevue 2007	2006 #3
Sunset Creek	SE 30th	1493.465	Bellevue 2007	2007 #25
Sunset Creek	SE 30th	1474.062	Bellevue 2007	2006 #2
Sunset Creek	SE 30th	1400.25	Bellevue 2007	2007 #24
Sunset Creek	SE 30th	1312.582	Bellevue 2007	2007 #23
Sunset Creek	SE 30th	1208.49	Bellevue 2007	2007 #21
Sunset Creek	SE 30th	1177.949	Bellevue 2007	2007 #19
Sunset Creek	SE 30th	1012.233	Bellevue 2007	2007 #18
Sunset Creek	SE 30th	852.3866	Bellevue 2007	2007 #17
Sunset Creek	SE 30th	834.4796	Bellevue 2007	2007 #16
Sunset Creek	SE 30th	816.2844	Bellevue 2007	2007 #15
Sunset Creek	SE 30th	795.8286	Bellevue 2007	2007 #14
Sunset Creek	SE 30th	772.6812	Bellevue 2007	2007 #13
Sunset Creek	SE 30th	742.021	Bellevue 2007	2007 #11
Sunset Creek	SE 30th	704.0906	Bellevue 2007	Bridge
Sunset Creek	SE 30th	637.1669	Bellevue 2007	2007 #10
Sunset Creek	SE 30th	616.5581	Bellevue 2007	2007 #9

HEC-RAS River ID	HEC-RAS Reach ID	River Station (ft)	Source	Cross Section Survey Year and Description
Sunset Creek	SE 30th	596.5916	Bellevue 2007	2007 #8
Sunset Creek	SE 30th	572.9708	Bellevue 2007	2007 #7
Sunset Creek	SE 30th	554.7107	Bellevue 2007	2007 #6
Sunset Creek	SE 30th	543.1325	Bellevue 2007	2007 #5
Sunset Creek	SE 30th	529.8341	Bellevue 2007	2007 #4
Sunset Creek	SE 30th	420.6496	Bellevue 2007	2007 #2
Sunset Creek	SE 30th	48.9477	Bellevue 2007	2007 #1
Richards Creek	Historical	1507.208	Entranco 2000	Based on Entranco section Z
Richards Creek	Historical	1481.097	Entranco 2000	Based on Entranco section Y
Richards Creek	Historical	1291.987	Entranco 2000	Based on Entranco section X
Richards Creek	Historical	999.2128	Entranco 2000	Based on Entranco section W
Richards Creek	Historical	968.151	Entranco 2000	Based on Entranco section V
Richards Creek	Historical	913.9713	Entranco 2000	3 36" dia. CMP along Richards @ Kamber Rd.
Richards Creek	Historical	875.7664	Entranco 2000	Based on Entranco section U
Richards Creek	Historical	843.4692	Entranco 2000	Based on Entranco section T
Richards Creek	Historical	240.4131	Entranco 2000	Based on Entranco section S
Richards Creek	Lower	85.48712	Entrnco 2000	Copy of East Creek Sta. 48.9 (elevations adjusted by (-) 0.104 ft
Richards Creek	Lower	26.62222	Entranco 2000	Copy of 85.5 (elevations adjusted by (-) 0.077 ft

Manning's Roughness Values

The Cowan method was used to develop and refine the Manning's *n* coefficients to simulate the contributed influence of channel bedform, sinuosity, substrate, and vegetation on the channel and overbank roughness. The formula is as follows:

$$n = (n_0 + n_1 + n_2 + n_3 + n_4) * m_5$$

Where: n_0 = The portion of the n value that represents the channel material in a straight, uniform smooth reach

n_1 = The additional value added to correct for the effect of channel surface irregularities

n_2 = The additional value for variations in shape and size of the channel cross section through the reach

n_3 = The additional value for obstructions (such as beaver dams, debris dams, stumps, downed trees, and root wads extending into the channel)

n_4 = The additional value for vegetation in the channel

m_5 = The correction factor for the meandering of the channel.

Table D-4 outlines the range of values to reference when selecting the most appropriate value for each parameter (Chow 1959).

Table D-4. Range of values to use for coefficients in Cowan's equation.

Channel Conditions		Values	
Material Involved	Earth Rock cut Fine gravel Coarse gravel	n_0	0.02 0.025 0.024 0.028-0.03
Degree of Irregularity	Smooth Minor Moderate Severe	n_1	0 0.005 0.01 0.02
Variations of Channel Cross Section	Gradual Alternating occasionally Alternating frequently	n_2	0 0.005 0.010-0.015
Relative Effect of Obstructions	Negligible Minor Appreciable Severe	n_3	0 0.010-0.015 0.020-0.030 0.040-0.060
Vegetation	Low Medium High Very high	n_4	0.005-0.010 0.010-0.025 0.025-0.050 0.050-0.100
Degree of Meandering	Minor Appreciable Severe	m_5	1 1.15 1.3

Hydrologic Data

Discharges used in the hydraulic analyses correspond to the 1.01-year, 2-year, 10-year, 25-year, and 100-year recurrence interval flows from the Richards Creek Basin Plan (Entranco 2000). Flows from the Richards Creek Basin Plan were generated using the Hydrologic Simulation Program – FORTRAN (HSPF) model to simulate rainfall runoff processes for 28 subbasins within the Richards Creek basin. Flows from the subbasins that contribute to the channel network modeled in the hydraulic analysis were selected as hydrologic inputs to the Sunset Creek HEC-RAS model (Table D-5).

Fish passage flows were included in this analysis to provide representative low flow conditions for model calibration and validation. These fish passage flows were derived using the method described for ungaged catchments in Appendix C of *Fish Passage Design at Road Culverts* (WDFW 2003). The procedure calculates a fish passage design flow as a 10 percent exceedance flow for the months of January and May. January represents the month of highest flow when adult salmonids are passing upstream, and May represents the most critical month for the upstream passage of juvenile salmonids. Other months are also important, but January and May represent the two extreme combinations for design considerations. Fish passage design flows are calculated using the following equation for urban streams with a drainage area comprising greater than 20 percent effective impervious surfaces:

$$Q_{fp}=aA^bP^c$$

Where: Q_{fp} = Fish passage design flow (cubic feet per second [cfs])
A = Drainage area in (square miles)
P = Mean annual precipitation (inches).

Drainage areas were based on subbasin areas provided in the Richards Creek Basin Plan (Entranco 2000). A mean annual precipitation depth of 35.96 inches was derived from National Weather Service data for Bellevue, Washington (http://www.idcide.com/weather/wa/bellevue.htm).

January fish passage design flows were calculated using the following inputs:

- a = 0.052
- b = 0.96
- c = 1.28.

May fish passage design flows were calculated using the following inputs:

- a = 0.003
- b = 1.10
- c = 1.60.

The standard errors for the January and May calculations are 40.7 percent, and 43.3 percent, respectively. The mean and confidence interval flows for each subbasin used to generate hydrologic inputs for the hydraulic analysis are presented in Table D-5. The high values from January were selected for use in the model as they represent the conditions under which high velocities may inhibit fish passage. The low values from May were used as they represent conditions under which flow depth may inhibit fish passage. Table D-6 presents the final 1.01-year, 2-year, 10-year, 25-year, and 100-year recurrence interval flows and low and high fish passage flows used in hydraulic modeling of existing conditions.

Model Calibration

The existing conditions hydraulic model was calibrated using visual observations and streamflow data from three onsite gage locations to evaluate the accuracy of the model in predicting water surface elevations. Figure D-6 indicates the locations of the three streamflow gages used for calibration of the Sunset Creek hydraulic model. Low flow data from stage/discharge measurements made during April and May 2007 were used to calibrate the model for WDFW fish passage flow at two onsite gage locations (station 1 and station 2). The 2-year, 25-year, and 100-year recurrence interval flows were used to calibrate the model based on a previous hydraulic model of the project area (Entranco 2000). The resulting quality of calibration was dependent on channel changes that occurred between 1999 and 2007. The stage/discharge relationship developed by the City of Bellevue on East Creek just downstream from Kamber Road (station 3) was also used to calibrate flows at the downstream end of the model. Calibration measurements using these gages were also compared to "on the ground" observations made by both Herrera and City of Bellevue employees (Ward 2008) of storm flows and their relative geographic extent of flood inundation.

Stage/Discharge Data

Flow measurements and water surface elevations were collected by Herrera staff at two streamflow gaging locations in the project reach during late winter and spring 2007. The first gage location, station 1, was located approximately 65 feet downstream of SE 30th Street, near model cross section 2513.681. The second gage location, station 2, was located approximately 265 feet downstream of the Sunset Creek confluence with Richards Creek, near model cross section 1817.494. Only base flow and low level storm flow data were collected because no major storms occurred during the time that gaging was conducted. As such, the resultant data was deemed not sufficient for the development of a robust stage/discharge relationship up to any significant flood flow. Instead, streamflow data collected from stations 1 and 2 were used to calibrate the low fish passage flows (see Table D-5). Figures D-7 and D-8 illustrate the relationships between the measured flows from these two gages compared to the modeled flow from the previous Entranco hydraulic model (Entranco 2000). The City of Bellevue established a gage location on East Creek (station 3) just downstream of Kamber Road, near model cross section 543.4692. The stage/discharge relationship developed for this site was used to compare water surface elevations for the cross section locations downstream of Kamber Road and to check that the optimized flow split between the flow-split channel and the Richards Creek historical channel was adequate. Further discussion of the flow optimization methodology is presented below.

Table D-5. Flood event and fish passage flows for the subbasins from the Richards Creek Basin Plan (Entranco 2000) used to determine hydrologic inputs to the hydraulic analysis.

				Tributary Area [a]		Peak Flows (cfs) [b]					WDFW Fish Passage Flows (cfs) [c]			
											January		May	
Location	Herrera Reach	HSPF Subbasin	HSPF Reach	(acres)	(sq mi)	1.01-year	2-year	10-year	25-year	100-year	Mean	C.I. [d]	Mean	C.I. [d]
East Creek														
Immediately upstream from confluence with Richards Flow-split channel	E	E2	205	187.7	0.29	16	23	36	45	63	1.6	0.9 to 2.2	0.2	0.1 to 0.3
Sunset Creek														
Sunset Creek from I-90 to the confluence with Richards Creek	S	S1	21	884.5	1.4	53	79	126	157	212	7	4.1 to 9.8	1.3	0.7 to 1.9
Richards Creek														
Richards Creek from SE 30th Street downstream to confluence with Sunset Creek	R6	R2b	14	487.8	0.8	48	72	110	140	200	3.9	2.3 to 5.5	0.7	0.4 to 1
Richards Creek from confluence with Sunset Creek to flow split [e]	R5	--	--	1372.3	2.1	101	151	236	297	412	10.6	6.3 to 14.9	2.1	1.2 to 3.1
Richards Creek from confluence with Richards Flow-split channel to Bannerwood Park	R1	R2a	2	1992.3	3.1	121	181	297	376	525	15.2	9 to 21.3	3.2	1.8 to 4.6

[a] Tributary areas from Richards Creek Basin Plan (Entranco 2000).
[b] Predicted peak flows from Richards Creek Basin Plan (Entranco 2000). Peak annual flows are based on log-Pearson type III analyses using the maximum peak flow simulated for each year of the 49-year period.
[c] Calculated using regression equation for fish passage design flow (10 percent exceedance flow) in Washington for urban streams (>20% effective impervious drainage area) in Region 2.
[d] Confidence interval flows were calculated by adjusting the mean January and May flow values up and down by 40.7 percent, and 43.3 percent, respectively.
[e] Area and flow data not available in the basin plan. Values for tributary subbasins R6 and S summed to estimate values.
cfs- cubic feet per second
sq mi- square miles
WDFW- Washington Department of Fish and Wildlife

Table D-6. 1.01-year, 2-year, 10-year, 25-year, and 100-year recurrence interval flows and low and high fish passage flows used in hydraulic modeling of existing conditions.

HEC-RAS Profile	River	Reach	River Station (RS)	Flows (cfs)						
				1.01-year	2-year	10-year	25-year	100-year	Q_{fp}-high	Q_{fp}-low
1	Richards Creek	Historical	1507.208	15.05	22.65	35.4	44.55	61.8	0.0001	0.0001
2	Richards Creek	Lower	85.48712	120.25	181	297	376	525	21.3	1.5
3	Sunset Creek	SE 30th	3272.859	52.48	79	126	157	212	9.8	0.7
4	Sunset Creek	SE 30th	2098.229	100.32	151	236	297	412	14.9	1.2
5	Sunset Creek	SE 30th	1535.154	85.27	128.35	200.6	252.45	350.2	14.8999	1.1999
6	Sunset Creek	SE 30th	1177.949	100.55	151.35	236.6	297.45	413.2	17.1	1.5

Flow Split Optimization

Approximately 550 feet downstream of the confluence of Sunset Creek and Richards Creek, the flow in Richards Creek is split, or bifurcated, into two channel alignments. One channel alignment heads directly north and historically functioned as the main flow path for Richards Creek. However, over the last five years, an increasing proportion of streamflow has begun to occupy the channel alignment that trends to the north-east, called the ‘flow-split channel’ throughout this report. At the present time the flow-split channel conveys nearly all of the Richards Creek flow during low stream flow conditions and the vast majority of stream flow during flooding events. The historical channel alignment that previously conveyed Richards Creek to the north is only utilized during peak flow events.

A flow optimization procedure was completed within HEC-RAS to assess the proportion of storm flows routed down the historical Richards Creek alignment and the flow-split channel during flooding events. The model was run with the flow split optimization to derive an initial flood proportion. The model-derived flow split values were then compared to both visual channel observations and comparisons of modeled water surfaces for each channel alignment directly downstream of the flow split location. Several iterations of the model steady flow inputs were analyzed, with a goal of obtaining a consistent water surface elevation for both channel alignments downstream of the flow split. Following this procedure, it was eventually determined that for flood flows in excess of the flow corresponding to the 1.01-year recurrence interval, approximately 15 percent of the total flow upstream of the flow split would be conveyed to the historical Richards Creek channel alignment, and approximately 85 percent of the total flow would be conveyed to the flow-split channel alignment. The final steady flow file used in HEC-RAS for both the existing conditions and alternative model analyses reflects this flow proportion.

Existing Conditions Model Results

The predicted water surface elevations, water surface gradients, flow velocities, and channel shear stress values for the existing conditions geometry are presented at the end of this appendix. Figure 9 of this report illustrates the 1.01-, 2-, 10-, 25-, and 100-year recurrence interval flow water surface profiles from upstream of SE 30th Street to the confluence of Sunset Creek and Richards Creek for the existing conditions model.

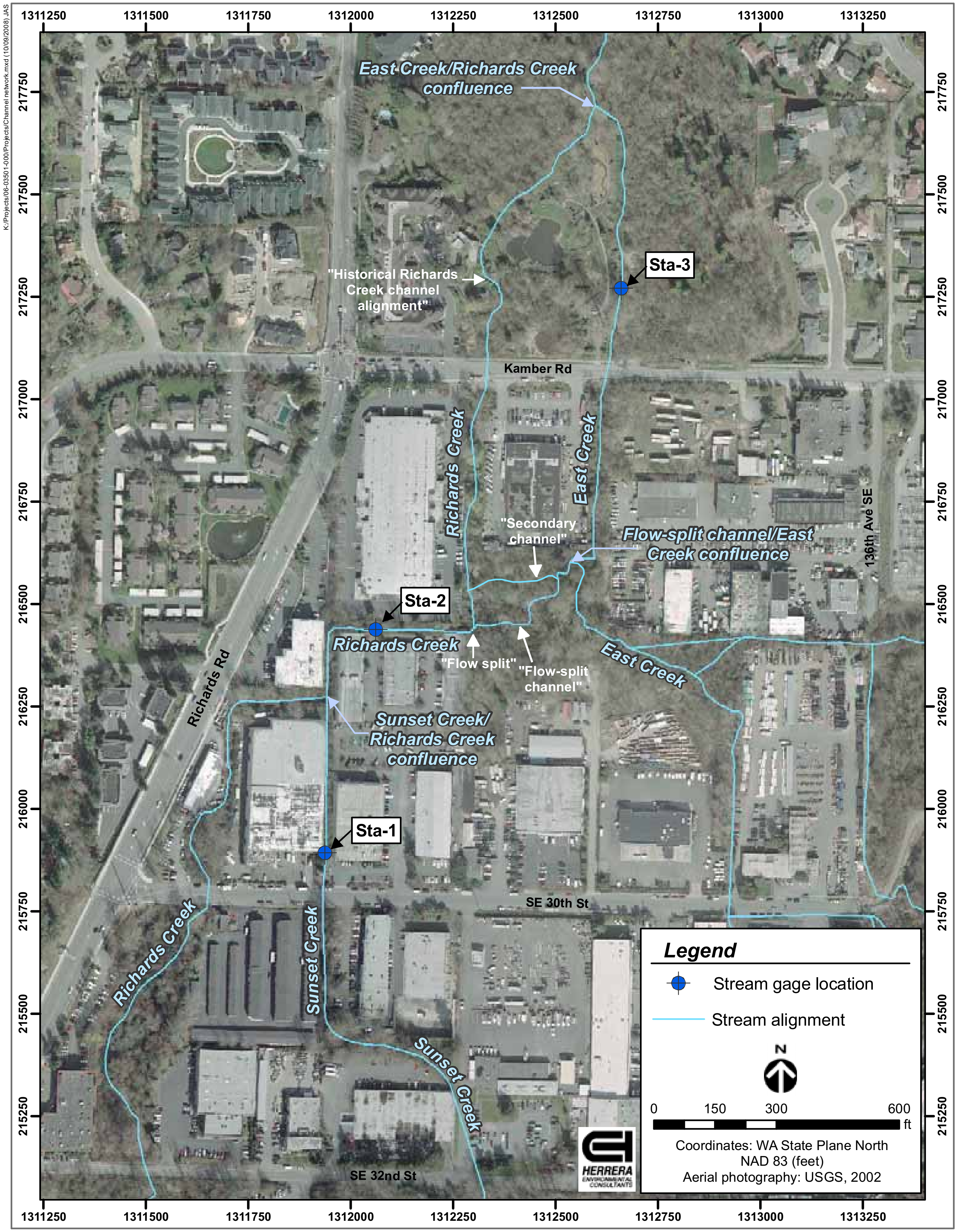

Figure D-6. Stream gage locations used for calibrating the Sunset Creek hydraulic model.

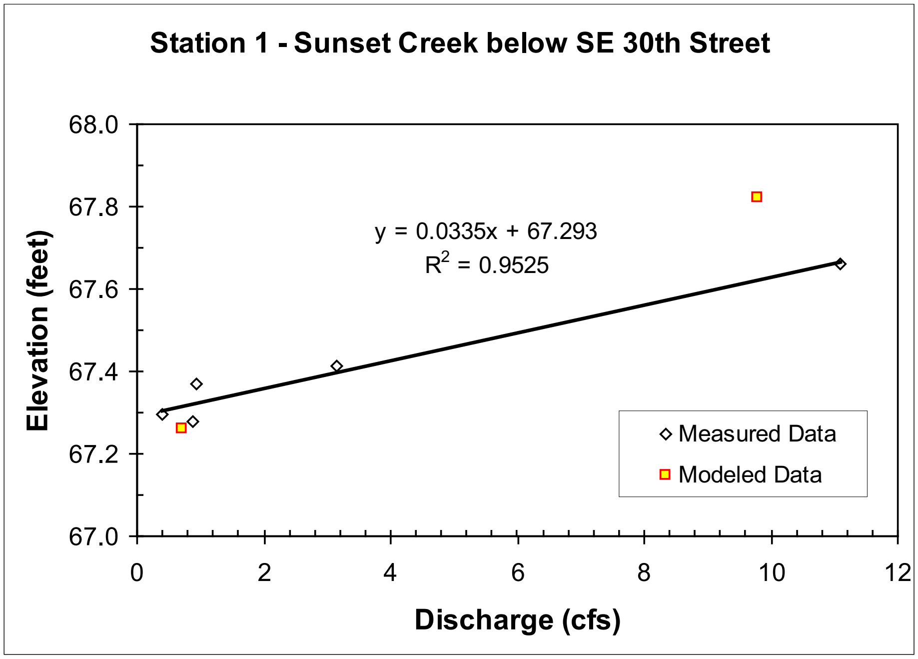

Figure D-7. Station 1 stage/discharge relationship used to calibrate low flows used in the Sunset Creek model.

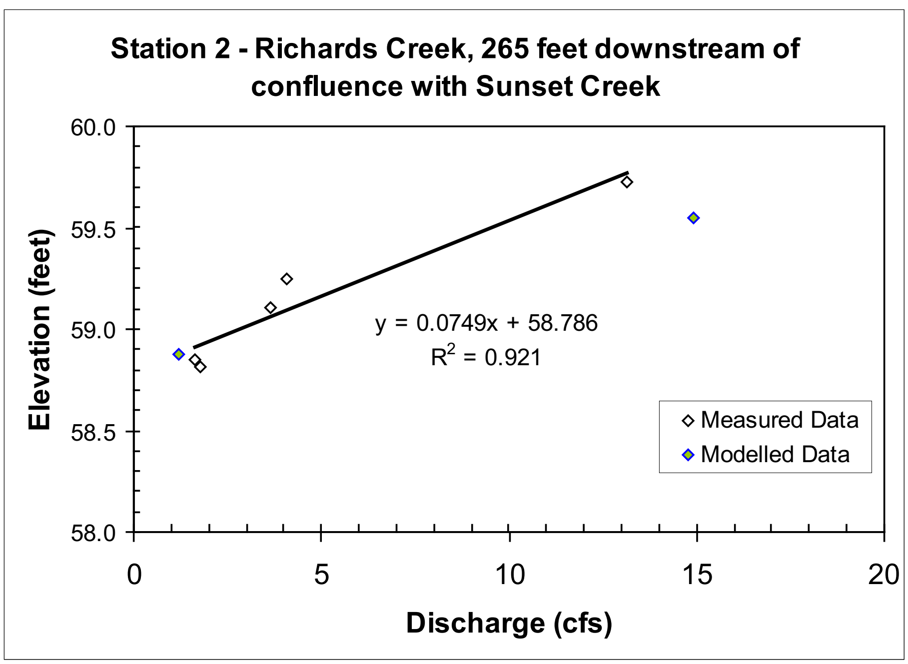

Figure D-8. Station 2 stage/discharge relationship used to calibrate low flows used in the Sunset Creek model.

The hydraulic analysis results for existing conditions illustrate a high risk of flooding during moderate peak flow events at both SE 30th Street and Kamber Road. The channel gradient upstream of SE 30th Street is about 4.3 percent and the channel gradient downstream of SE 30th Street is about 0.8 percent. The existing twin 42-inch diameter culverts beneath SE 30th Street are about half-way filled with sediment and even in low flow conditions, experience backwaters from about 80 feet downstream of the culvert back through the culvert, due to the aggradation that the reach has experienced. The Sunset Creek model of the existing conditions indicates that storm flows with magnitudes at or greater than the 1.01-year recurrence interval flood will flood the SE 30th Street roadway

The results at the Kamber Road culvert indicate that a free water surface (i.e., water surface that remains below the top of the culvert) is lost for flood flows including and in excess of the 2-year flow. These results indicate that flooding of Kamber Road may occur for flows near or greater than the 10-year event.

Alternative Evaluation

This section describes the hydraulic evaluation that was completed to enable comparisons of the flood control and sedimentation benefits for several culvert and channel improvement alternatives. The four alternatives discussed below were simulated with the Sunset Creek HEC-RAS model. The final alternative, Phase III Alternative 3, represents the recommended combination of the design characteristics from the first three alternatives evaluated.

Phase I Alternative 1

The objective of the Phase 1 Alternative 1 improvements is to optimize flood conveyance capacity and to reduce sedimentation impacts in Sunset Creek from SE 30th Street to downstream of the confluence with Richards Creek. The SE 30th Street crossing is located in a natural depositional area within the Sunset Creek channel profile.

Phase 1 Alternative 1 involves the replacement of the existing twin 42-inch diameter culverts under SE 30th Street with a larger culvert incorporating a sedimentation structure (called a sediment trap below), channel modifications just upstream SE 30th Street to add roughness and maintain channel diversity, as well as channel modifications downstream of SE 30th Street to support fish passage through the reach and promote channel stability.

Sediment Trap and Culvert Structure Details

The structural dimensions of the culvert and sediment trap were developed iteratively within the HEC-RAS Sunset Creek model, using the context of possible dimensions imposed by existing utilities (mainly the large King County sewer that lies just east of the culvert alignment), flood flow conveyance, and fish passage. After several iterations, the proposed structure was determined to have a total length of 59.2 feet, an interior width of 13 feet, and to include both a stream simulation portion and a sedimentation portion. Using a stream simulation approach, the upstream segment of the culvert for a length of 29.2 feet within the structure was set to have a bed slope of 4.3 percent and to maintain the flow and sediment transport capacity of the reach upstream of the culvert in order to convey sediment to the sediment trap at the downstream end of the structure. The 28–foot-long downstream segment of the structure was designed to act as a sedimentation structure, with a depth of four feet and a storage volume of 54 cubic yards. The ceiling of the structure was maintained at a constant elevation of 69.3 feet. Sheet C-7 of the design plans in Appendix C illustrates the proposed structural dimensions and relative elevations.

Upstream Channel Modifications

Phase I Alternative 1 includes modifications to the channel bed elevations and cross section geometries extending for a distance of 120 feet upstream of the proposed culvert replacement structure. Through this reach, the modeled channel bed profile was revised to maintain a more consistent gradient of 4.3 percent. The design of this modified channel reach includes grade-control logs, bank logs and root wads to stabilize the bank toes, provide a low flow channel, and to create a floodplain bench to add channel diversity and flow attenuation during higher flow events. Using the Cowan's method, the Manning's *n* coefficients for this modified channel reach were revised to represent increased roughness at the cross sections where logs and root-wads will be placed. Sheets C-11 and C-13 of the design plans in Appendix C illustrate the proposed channel profile and cross section modifications to the reach upstream of the proposed sediment trap and culvert structure. A two-stage channel was also developed for the modified reach upstream of SE 30th Street, and the bench elevation was set at a height that would enable the 1.01-year flow to inundate it with a few inches of water depth.

Downstream Channel Modifications

Phase I Alternative 1 also includes channel modifications extending for a distance of 100 feet downstream of the proposed culvert replacement structure. The design includes a log grade-control structure located about five feet downstream of the culvert structure. The sill of the log grade-control was placed at an elevation of 64.5 feet to induce a backwater depth of 6 inches into the culvert outlet, enabling low-flow fish passage through the culvert structure. The log grade-control structure will have a "V"- shaped form, to further promote fish passage during low flow conditions. A second grade-control structure, a boulder weir, is included in the design plans about 35 feet downstream of the log weir to promote channel bed stability and a consistent grade between the two grade-control structures. Using Cowan's method, the Manning's *n* coefficients for the modified channel reach downstream of SE 30th Street were revised to represent increased roughness at the cross sections where the log and boulder grade-control structures will be placed.

Downstream of these grade-control structures, the HEC-RAS cross sectional geometry was adjusted to represent the effect of suction dredging to a distance of approximately 100 feet downstream of the culvert replacement structure. Dredging of the aggraded channel bottom is included in the design to restore the channel grade to the approximate elevation that it was decades ago when the channel was constructed in this location. The channel geometry in the HEC-RAS model was revised in this 100-foot reach to include a two-stage channel with approximately five feet of bottom width at the lower stage. The cross section thalweg elevations were adjusted to gradually taper into the existing channel elevation at a point 100 feet downstream of the culvert. Sheets C-12 and C-13 of the design plans in Appendix C illustrate the proposed channel profile and cross section modifications to the reach downstream of the proposed culvert structure.

Phase I Alternative 1 Results

Modeling the combined Phase I Alternative 1 geometry changes yielded significant improvements to flood flow conveyance and sedimentation. Figure 10 of this report illustrates the geometry of the replacement culvert and channel modifications both upstream and downstream of SE 30th Street. Although the 10-year, 25-year, and 100-year recurrence interval flows do not pass freely through the culvert, the model indicates that those flows will no longer inundate the roadway with the proposed replacement culvert in place. The energy grade line through the modified reach is also fairly stable and model results indicate that the low-flow channel will consistently contain adequate flows for fish passage. The model was also run to simulate the channel geometry with a full sediment trap within the replacement culvert. Even after the sediment trap has reached capacity, the proposed culvert is capable of passing flows up to the 100-year event without flooding the roadway. The tabulated model results for each cross section, as well as graphs of the channel cross sections are attached at the end of this appendix.

The model results for the Phase I Alternative I channel modifications indicate a temporary backwater condition through the replacement culvert. However, this backwater condition will be resolved with the construction of the proposed Phase II channel modifications (see discussion below). The hydraulic analysis also included an assessment of the risk that could be caused by potential severe channel bed aggradation (sedimentation of the lowered channel profile, causing the profile to rise considerably) prior to the implementation of the Phase II channel modifications. Although the likelihood of such aggradation is considered low, the effect on design flow water surface profiles at the replacement culvert are illustrated in Figure 15 of this report. These model results are based on a very conservative modification of the bed topography, in terms of hydraulic analysis, as the modified bed topography represents aggradation of the entire channel bed for a depth up to 2.5 feet over a distance of approximately 200 feet, from the upstream end of the replacement culvert to a distance 140 feet downstream of the culvert. This represents a total of over 220 cubic yards of sediment, including the storage provided by the sediment trap within the culvert. Although increases of the bed elevation under this potential scenario would result in temporary increases in water surface elevation for all flood flow profiles, none of the flows are predicted to overtop SE 30th Street. Therefore, these conditions would still represent an overall decrease in flood risks at the replacement culvert site when compared to the existing conditions.

Phase II Alternative 2

Channel Modifications

The HEC-RAS model for the Phase II Alternative 2 modifications incorporated the modifications from Phase I Alternative 1 as described above, and also accounted for a greater length of removal of the excess sediment that has deposited in the reach of Sunset Creek from the SE 30th Street culvert downstream to the confluence with Richards Creek. Within the Sunset Creek HEC-RAS model, the channel profile was modified to maintain a consistent gradient of about

0.93 percent from the boulder weir in Phase I down to the cross section (2098.229) located just upstream of the confluence with Richards Creek. The model cross sections through this reach were also modified to maintain a two-stage channel and to shift the channel centerline and thalweg away from the adjacent buildings that confine the floodplain. The low flow channel dimensions were fine-tuned throughout this reach in order to maintain bed shear stress for sediment transport, flow conveyance, and transport of sand-sized particles. The bench elevation for the two-stage channel was also set at a height that would enable the 1.01-year flow to inundate it with a few inches of water depth. Finally, a flood containment berm was added to the top of the right bank in the model between cross sections 2175.255 and 2313.296 to evaluate whether the 100-year peak flood flow could be contained within the modified Sunset Creek channel to the confluence with Richards Creek with a minimum of 9 inches of freeboard. The top of the berm elevation was iteratively adjusted for optimum freeboard design.

Phase II Alternative 2 Results

The Phase II Alternative 2 model results for each channel cross section, as well as graphs of the channel cross sections, are attached at the end of this appendix. The model results for Phase II Alternative 2 indicate a consistently smooth energy grade line from upstream of the culvert replacement structure downstream to the confluence of Sunset Creek with Richards Creek. These results show that removal of excess sediment and the adjustment of the channel profile will promote increased flow conveyance through the culvert structure at SE 30th Street as well, improving upon flood control benefits that can be achieved with Phase I alone. The Phase II Alternative II model indicates that flows up to and including the 25-year recurrence interval flow will pass through the replacement culvert with a free water surface. Although the model shows that the 100-year recurrence interval flow will backwater upstream of the road crossing, it still will not flood the roadway. In fact, the Phase II Alternative 2 100-year water surface elevation is estimated to be approximately 0.6 feet lower at the upstream culvert entrance compared to the Phase I Alternative 1 water surface elevation.

Downstream of SE 30th Street, the combination of channel modifications and a flood containment berm constructed above the right bank between the channel and a parking lot between Stations 2313 and 2175 will provide conveyance of the 100-year flow with a minimum of 9 inches of freeboard along Sunset Creek to the confluence with Richards Creek, consistent with City of Bellevue Engineering Standards.

Phase III Alternative 3

Channel Modifications

The Phase III Alternative 3 model modifications build upon the Phase II Alternative 2 model, with the addition of grade-control steps to provide a consistent channel profile along the flow-split channel and East Creek between model cross sections 1312.582 and 852.3866. The channel profile was also raised in this reach of the channel network to assess the impacts of increased floodplain interaction and potential overbank flood storage.

Phase III Alternative 3 Results

The Phase III Alternative 3 model results for each cross section, as well as graphs of the channel cross sections, are attached at the end of this appendix. Although the model indicates that the water surface profile would increase by a maximum of 0.7 feet near cross section 1210.31, the overall impact is a much more consistent water surface profile from the flow-split channel downstream to Kamber Road. Figure 14 of this report compares the proposed Phase III Alternative 3 bed modifications between the Richards Creek flow split and East Creek at Kamber Road to existing conditions. Comparisons of the modeled 1.01-year and 100-year water surface profiles illustrate how the grade control structures can be utilized to provide local increases in water surface elevation to restore floodplain reconnection.

Phase III Alternative 4

Downstream Boundary Condition Modifications

The Phase III Alternative 4 model modifications build upon the Phase III Alternative 3 model, specifically to assess the impacts of a modified downstream boundary condition that could be realized with removal of beaver dams downstream of the confluence of East Creek and the historical Richards Creek channel. Beaver dams that are currently present in the wetland complex downstream of this confluence cause significant backwater conditions upstream in East Creek at the Kamber Road crossing, and are associated with significant sedimentation and decreased flow conveyance. Therefore, the City of Bellevue is interested to understand if beaver dam maintenance activities could be effective at maintaining a consistent channel gradient that could facilitate both flow conveyance and sediment transport through the East Creek crossing at Kamber Road.

The Phase III Alternative 4 HEC-RAS model plan evaluated this option by adjusting the downstream boundary condition to have a normal depth with a slope of 0.003 (or 0.3 percent) instead of the normal depth with a slope of 0.0013 (or 0.13 percent) that was used to simulate existing conditions.

Phase III Alternative 4 Results

The Phase III Alternative 4 model results for each cross section, as well as graphs of the channel cross sections, are attached at the end of this appendix. Figure 16 of this report illustrates the modeled differences in the 2-year and 100-year water surface profiles, reflecting the Phase III Alternative 4 channel modifications. However, these results indicate limitations in the accuracy of the model at Kamber Road. The model output does not predict that downstream changes in the reach boundary conditions will affect water surface profiles at Kamber Road or further upstream in East Creek. Observations of water surface elevations and depositional conditions, both during significant back water conditions and following recent maintenance activities consistent with the Phase III Alternative 4 analysis, have shown that changes in the downstream water surface boundary condition influence flow conditions at Kamber Road. These inconsistencies between model output and observed conditions are likely due to hydraulic complexities and channel geometries that are not adequately represented by the model, particularly in the transition from the wide channel in the vicinity of the Kamber Road culvert to the narrow channel downstream.

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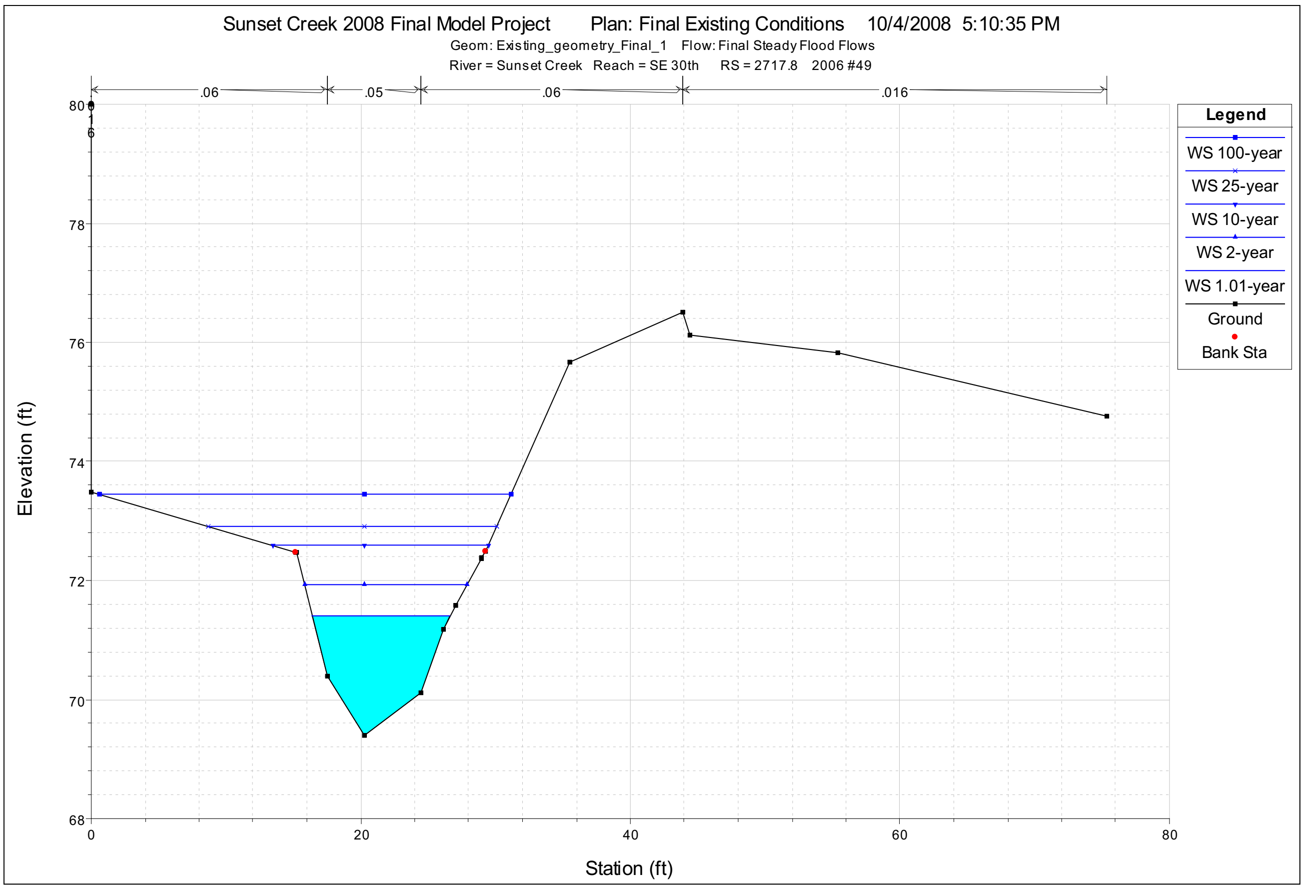

Figure D-9. Final Existing Conditions cross section plot for river station 2717.8.

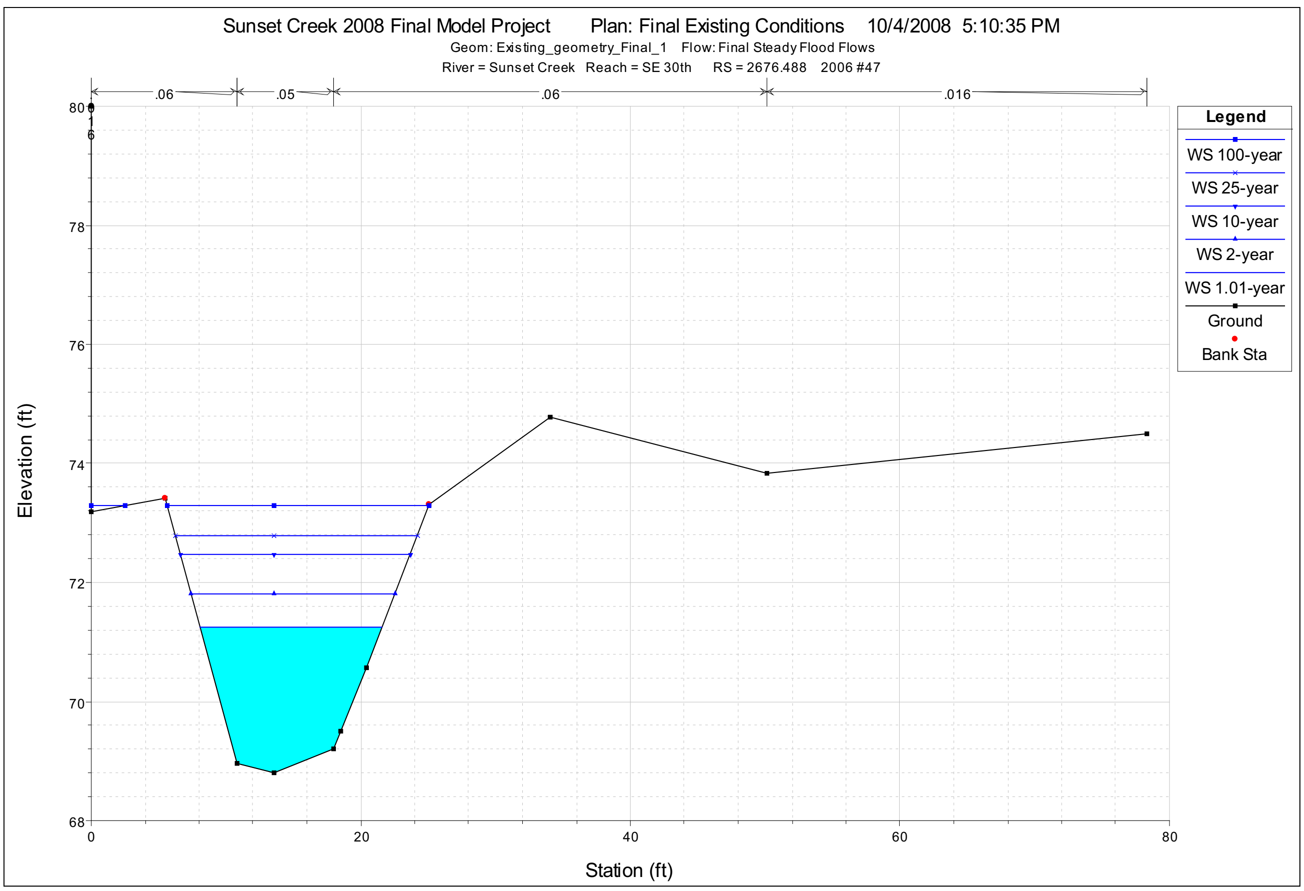

Figure D-10. Final Existing Conditions cross section plot for river station 2676.488.

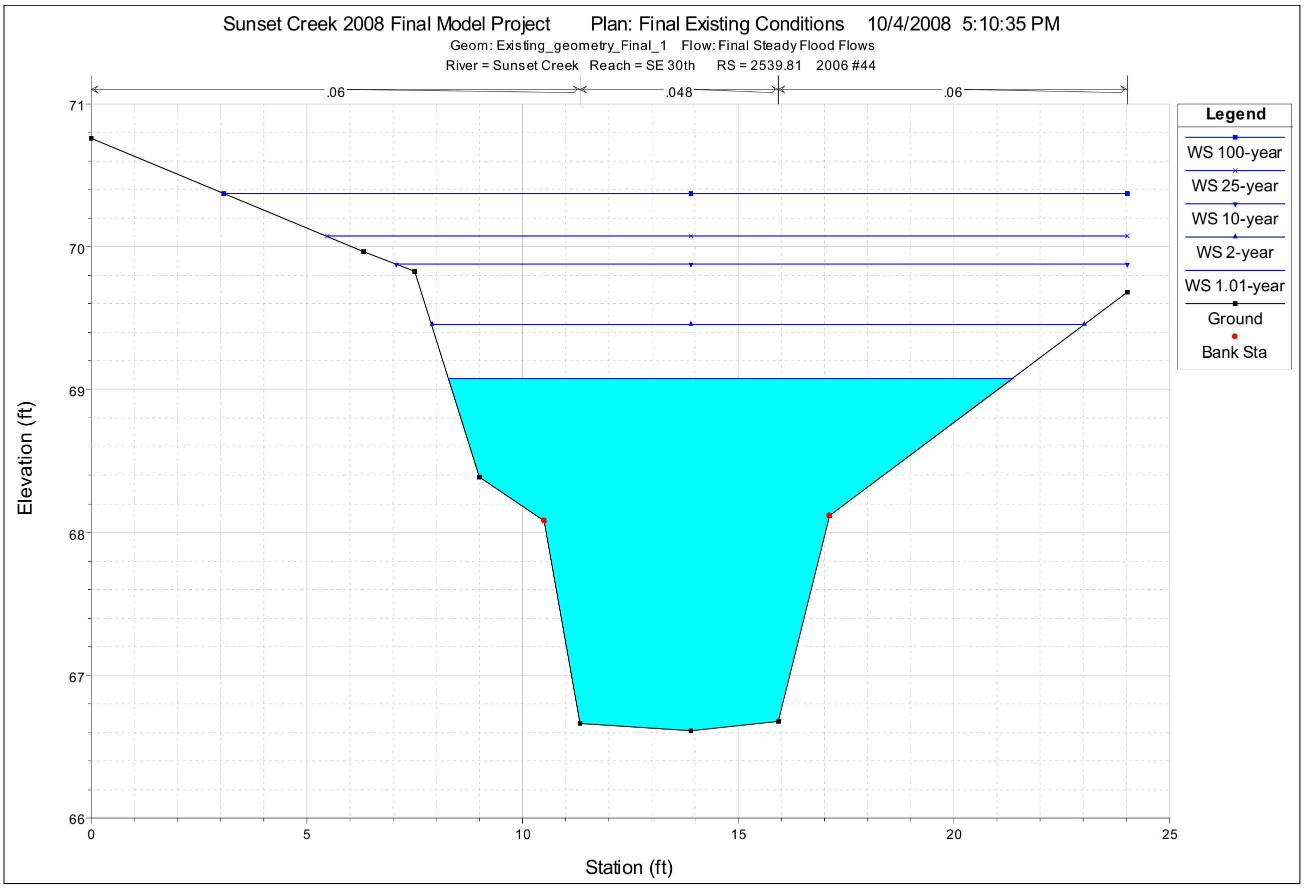

Figure D-11. Final Existing Conditions cross section plot for river station 2539.81.

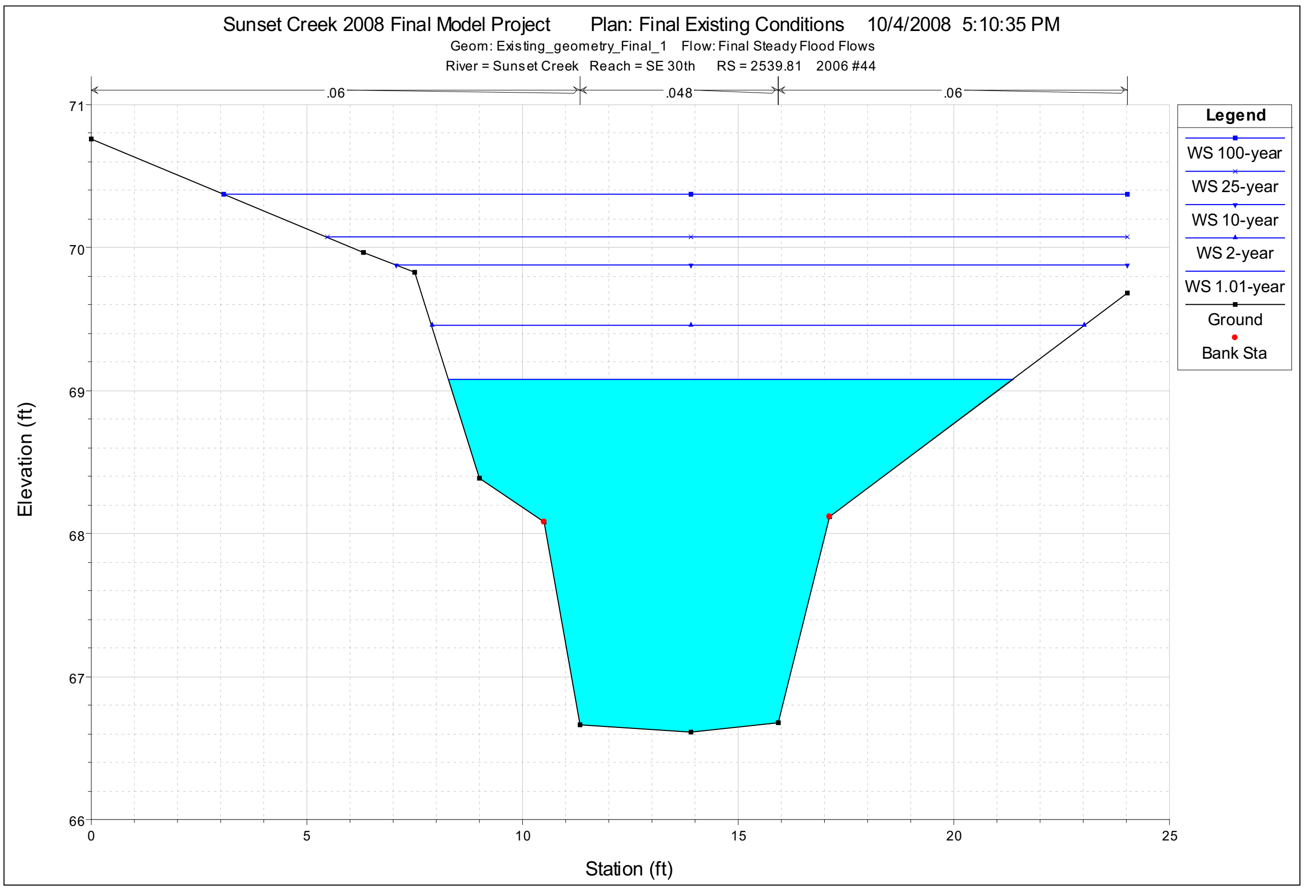

Figure D-12. Final Existing Conditions cross section plot for river station 2539.81.

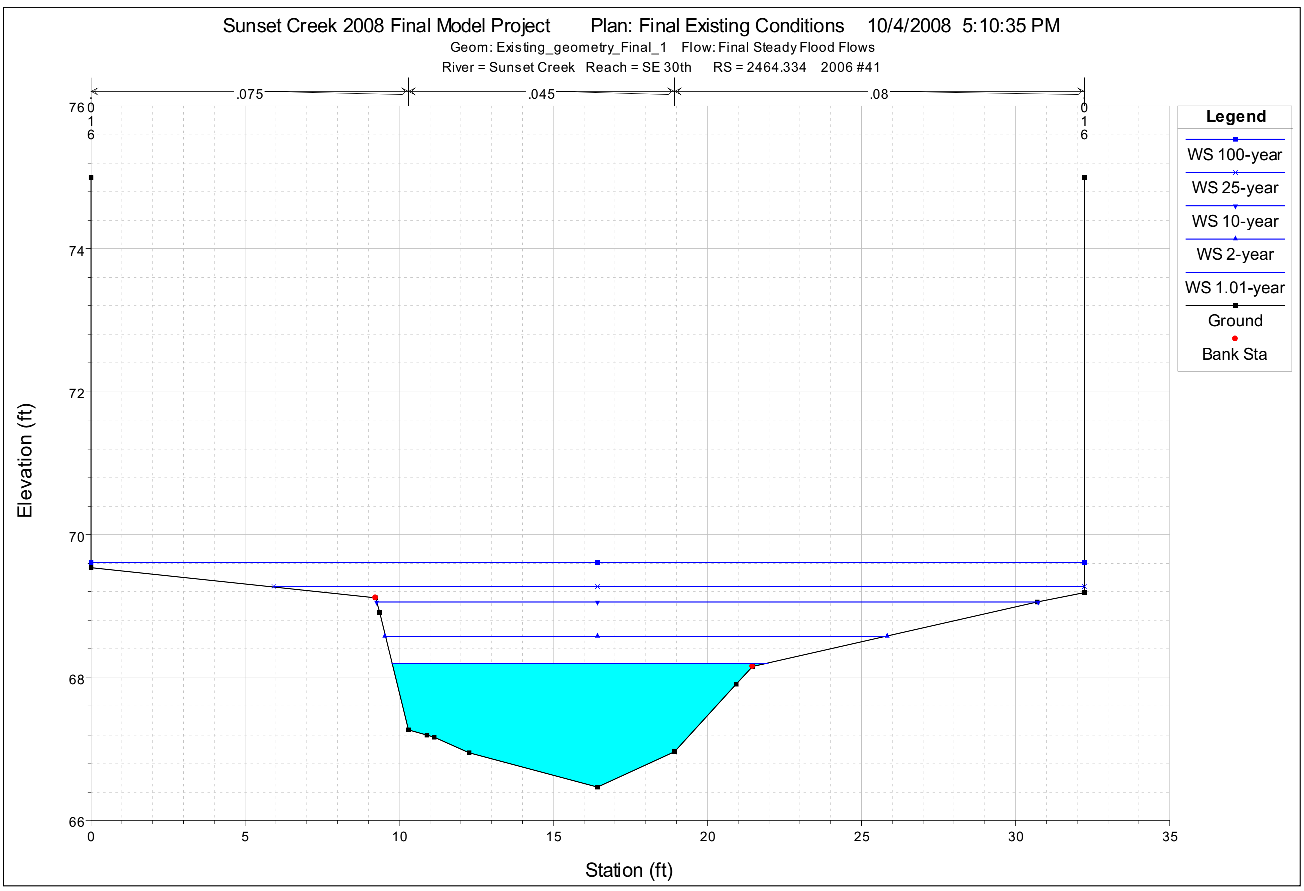

Figure D-13. Final Existing Conditions cross section plot for river station 2464.334.

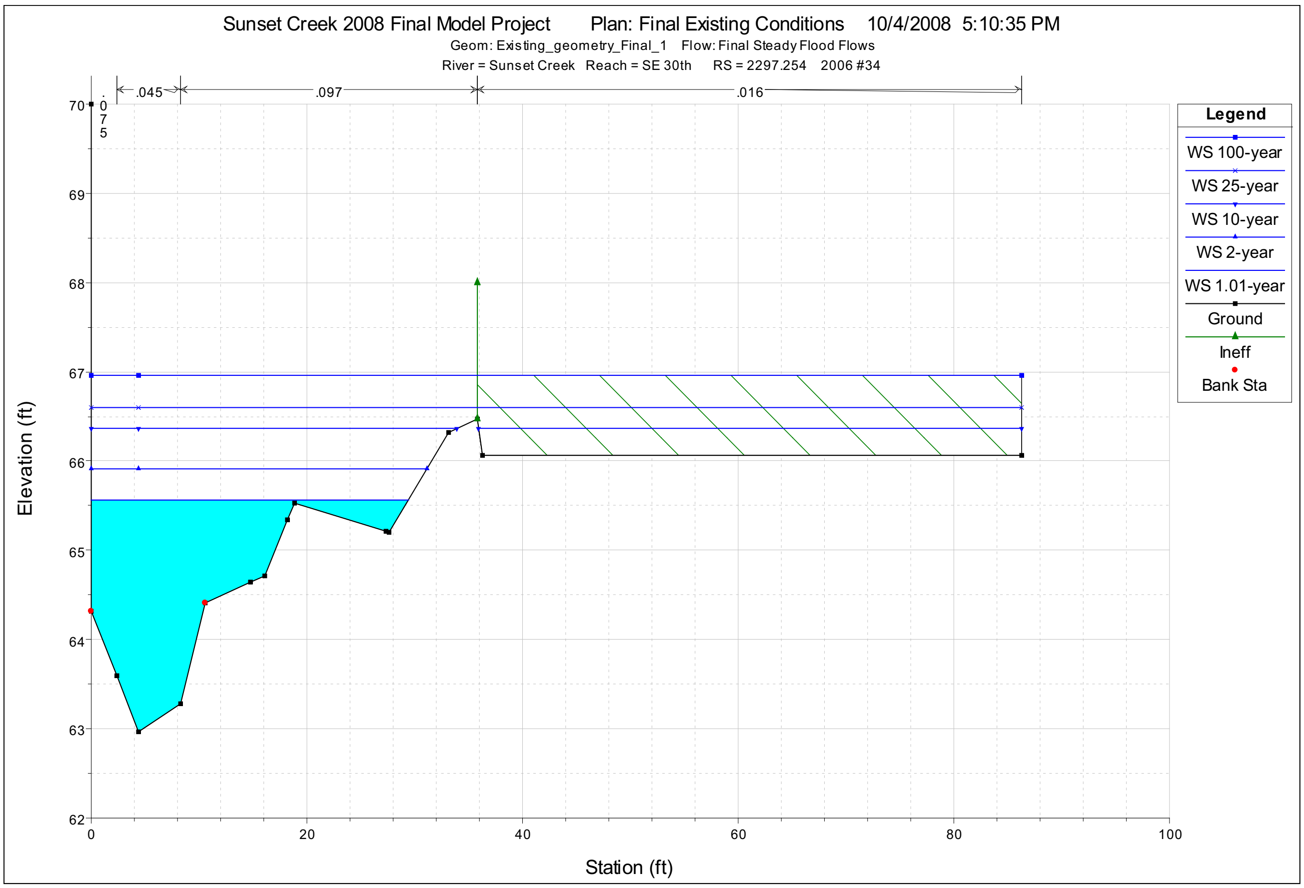

Figure D-14. Final Existing Conditions cross section plot for river station 2297.254.

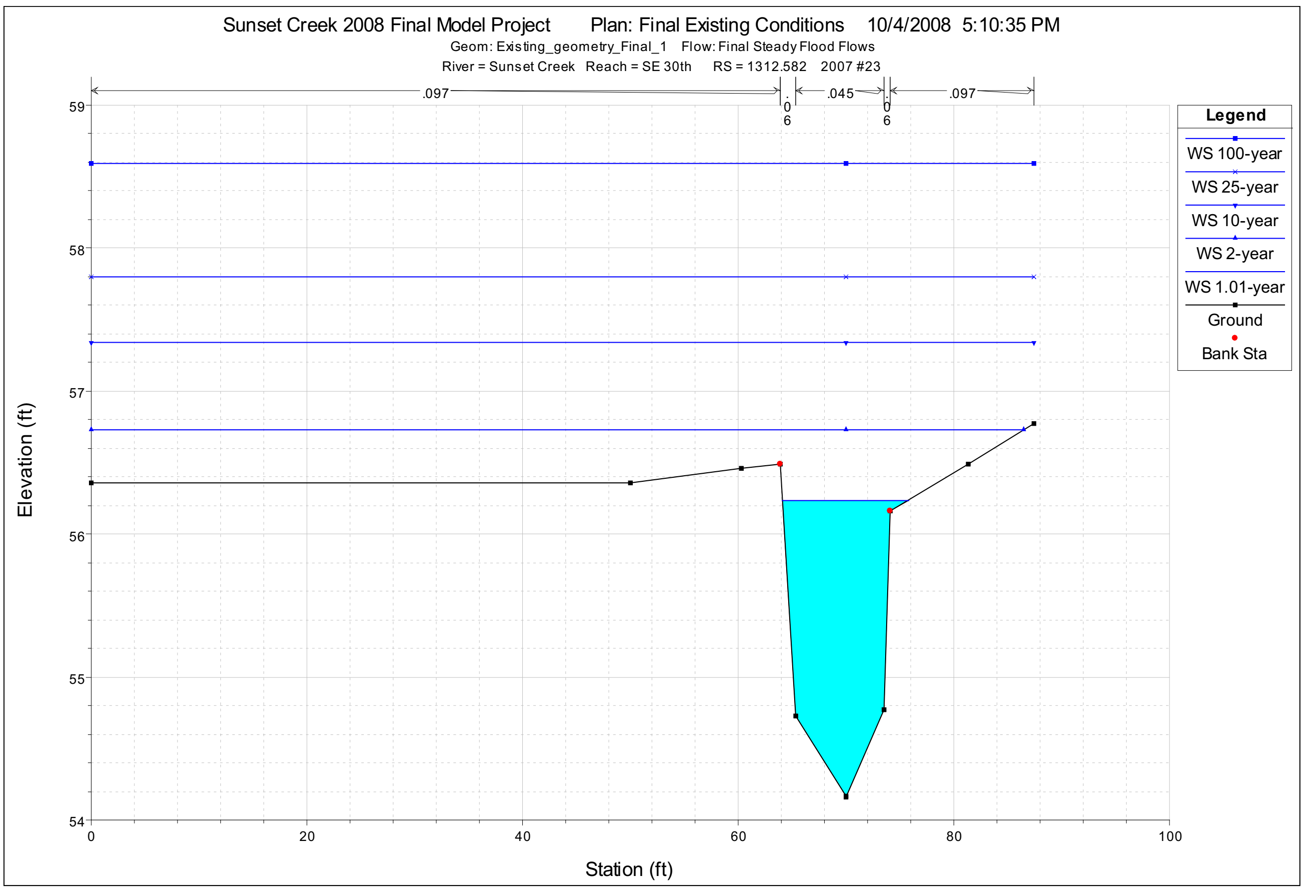

Figure D-15. Final Existing Conditions cross section plot for river station 1312.582.

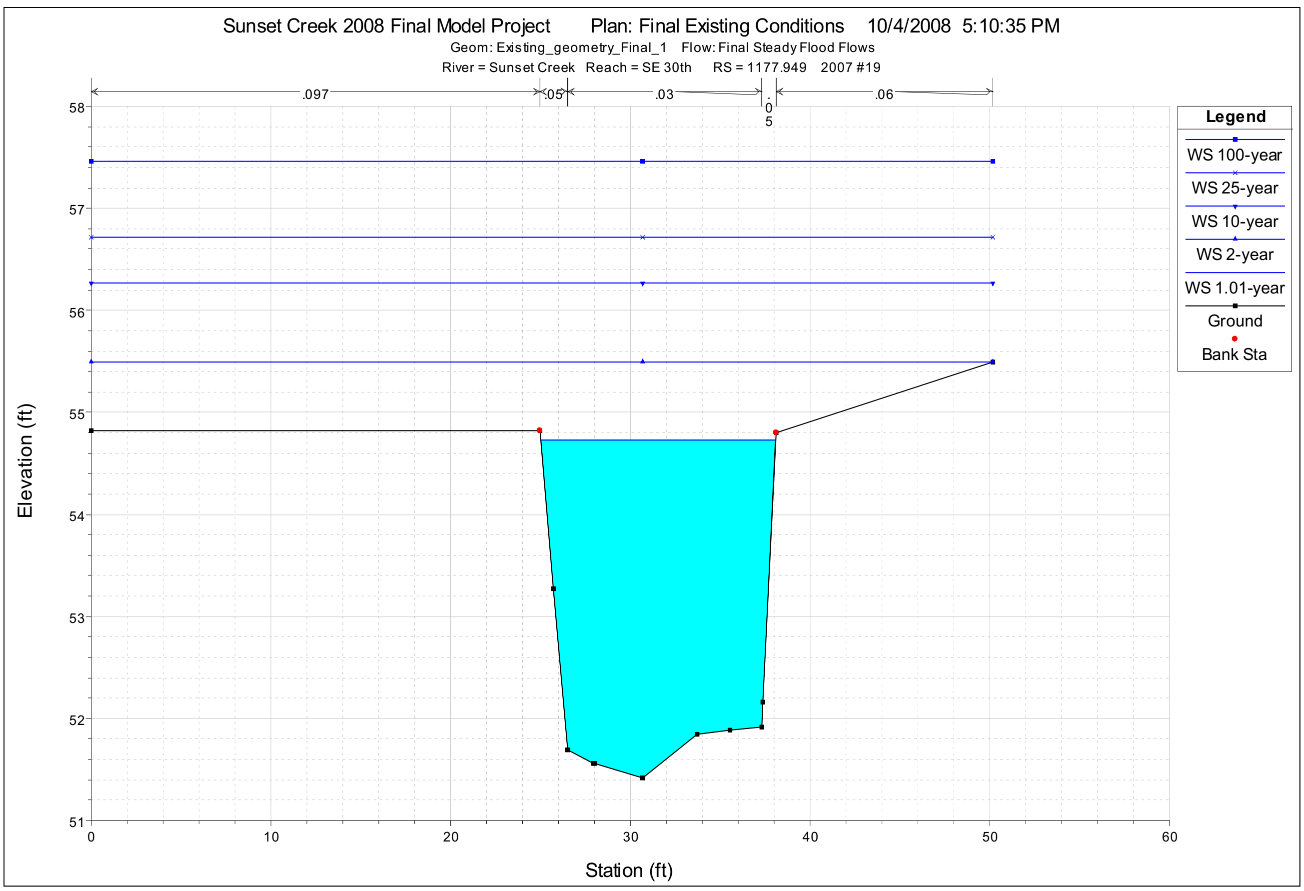

Figure D-16. Final Existing Conditions cross section plot for river station 1177.949.

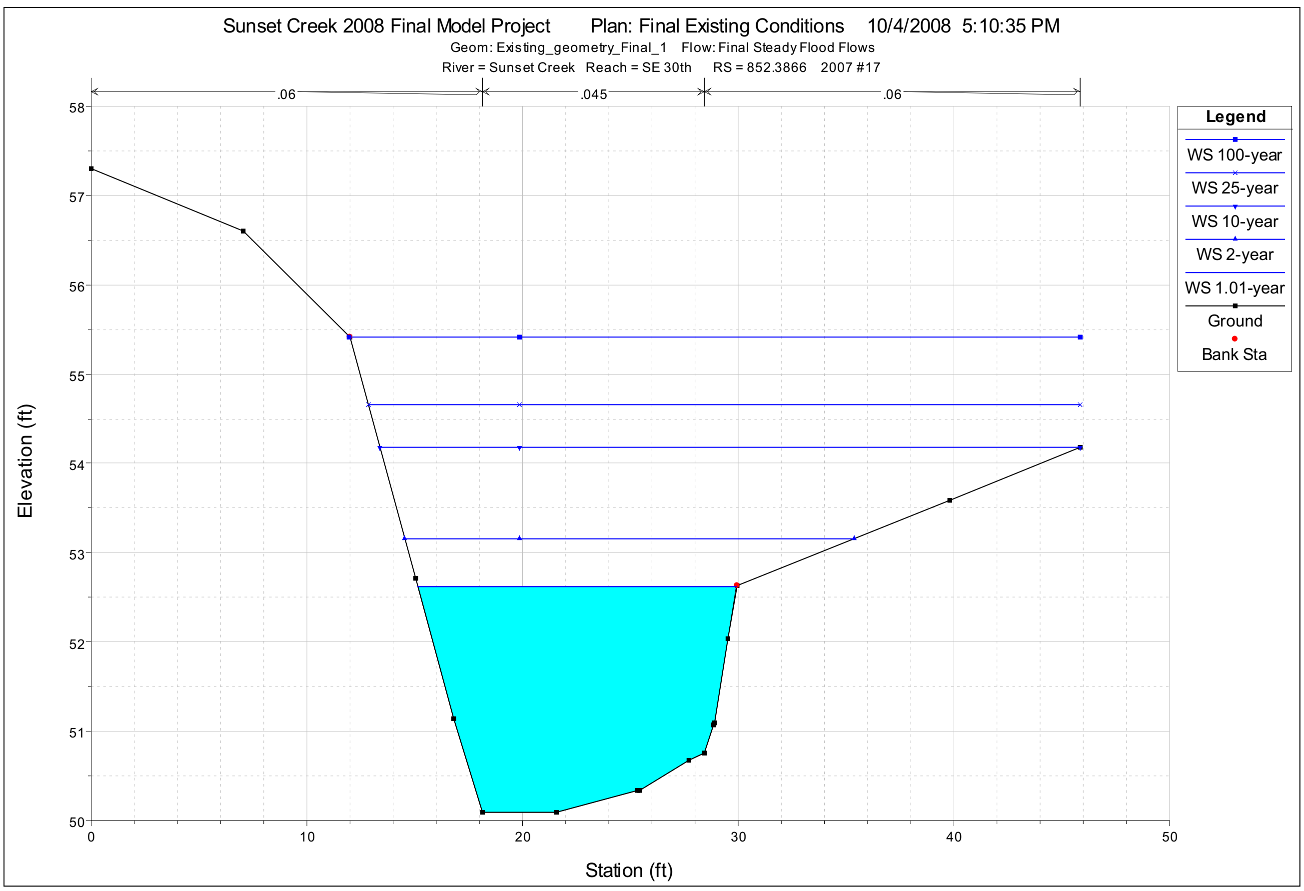

Figure D-17. Final Existing Conditions cross section plot for river station 852.3866.

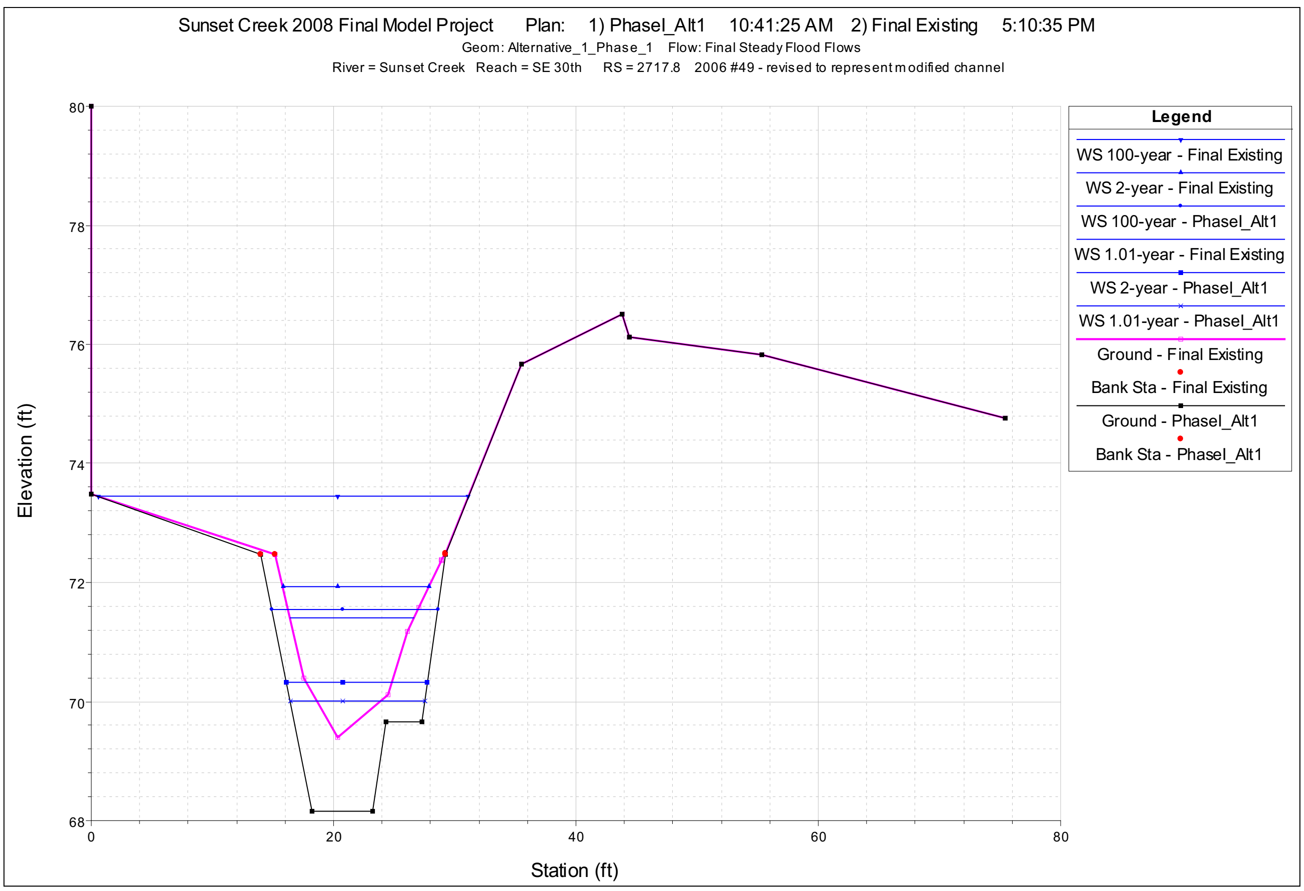

Figure D-18. Comparison of Phase I Alternative 1 and Final Existing cross section plots for river station 2717.8.

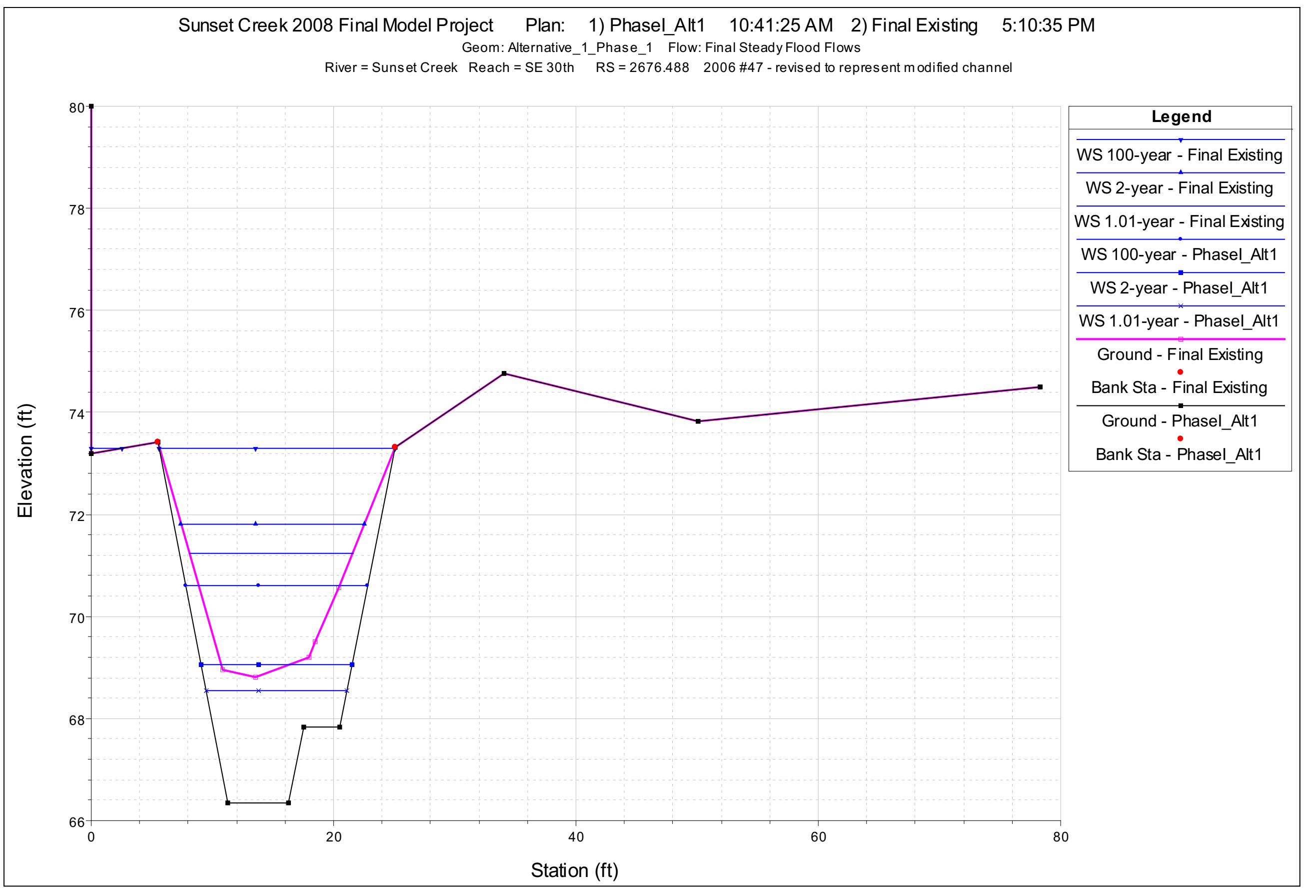

Figure D-19. Comparison of Phase I Alternative 1 and Final Existing cross section plots for river station 2676.488.

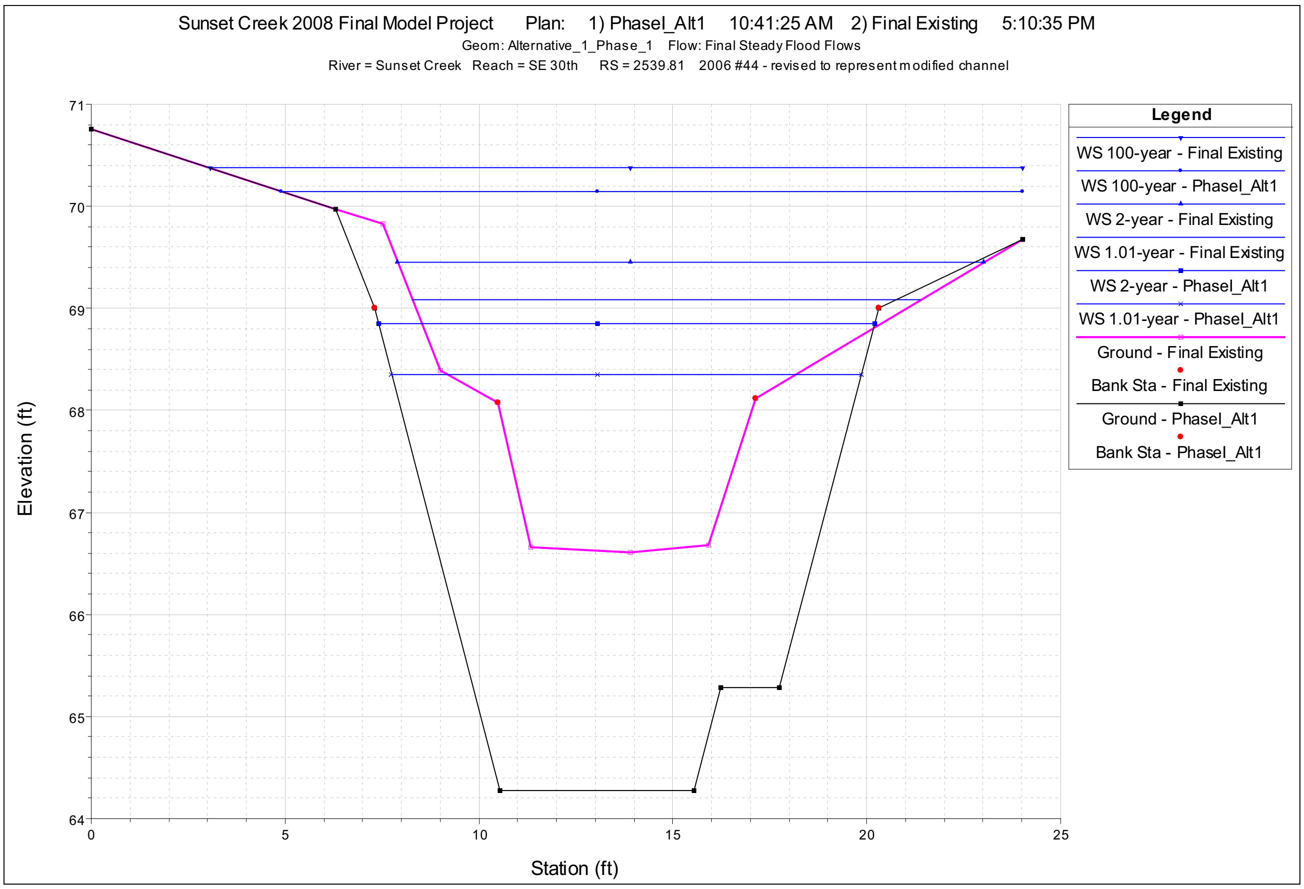

Figure D-20. Comparison of Phase I Alternative 1 and Final Existing cross section plots for river station 2539.81.

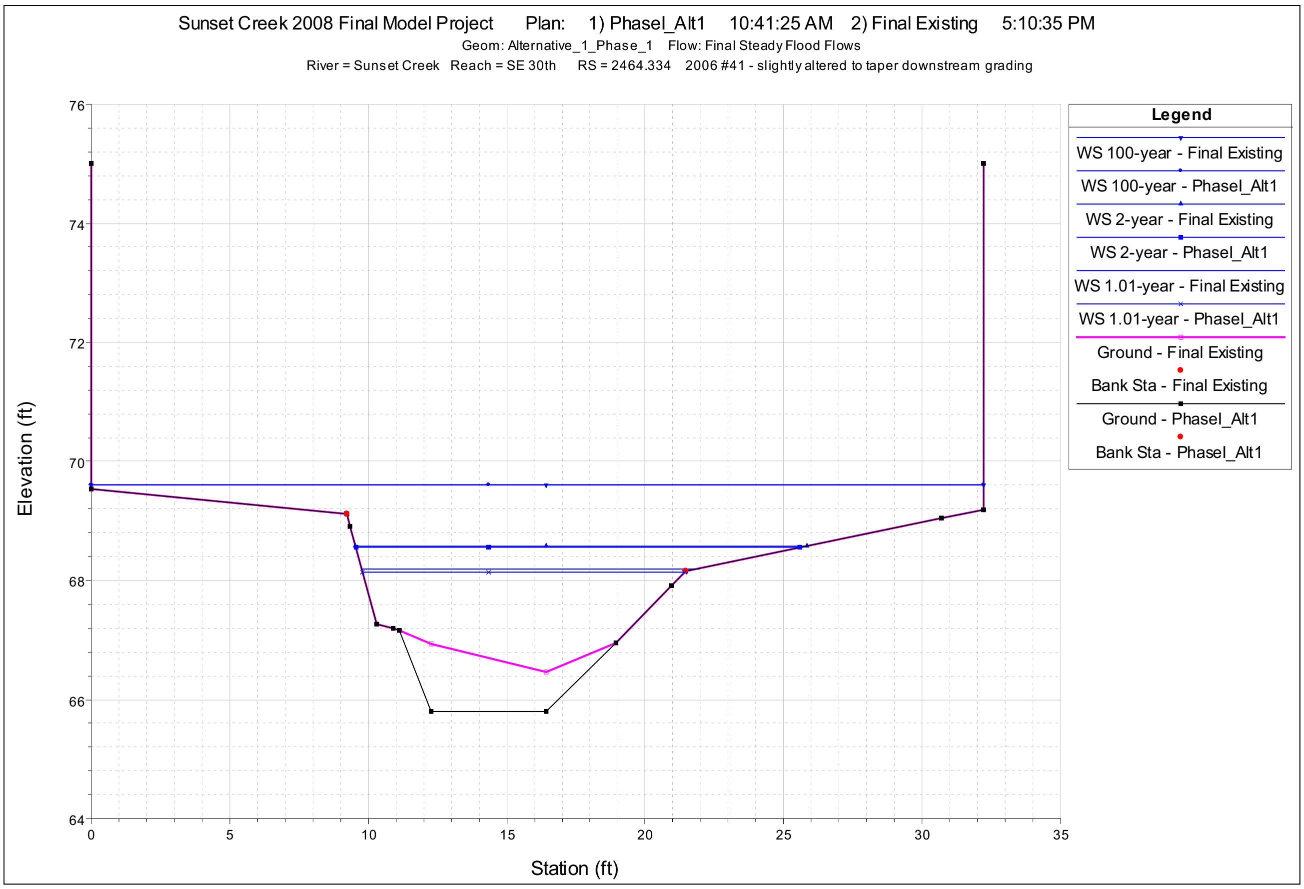

Figure D-21. Comparison of Phase I Alternative 1 and Final Existing cross section plots for river station 2464.334.

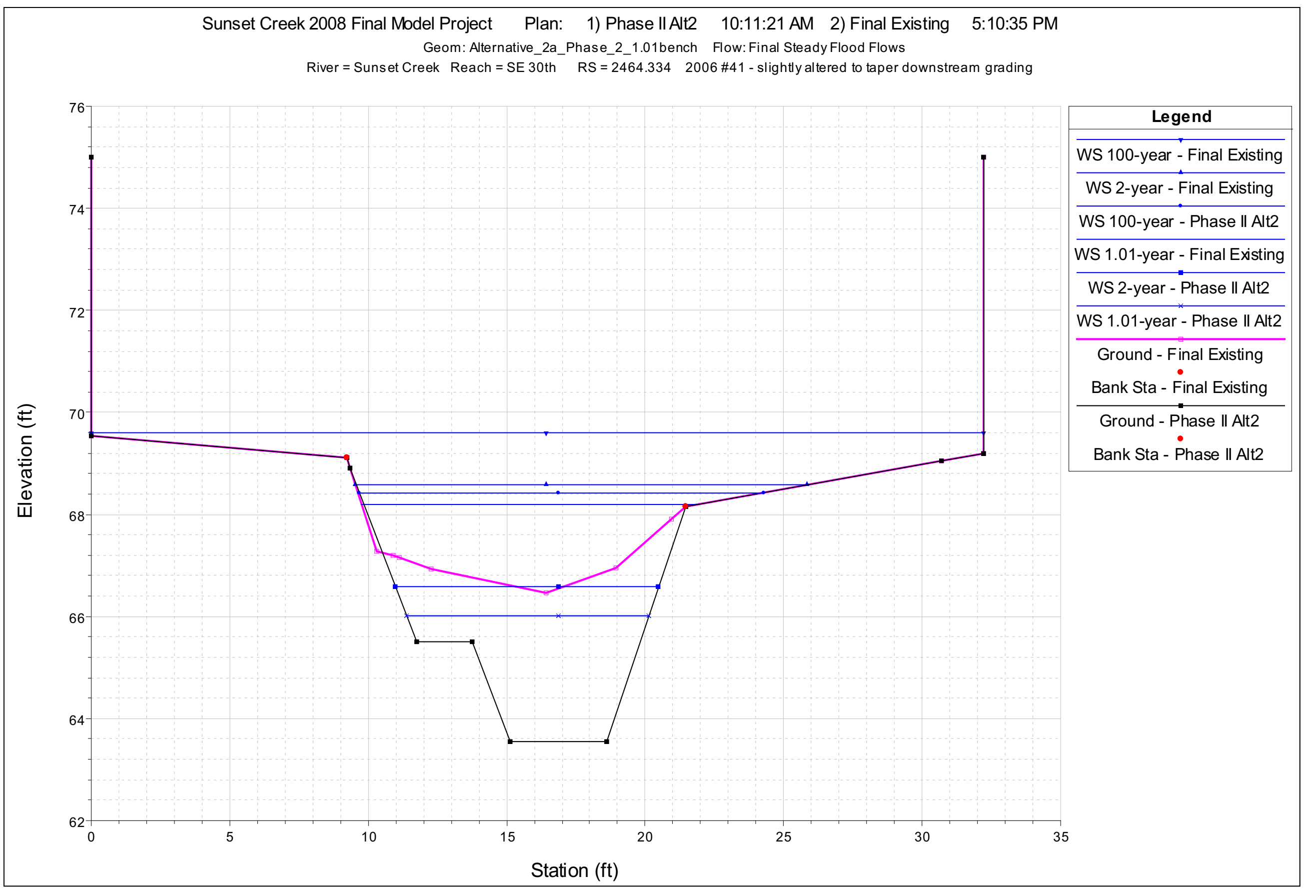

Figure D-22. Comparison of Phase II Alternative 2 and Final Existing cross section plots for river station 2464.334.

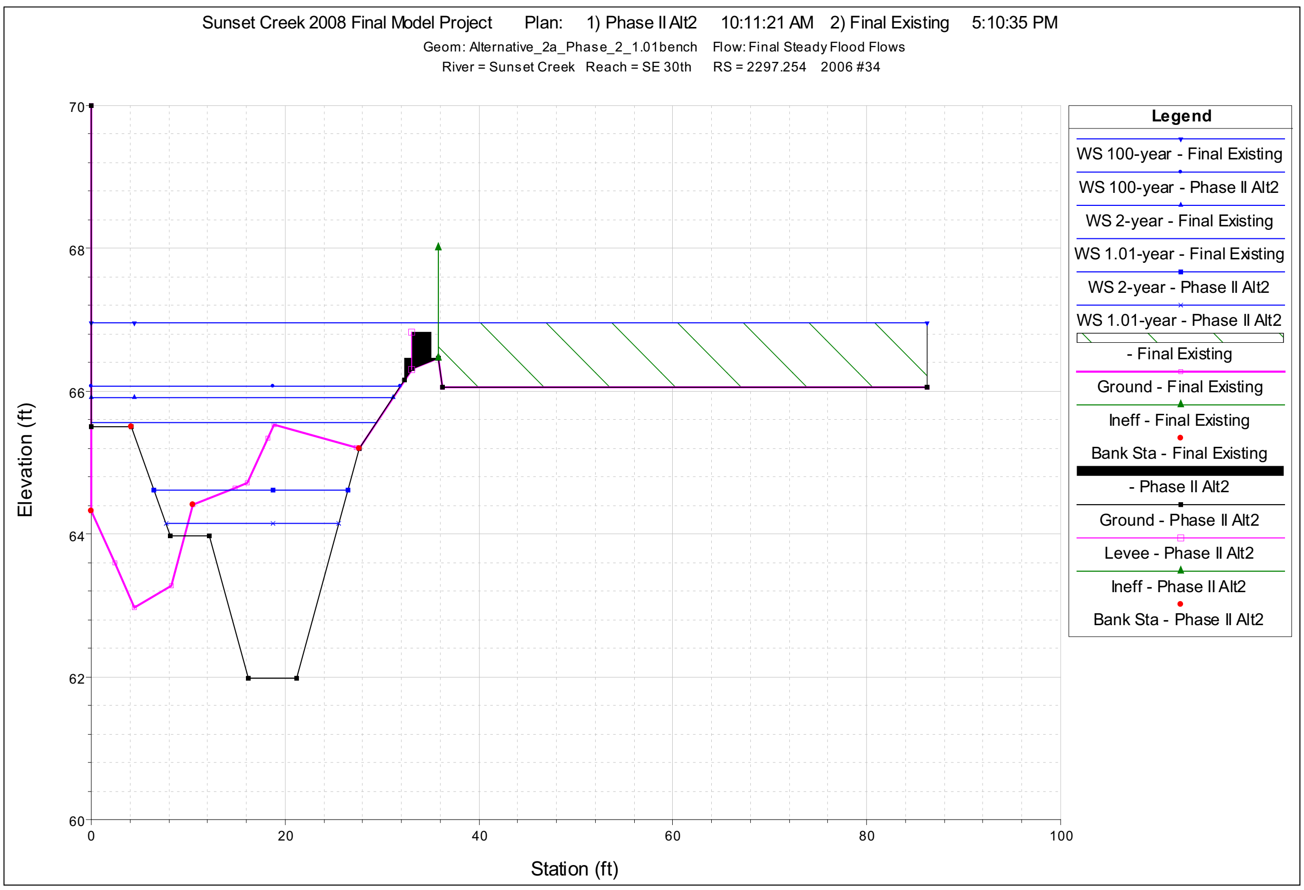

Figure D-23. Comparison of Phase II Alternative 2 and Final Existing cross section plots for river station 2297.254.

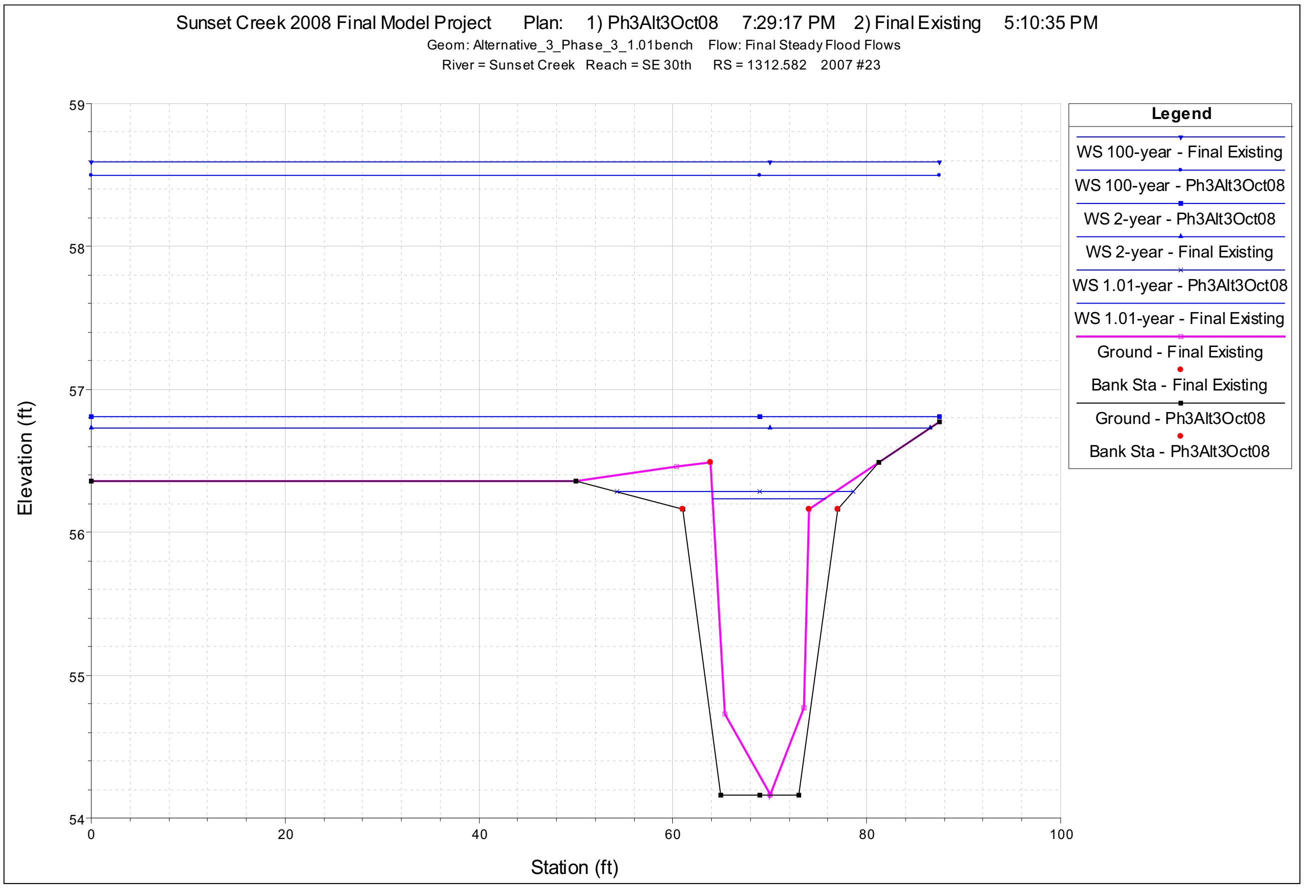

Figure D-24. Comparison of Phase III Alternative 3 and Final Existing cross section plots for river station 1312.582.

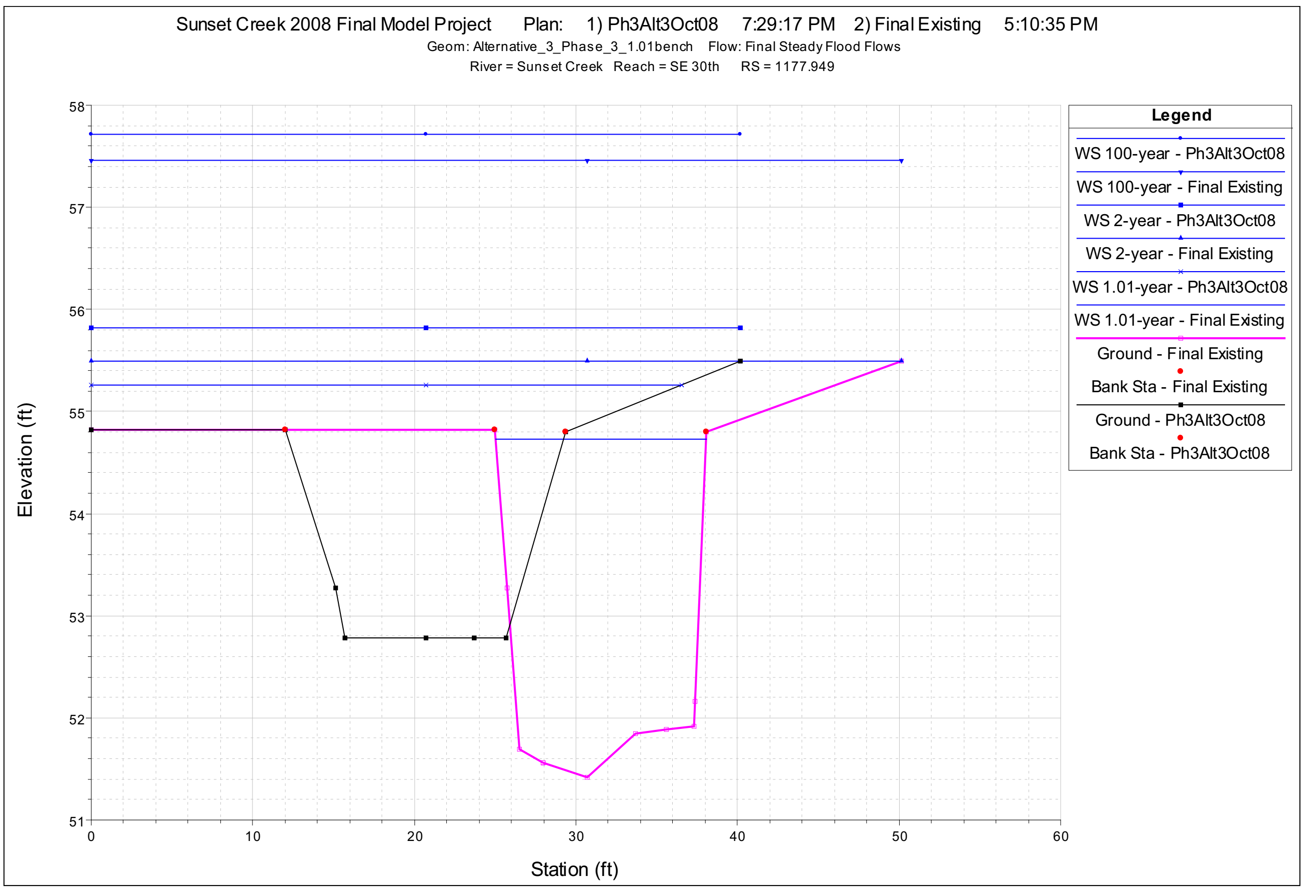

Figure D-25. Comparison of Phase III Alternative 3 and Final Existing cross section plots for river station 1177.949.

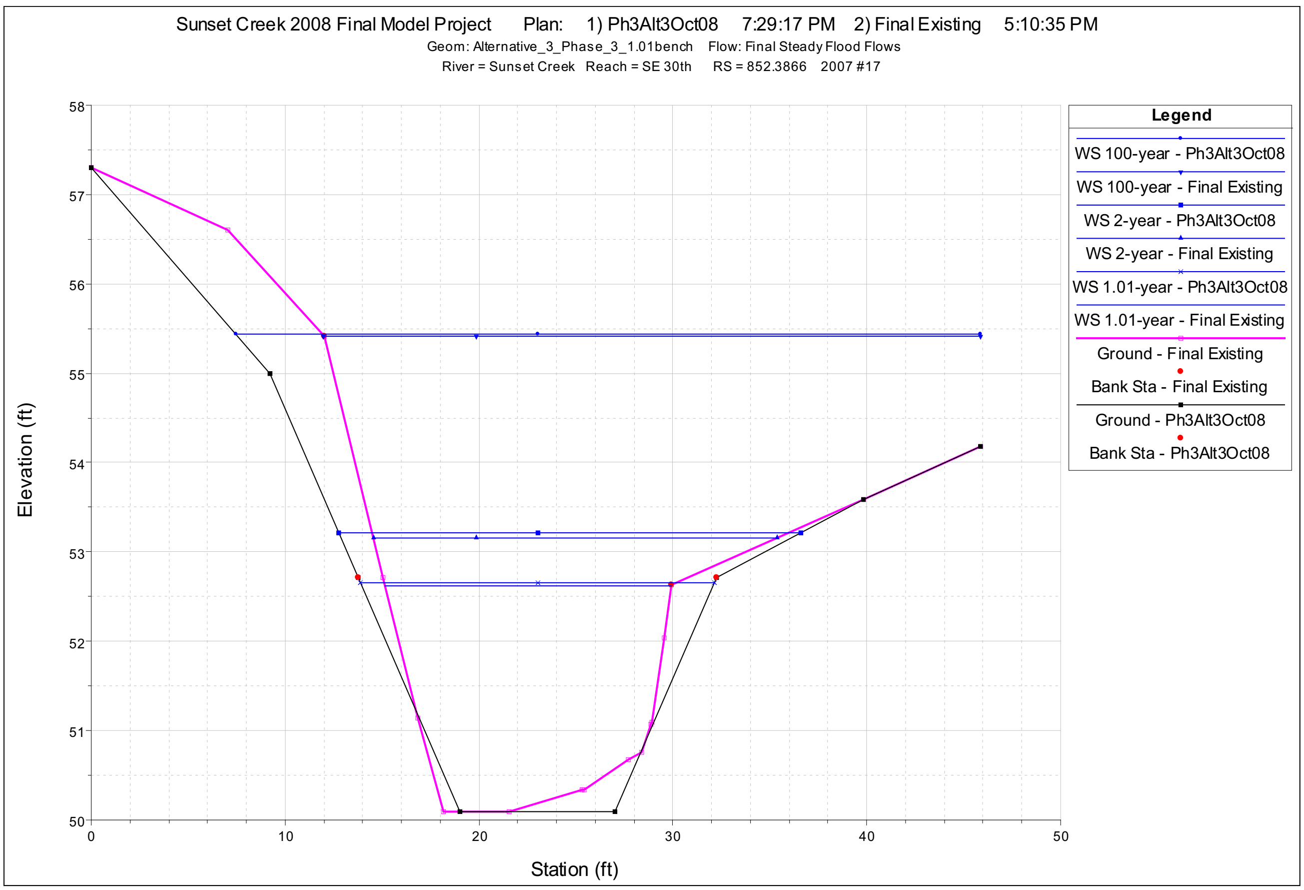

Figure D-26. Comparison of Phase III Alternative 3 and Final Existing cross section plots for river station 1177.949.

FINAL EXISTING CONDITIONS OUTPUT TABLE

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	3272.859	1.01-year	52.48	82.49	85.22	83.99	2.73	0.006909	2.99	17.54	7.87	0.35	1.53	0.66
Sunset Creek	SE 30th	3272.859	2-year	79	82.49	85.87	84.38	3.38	0.007726	3.46	22.83	8.32	0.37	1.77	0.86
Sunset Creek	SE 30th	3272.859	10-year	126	82.49	86.72	84.96	4.23	0.009492	4.19	30.1	8.9	0.4	2.06	1.22
Sunset Creek	SE 30th	3272.859	25-year	157	82.49	87.13	85.3	4.64	0.010441	4.63	34.08	10.3	0.42	2.24	1.46
Sunset Creek	SE 30th	3272.859	100-year	212	82.49	87.79	85.83	5.3	0.011482	5.24	41.64	12.71	0.45	2.52	1.81
Sunset Creek	SE 30th	3251.92	1.01-year	52.48	82.52	84.68	84.21	2.16	0.024525	5.08	10.33	5.78	0.67	1.2	1.84
Sunset Creek	SE 30th	3251.92	2-year	79	82.52	85.22	84.69	2.7	0.027799	5.84	13.53	6.22	0.7	1.39	2.41
Sunset Creek	SE 30th	3251.92	10-year	126	82.52	86	85.54	3.48	0.031764	6.33	19.9	8.8	0.74	1.5	2.97
Sunset Creek	SE 30th	3251.92	25-year	157	82.52	86.34	85.88	3.82	0.033201	6.84	22.96	9.05	0.76	1.64	3.39
Sunset Creek	SE 30th	3251.92	100-year	212	82.52	86.88	86.38	4.36	0.035496	7.59	27.92	9.43	0.78	1.84	4.08
Sunset Creek	SE 30th	3230.282	1.01-year	52.48	81.37	84.02	83.73	2.65	0.030615	5.49	9.55	6.31	0.79	1.09	2.08
Sunset Creek	SE 30th	3230.282	2-year	79	81.37	84.46	84.23	3.09	0.033662	6.29	12.56	7.21	0.84	1.24	2.61
Sunset Creek	SE 30th	3230.282	10-year	126	81.37	85.18	84.92	3.81	0.034461	6.77	18.62	9.27	0.84	1.45	3.12
Sunset Creek	SE 30th	3230.282	25-year	157	81.37	85.54	85.24	4.17	0.03394	7.15	21.97	9.59	0.83	1.61	3.42
Sunset Creek	SE 30th	3230.282	100-year	212	81.37	86.11	85.72	4.74	0.033218	7.67	27.63	10.1	0.82	1.86	3.85
Sunset Creek	SE 30th	3207.655	1.01-year	52.48	81.58	83.02	83.02	1.44	0.045494	6.27	8.36	6.93	1.01	0.98	2.8
Sunset Creek	SE 30th	3207.655	2-year	79	81.58	83.43	83.43	1.85	0.044215	7.02	11.25	7.41	1.01	1.19	3.29
Sunset Creek	SE 30th	3207.655	10-year	126	81.58	84.06	84.06	2.48	0.044338	7.75	16.25	8.79	1	1.42	3.92
Sunset Creek	SE 30th	3207.655	25-year	157	81.58	84.37	84.37	2.79	0.044896	8.25	19.02	9.07	1	1.57	4.39
Sunset Creek	SE 30th	3207.655	100-year	212	81.58	84.86	84.86	3.28	0.045967	8.98	23.6	9.51	1	1.78	5.12
Sunset Creek	SE 30th	3193.525	1.01-year	52.48	81.39	82.96	82.47	1.57	0.012631	3.2	16.4	13.89	0.52	0.99	0.78
Sunset Creek	SE 30th	3193.525	2-year	79	81.39	83.44	82.75	2.05	0.010801	3.36	23.53	15.91	0.49	1.2	0.81
Sunset Creek	SE 30th	3193.525	10-year	126	81.39	84.14	83.16	2.75	0.008933	3.52	35.78	18.79	0.45	1.5	0.84
Sunset Creek	SE 30th	3193.525	25-year	157	81.39	84.54	83.39	3.15	0.00785	3.62	43.42	19.42	0.43	1.74	0.85
Sunset Creek	SE 30th	3193.525	100-year	212	81.39	85.16	83.75	3.77	0.00686	3.82	55.51	19.91	0.4	2.11	0.9
Sunset Creek	SE 30th	3181.277	1.01-year	52.48	80.83	82.23	82.23	1.4	0.049653	6.06	8.66	7.7	1.01	0.97	3.01
Sunset Creek	SE 30th	3181.277	2-year	79	80.83	82.63	82.61	1.8	0.047241	6.68	11.83	8.35	0.99	1.19	3.51
Sunset Creek	SE 30th	3181.277	10-year	126	80.83	83.26	83.16	2.43	0.04141	7.2	17.49	9.4	0.93	1.5	3.89
Sunset Creek	SE 30th	3181.277	25-year	157	80.83	83.58	83.46	2.75	0.039203	7.67	20.55	10.44	0.92	1.73	4.22
Sunset Creek	SE 30th	3181.277	100-year	212	80.83	84.06	83.99	3.23	0.035379	8.35	26.15	12.35	0.91	2.12	4.68
Sunset Creek	SE 30th	3171.478	1.01-year	52.48	79.8	82.09	81.5	2.29	0.017938	4.34	12.08	6.96	0.58	1.29	1.44
Sunset Creek	SE 30th	3171.478	2-year	79	79.8	82.53	81.92	2.73	0.020229	5.19	15.34	7.97	0.63	1.55	1.96
Sunset Creek	SE 30th	3171.478	10-year	126	79.8	83.09	82.55	3.29	0.022901	6.46	20.2	9.36	0.7	1.96	2.8
Sunset Creek	SE 30th	3171.478	25-year	157	79.8	83.37	82.91	3.57	0.024983	7.2	22.91	10.06	0.74	2.16	3.37
Sunset Creek	SE 30th	3171.478	100-year	212	79.8	83.77	83.5	3.97	0.0285	8.38	27.21	11.07	0.81	2.46	4.38
Sunset Creek	SE 30th	3160.526	1.01-year	52.48	79.96	81.89	81.42	1.93	0.018375	4.34	12.09	7.93	0.62	1.24	1.42
Sunset Creek	SE 30th	3160.526	2-year	79	79.96	82.32	81.81	2.36	0.020239	5.05	15.65	8.81	0.66	1.47	1.86
Sunset Creek	SE 30th	3160.526	10-year	126	79.96	82.89	82.38	2.93	0.022223	6.07	21.16	10.52	0.7	1.82	2.53
Sunset Creek	SE 30th	3160.526	25-year	157	79.96	83.18	82.72	3.22	0.022836	6.66	24.36	11.4	0.73	2.05	2.92
Sunset Creek	SE 30th	3160.526	100-year	212	79.96	83.62	83.23	3.66	0.023797	7.55	29.71	12.74	0.76	2.4	3.56
Sunset Creek	SE 30th	3145.921	1.01-year	52.48	78.83	81.92	80.46	3.09	0.003732	2.52	21.19	10.58	0.29	1.92	0.45
Sunset Creek	SE 30th	3145.921	2-year	79	78.83	82.37	80.86	3.54	0.004594	3.15	26.22	11.91	0.33	2.29	0.66
Sunset Creek	SE 30th	3145.921	10-year	126	78.83	82.97	81.42	4.14	0.005759	4.01	33.92	13.69	0.38	2.78	1
Sunset Creek	SE 30th	3145.921	25-year	157	78.83	83.29	81.74	4.46	0.006411	4.49	38.41	14.63	0.41	3.04	1.22
Sunset Creek	SE 30th	3145.921	100-year	212	78.83	83.77	82.27	4.94	0.007307	5.21	45.89	16.07	0.45	3.44	1.57
Sunset Creek	SE 30th	3119.845	1.01-year	52.48	79.67	81.65	81.05	1.98	0.011764	3.56	14.77	10.26	0.51	1.32	0.97
Sunset Creek	SE 30th	3119.845	2-year	79	79.67	82.05	81.4	2.38	0.011998	4.21	19.08	11.5	0.54	1.67	1.25
Sunset Creek	SE 30th	3119.845	10-year	126	79.67	82.57	81.89	2.9	0.013116	5.17	25.47	13.13	0.59	2.13	1.74
Sunset Creek	SE 30th	3119.845	25-year	157	79.67	82.82	82.17	3.15	0.014262	5.77	28.89	13.92	0.62	2.35	2.1
Sunset Creek	SE 30th	3119.845	100-year	212	79.67	83.2	82.63	3.53	0.016027	6.69	34.41	15.12	0.68	2.69	2.69
Sunset Creek	SE 30th	3103.342	1.01-year	52.48	79.66	81.46	80.89	1.8	0.011936	3.47	15.11	10.95	0.52	1.24	0.92
Sunset Creek	SE 30th	3103.342	2-year	79	79.66	81.86	81.22	2.2	0.01343	4.03	19.62	12.1	0.56	1.44	1.21
Sunset Creek	SE 30th	3103.342	10-year	126	79.66	82.36	81.7	2.7	0.01577	4.81	26.17	13.61	0.61	1.7	1.67
Sunset Creek	SE 30th	3103.342	25-year	157	79.66	82.61	81.98	2.95	0.016334	5.31	29.67	14.35	0.63	1.92	1.95
Sunset Creek	SE 30th	3103.342	100-year	212	79.66	82.99	82.39	3.33	0.017504	6.1	35.2	15.45	0.67	2.24	2.45
Sunset Creek	SE 30th	3082.734	1.01-year	52.48	79.61	81.15	80.76	1.54	0.015717	3.74	14.02	11.68	0.6	1.11	1.09
Sunset Creek	SE 30th	3082.734	2-year	79	79.61	81.52	81.06	1.91	0.015628	4.26	18.63	13.16	0.61	1.37	1.33
Sunset Creek	SE 30th	3082.734	10-year	126	79.61	82	81.5	2.39	0.015851	5.1	25.43	15.76	0.64	1.78	1.76
Sunset Creek	SE 30th	3082.734	25-year	157	79.61	82.23	81.76	2.62	0.01654	5.61	29.26	17.06	0.67	1.99	2.06
Sunset Creek	SE 30th	3082.734	100-year	212	79.61	82.61	82.16	3	0.016909	6.32	36.13	19.16	0.7	2.34	2.47
Sunset Creek	SE 30th	3066.484	1.01-year	52.48	79.15	80.44	80.44	1.29	0.045593	5.66	9.27	9.44	1.01	0.91	2.59
Sunset Creek	SE 30th	3066.484	2-year	79	79.15	80.77	80.77	1.62	0.041061	6.3	12.68	11.37	0.98	1.17	2.99
Sunset Creek	SE 30th	3066.484	10-year	126	79.15	81.27	81.27	2.12	0.032155	6.97	19.39	15.18	0.92	1.63	3.27
Sunset Creek	SE 30th	3066.484	25-year	157	79.15	81.55	81.55	2.4	0.028891	7.28	23.84	16.54	0.89	1.88	3.4
Sunset Creek	SE 30th	3066.484	100-year	212	79.15	81.92	81.92	2.77	0.027733	7.96	30.23	17.83	0.9	2.23	3.85
Sunset Creek	SE 30th	3034.622	1.01-year	52.48	77.36	78.8	78.83	1.44	0.053489	6	8.75	8.57	1.05	0.94	3.13
Sunset Creek	SE 30th	3034.622	2-year	79	77.36	79.11	79.19	1.75	0.057465	6.84	11.54	9.56	1.1	1.1	3.94
Sunset Creek	SE 30th	3034.622	10-year	126	77.36	79.48	79.7	2.12	0.068201	8.2	15.36	10.77	1.21	1.29	5.48
Sunset Creek	SE 30th	3034.622	25-year	157	77.36	79.7	79.98	2.34	0.071417	8.82	17.81	11.47	1.25	1.39	6.22
Sunset Creek	SE 30th	3034.622	100-year	212	77.36	80.11	80.4	2.75	0.068713	9.35	22.66	12.75	1.24	1.59	6.81

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	3020.31	1.01-year	52.48	76.74	78.69	78.18	1.95	0.011941	3.74	14.04	11.02	0.58	1.14	0.85
Sunset Creek	SE 30th	3020.31	2-year	79	76.74	79.07	78.53	2.33	0.012354	4.22	18.74	13.76	0.63	1.24	0.96
Sunset Creek	SE 30th	3020.31	10-year	126	76.74	79.57	79.08	2.83	0.012503	4.77	26.69	17.98	0.67	1.45	1.13
Sunset Creek	SE 30th	3020.31	25-year	157	76.74	79.84	79.34	3.1	0.012582	5.03	31.75	19.91	0.68	1.59	1.25
Sunset Creek	SE 30th	3020.31	100-year	212	76.74	80.22	79.74	3.48	0.012788	5.51	39.63	21.2	0.67	1.94	1.55
Sunset Creek	SE 30th	2982.026	1.01-year	52.48	76.27	77.64	77.64	1.37	0.041864	5.49	9.57	10.28	1	0.86	2.24
Sunset Creek	SE 30th	2982.026	2-year	79	76.27	77.97	77.97	1.7	0.041566	5.98	13.22	12.11	1.01	1	2.6
Sunset Creek	SE 30th	2982.026	10-year	126	76.27	78.42	78.42	2.15	0.042101	6.55	19.23	14.7	1.01	1.2	3.15
Sunset Creek	SE 30th	2982.026	25-year	157	76.27	78.66	78.66	2.39	0.042096	6.84	22.94	16.1	1.01	1.3	3.42
Sunset Creek	SE 30th	2982.026	100-year	212	76.27	79.03	79.03	2.76	0.041059	7.23	29.3	18.1	1	1.48	3.78
Sunset Creek	SE 30th	2969.117	1.01-year	52.48	75.88	76.97	77.07	1.09	0.065542	5.54	9.48	14.93	1.22	0.62	2.54
Sunset Creek	SE 30th	2969.117	2-year	79	75.88	77.13	77.29	1.25	0.07752	6.56	12.04	16.63	1.36	0.71	3.42
Sunset Creek	SE 30th	2969.117	10-year	126	75.88	77.99	77.62	2.11	0.016637	4.66	27.04	18.12	0.67	1.39	1.44
Sunset Creek	SE 30th	2969.117	25-year	157	75.88	78.3	77.81	2.42	0.014764	4.81	32.64	18.59	0.64	1.61	1.49
Sunset Creek	SE 30th	2969.117	100-year	212	75.88	78.72	78.12	2.84	0.014239	5.23	40.57	19.24	0.63	1.9	1.69
Sunset Creek	SE 30th	2939.869	1.01-year	52.48	73.61	76.82	75.69	3.21	0.0053	2.32	22.64	14.71	0.33	1.38	0.46
Sunset Creek	SE 30th	2939.869	2-year	79	73.61	77.25	76.05	3.64	0.006354	2.69	29.37	16.87	0.36	1.56	0.62
Sunset Creek	SE 30th	2939.869	10-year	126	73.61	77.81	76.54	4.2	0.007148	3.22	39.19	18.18	0.39	1.91	0.85
Sunset Creek	SE 30th	2939.869	25-year	157	73.61	78.11	76.8	4.5	0.007632	3.51	44.79	18.85	0.4	2.09	1
Sunset Creek	SE 30th	2939.869	100-year	212	73.61	78.51	77.2	4.9	0.008977	4.04	52.43	19.74	0.44	2.32	1.3
Sunset Creek	SE 30th	2904.859	1.01-year	52.48	74.07	76.39	75.43	2.32	0.035375	2.86	18.34	15.88	0.47	1.03	2.28
Sunset Creek	SE 30th	2904.859	2-year	79	74.07	76.76	75.8	2.69	0.035069	3.22	24.51	17.55	0.48	1.25	2.74
Sunset Creek	SE 30th	2904.859	10-year	126	74.07	77.28	76.48	3.21	0.034618	3.67	34.34	19.94	0.49	1.54	3.34
Sunset Creek	SE 30th	2904.859	25-year	157	74.07	77.58	76.7	3.51	0.033762	3.86	41.26	28.12	0.49	1.7	3.59
Sunset Creek	SE 30th	2904.859	100-year	212	74.07	77.99	77.03	3.92	0.029905	4.01	54.84	34.28	0.48	1.98	3.69
Sunset Creek	SE 30th	2887.542	1.01-year	52.48	73.52	76	75.02	2.48	0.01689	2.48	21.14	16.68	0.39	1.13	1.19
Sunset Creek	SE 30th	2887.542	2-year	79	73.52	76.35	75.58	2.83	0.018422	2.91	27.14	17.78	0.42	1.36	1.56
Sunset Creek	SE 30th	2887.542	10-year	126	73.52	76.85	75.94	3.33	0.020043	3.46	36.45	19.36	0.44	1.66	2.08
Sunset Creek	SE 30th	2887.542	25-year	157	73.52	77.14	76.13	3.62	0.020645	3.73	42.11	20.26	0.46	1.83	2.36
Sunset Creek	SE 30th	2887.542	100-year	212	73.52	77.55	76.47	4.03	0.020457	4.12	54.03	31.33	0.46	2.14	2.74
Sunset Creek	SE 30th	2869.669	1.01-year	52.48	73.86	74.99	74.99	1.13	0.1141	5.38	9.76	11.01	1.01	0.84	6
Sunset Creek	SE 30th	2869.669	2-year	79	73.86	75.46	75.31	1.6	0.076869	5.09	15.52	13.76	0.84	1.07	5.13
Sunset Creek	SE 30th	2869.669	10-year	126	73.86	76.06	75.72	2.2	0.05229	5.13	24.66	16.55	0.73	1.46	4.78
Sunset Creek	SE 30th	2869.669	25-year	157	73.86	76.37	75.95	2.51	0.045845	5.28	30.09	18.65	0.7	1.69	4.84
Sunset Creek	SE 30th	2869.669	100-year	212	73.86	76.83	76.3	2.97	0.037398	5.55	40.53	26.67	0.65	2.13	4.96
Sunset Creek	SE 30th	2850.365	1.01-year	52.48	72.12	74.8	73.51	2.68	0.008517	2.47	21.9	12.17	0.29	1.83	0.97
Sunset Creek	SE 30th	2850.365	2-year	79	72.12	75.2	73.85	3.08	0.010492	3.08	27.19	14.33	0.34	2.17	1.42
Sunset Creek	SE 30th	2850.365	10-year	126	72.12	75.73	74.37	3.61	0.013528	3.94	34.68	18.54	0.39	2.6	2.2
Sunset Creek	SE 30th	2850.365	25-year	157	72.12	76	74.67	3.88	0.015279	4.43	38.79	20.56	0.42	2.83	2.7
Sunset Creek	SE 30th	2850.365	100-year	212	72.12	76.4	75.15	4.28	0.018215	5.21	45.01	23.53	0.47	3.16	3.6
Sunset Creek	SE 30th	2823.726	1.01-year	52.48	72.56	74.33	73.76	1.77	0.027126	3.37	15.7	13.65	0.51	1.25	2.12
Sunset Creek	SE 30th	2823.726	2-year	79	72.56	74.66	74.08	2.1	0.02991	3.97	21.01	17.43	0.55	1.5	2.79
Sunset Creek	SE 30th	2823.726	10-year	126	72.56	75.09	74.62	2.53	0.031842	4.75	28.98	19.94	0.59	1.87	3.72
Sunset Creek	SE 30th	2823.726	25-year	157	72.56	75.33	74.85	2.77	0.032204	5.15	33.94	21.52	0.6	2.09	4.2
Sunset Creek	SE 30th	2823.726	100-year	212	72.56	75.68	75.2	3.12	0.033137	5.75	42.05	23.88	0.62	2.42	5
Sunset Creek	SE 30th	2794.948	1.01-year	52.48	71.19	73.3	72.93	2.11	0.041455	3.96	13.71	14	0.62	1.16	3.01
Sunset Creek	SE 30th	2794.948	2-year	79	71.19	73.74	73.29	2.55	0.03285	4.14	21.11	19.29	0.57	1.48	3.04
Sunset Creek	SE 30th	2794.948	10-year	126	71.19	74.19	73.8	3	0.03146	4.73	30.56	22.79	0.58	1.87	3.68
Sunset Creek	SE 30th	2794.948	25-year	157	71.19	74.38	74.01	3.19	0.034206	5.22	34.91	24.23	0.61	2.04	4.36
Sunset Creek	SE 30th	2794.948	100-year	212	71.19	74.67	74.32	3.48	0.037454	5.93	42.3	26.49	0.66	2.31	5.39
Sunset Creek	SE 30th	2760.247	1.01-year	52.48	70.04	72.19	71.78	2.15	0.021386	4.59	11.44	7.83	0.67	1.22	1.63
Sunset Creek	SE 30th	2760.247	2-year	79	70.04	72.61	72.19	2.57	0.022586	5.28	15.51	13.21	0.7	1.46	2.06
Sunset Creek	SE 30th	2760.247	10-year	126	70.04	73.18	72.94	3.14	0.019203	5.72	26.18	23.05	0.66	1.87	2.25
Sunset Creek	SE 30th	2760.247	25-year	157	70.04	73.47	73.26	3.43	0.017131	5.84	32.95	24.53	0.64	2.11	2.25
Sunset Creek	SE 30th	2760.247	100-year	212	70.04	73.91	73.59	3.87	0.014582	5.99	44.35	26.84	0.61	2.47	2.25
Sunset Creek	SE 30th	2717.8	1.01-year	52.48	69.4	71.4	71.02	2	0.018327	4.1	12.8	10.21	0.65	1.15	1.31
Sunset Creek	SE 30th	2717.8	2-year	79	69.4	71.93	71.36	2.53	0.015364	4.22	18.73	12.06	0.6	1.4	1.35
Sunset Creek	SE 30th	2717.8	10-year	126	69.4	72.59	71.86	3.19	0.014027	4.6	27.49	15.99	0.58	1.75	1.53
Sunset Creek	SE 30th	2717.8	25-year	157	69.4	72.91	72.13	3.51	0.012799	4.87	33.54	21.43	0.57	2.04	1.63
Sunset Creek	SE 30th	2717.8	100-year	212	69.4	73.45	72.56	4.05	0.010375	5.05	47.55	30.52	0.53	2.52	1.63
Sunset Creek	SE 30th	2702.718	1.01-year	52.48	69.19	71.35	70.61	2.16	0.006362	2.65	19.84	14.94	0.4	1.25	0.5
Sunset Creek	SE 30th	2702.718	2-year	79	69.19	71.92	70.91	2.73	0.00504	2.75	28.73	16.42	0.37	1.61	0.51
Sunset Creek	SE 30th	2702.718	10-year	126	69.19	72.59	71.31	3.4	0.004965	3.14	40.14	17.5	0.37	2.03	0.63
Sunset Creek	SE 30th	2702.718	25-year	157	69.19	72.92	71.54	3.73	0.005283	3.42	45.96	18.03	0.38	2.22	0.73
Sunset Creek	SE 30th	2702.718	100-year	212	69.19	73.44	71.9	4.25	0.005713	3.82	55.56	18.86	0.39	2.5	0.89
Sunset Creek	SE 30th	2676.488	1.01-year	52.48	68.81	71.24	70.09	2.43	0.00396	2.27	23.13	13.49	0.31	1.56	0.38
Sunset Creek	SE 30th	2676.488	2-year	79	68.81	71.82	70.41	3.01	0.003948	2.52	31.33	15.15	0.31	1.85	0.46
Sunset Creek	SE 30th	2676.488	10-year	126	68.81	72.48	70.86	3.67	0.004588	3	41.95	17.05	0.34	2.18	0.63
Sunset Creek	SE 30th	2676.488	25-year	157	68.81	72.79	71.13	3.98	0.00512	3.31	47.48	17.97	0.36	2.34	0.75
Sunset Creek	SE 30th	2676.488	100-year	212	68.81	73.3	71.52	4.49	0.005754	3.72	57.07	21.97	0.38	2.57	0.92

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	2651.525	1.01-year	52.48	67.48	71.25	68.73	3.77	0.000734	1.18	44.3	18.1	0.13	2.19	0.1
Sunset Creek	SE 30th	2651.525	2-year	79	67.48	71.82	69.06	4.34	0.000906	1.43	55.19	19.71	0.15	2.5	0.14
Sunset Creek	SE 30th	2651.525	10-year	126	67.48	72.48	69.53	5	0.001215	1.83	68.68	20.97	0.18	2.93	0.22
Sunset Creek	SE 30th	2651.525	25-year	157	67.48	72.81	69.8	5.33	0.001359	2.05	78.77	47.92	0.19	3.17	0.27
Sunset Creek	SE 30th	2651.525	100-year	212	67.48	73.36	70.2	5.88	0.001053	1.98	114.11	74.37	0.17	3.66	0.24
Sunset Creek	SE 30th	2643.063	1.01-year	52.48	66.06	71.25	67.28	5.19	0.000479	1.06	49.64	14.57	0.1	2.49	0.07
Sunset Creek	SE 30th	2643.063	2-year	79	66.06	71.82	67.63	5.76	0.000683	1.37	58.53	16.51	0.12	2.81	0.12
Sunset Creek	SE 30th	2643.063	10-year	126	66.06	72.47	68.17	6.41	0.001079	1.85	70.09	18.64	0.15	3.16	0.21
Sunset Creek	SE 30th	2643.063	25-year	157	66.06	72.79	68.49	6.73	0.001355	2.14	76.04	19.02	0.17	3.32	0.28
Sunset Creek	SE 30th	2643.063	100-year	212	66.06	73.3	69.05	7.24	0.001798	2.59	85.69	19.02	0.19	3.57	0.4
Sunset Creek	SE 30th	2608.794		Culvert											
Sunset Creek	SE 30th	2578.872	1.01-year	52.48	64.12	69.28	65.29	5.16	0.000613	1.19	44.59	11.38	0.1	2.56	0.1
Sunset Creek	SE 30th	2578.872	2-year	79	64.12	69.74	65.65	5.62	0.001005	1.61	50.29	14.25	0.13	2.79	0.18
Sunset Creek	SE 30th	2578.872	10-year	126	64.12	70.31	66.19	6.19	0.001697	2.25	59.97	20.07	0.17	3.11	0.33
Sunset Creek	SE 30th	2578.872	25-year	157	64.12	70.61	66.51	6.49	0.002113	2.6	66.59	23.67	0.19	3.28	0.43
Sunset Creek	SE 30th	2578.872	100-year	212	64.12	71.08	67.02	6.96	0.002697	3.1	78.98	28.22	0.22	3.55	0.6
Sunset Creek	SE 30th	2539.81	1.01-year	52.48	66.61	69.08	68.12	2.47	0.006284	3.27	18.2	13.08	0.39	1.81	0.71
Sunset Creek	SE 30th	2539.81	2-year	79	66.61	69.45	68.59	2.84	0.007555	3.98	23.47	15.12	0.44	2.11	1
Sunset Creek	SE 30th	2539.81	10-year	126	66.61	69.88	69.17	3.27	0.010055	5.09	30.37	16.96	0.52	2.46	1.54
Sunset Creek	SE 30th	2539.81	25-year	157	66.61	70.07	69.47	3.46	0.012071	5.81	33.79	18.55	0.57	2.62	1.97
Sunset Creek	SE 30th	2539.81	100-year	212	66.61	70.37	69.85	3.76	0.014879	6.85	39.71	20.94	0.64	2.86	2.66
Sunset Creek	SE 30th	2527.427	1.01-year	52.48	66.69	69	68.15	2.31	0.006738	3.23	17.82	15.3	0.41	1.58	0.66
Sunset Creek	SE 30th	2527.427	2-year	79	66.69	69.37	68.54	2.68	0.007484	3.83	24.28	19.66	0.45	1.89	0.88
Sunset Creek	SE 30th	2527.427	10-year	126	66.69	69.8	69.16	3.11	0.008711	4.65	33.61	22.27	0.5	2.25	1.22
Sunset Creek	SE 30th	2527.427	25-year	157	66.69	70.01	69.46	3.32	0.009707	5.15	38.21	22.84	0.53	2.42	1.47
Sunset Creek	SE 30th	2527.427	100-year	212	66.69	70.32	69.87	3.63	0.011234	5.93	46.44	28.4	0.58	2.68	1.88
Sunset Creek	SE 30th	2513.681	1.01-year	52.48	66.48	68.93	67.96	2.45	0.007372	2.76	19.33	16.44	0.4	1.27	0.58
Sunset Creek	SE 30th	2513.681	2-year	79	66.48	69.3	68.47	2.82	0.007625	3.18	26.86	34.16	0.42	1.54	0.73
Sunset Creek	SE 30th	2513.681	10-year	126	66.48	69.76	68.92	3.28	0.007608	3.7	39.41	40.56	0.44	1.94	0.92
Sunset Creek	SE 30th	2513.681	25-year	157	66.48	69.97	69.24	3.49	0.007933	4.02	46.27	43.31	0.45	2.12	1.05
Sunset Creek	SE 30th	2513.681	100-year	212	66.48	70.32	69.63	3.84	0.007894	4.38	58.43	44.84	0.46	2.43	1.2
Sunset Creek	SE 30th	2492.185	1.01-year	52.48	67.13	68.66	68.18	1.53	0.012461	3.41	15.41	13.79	0.55	1.09	0.85
Sunset Creek	SE 30th	2492.185	2-year	79	67.13	69.02	68.51	1.89	0.011656	3.86	21.3	19.89	0.55	1.39	1.01
Sunset Creek	SE 30th	2492.185	10-year	126	67.13	69.54	68.94	2.41	0.008839	4.09	38.79	42.47	0.51	1.87	1.03
Sunset Creek	SE 30th	2492.185	25-year	157	67.13	69.81	69.28	2.68	0.007309	4.05	50.55	42.47	0.47	2.12	0.97
Sunset Creek	SE 30th	2492.185	100-year	212	67.13	70.2	69.66	3.07	0.006265	4.16	66.99	42.47	0.45	2.48	0.97
Sunset Creek	SE 30th	2464.334	1.01-year	52.48	66.47	68.2	67.83	1.73	0.017898	3.77	13.93	12.19	0.61	1.1	1.23
Sunset Creek	SE 30th	2464.334	2-year	79	66.47	68.58	68.12	2.11	0.016828	4.25	19.33	16.31	0.6	1.41	1.48
Sunset Creek	SE 30th	2464.334	10-year	126	66.47	69.05	68.59	2.58	0.017434	4.98	28.3	21.47	0.62	1.77	1.93
Sunset Creek	SE 30th	2464.334	25-year	157	66.47	69.27	68.85	2.8	0.018273	5.43	33.46	26.29	0.65	1.96	2.24
Sunset Creek	SE 30th	2464.334	100-year	212	66.47	69.61	69.31	3.14	0.018373	5.99	43.48	32.21	0.66	2.26	2.59
Sunset Creek	SE 30th	2429.853	1.01-year	52.48	66.05	67.9	67.23	1.85	0.007127	2.71	19.88	16.76	0.4	1.28	0.57
Sunset Creek	SE 30th	2429.853	2-year	79	66.05	68.31	67.5	2.26	0.006992	3.09	27.43	20.07	0.41	1.61	0.7
Sunset Creek	SE 30th	2429.853	10-year	126	66.05	68.78	67.9	2.73	0.007716	3.74	38.45	28.92	0.44	2.01	0.97
Sunset Creek	SE 30th	2429.853	25-year	157	66.05	68.98	68.13	2.93	0.008643	4.18	44.22	29.86	0.47	2.18	1.18
Sunset Creek	SE 30th	2429.853	100-year	212	66.05	69.27	68.52	3.22	0.009971	4.84	53.02	29.86	0.51	2.44	1.52
Sunset Creek	SE 30th	2407.706	1.01-year	52.48	65.66	67.2	67.18	1.54	0.050024	5.41	9.7	10.14	0.97	0.9	2.81
Sunset Creek	SE 30th	2407.706	2-year	79	65.66	67.49	67.49	1.83	0.055912	6.15	12.85	11.41	1.01	1.07	3.72
Sunset Creek	SE 30th	2407.706	10-year	126	65.66	68.08	68.08	2.42	0.035381	6.11	23.27	26.99	0.83	1.53	3.38
Sunset Creek	SE 30th	2407.706	25-year	157	65.66	68.32	68.32	2.66	0.031455	6.25	30.63	31.58	0.8	1.73	3.4
Sunset Creek	SE 30th	2407.706	100-year	212	65.66	68.59	68.59	2.93	0.031333	6.82	39.24	31.58	0.82	1.98	3.88
Sunset Creek	SE 30th	2379.636	1.01-year	52.48	65.03	66.82	66.35	1.79	0.011821	2.88	18.23	17.64	0.49	1.02	0.75
Sunset Creek	SE 30th	2379.636	2-year	79	65.03	67.2	66.61	2.17	0.010089	3.17	25.26	19.24	0.47	1.35	0.85
Sunset Creek	SE 30th	2379.636	10-year	126	65.03	67.63	66.95	2.6	0.010673	3.82	34.07	22.65	0.5	1.73	1.15
Sunset Creek	SE 30th	2379.636	25-year	157	65.03	67.84	67.15	2.81	0.011446	4.24	38.98	25.69	0.53	1.92	1.37
Sunset Creek	SE 30th	2379.636	100-year	212	65.03	68.13	67.45	3.1	0.012803	4.92	47.18	30.11	0.57	2.2	1.76
Sunset Creek	SE 30th	2361.19	1.01-year	52.48	64.42	66.75	65.77	2.33	0.003291	2.31	24.33	17.71	0.31	1.57	0.32
Sunset Creek	SE 30th	2361.19	2-year	79	64.42	67.12	66.06	2.7	0.003979	2.78	31.28	20	0.34	1.84	0.46
Sunset Creek	SE 30th	2361.19	10-year	126	64.42	67.53	66.48	3.11	0.005537	3.55	39.95	22.43	0.4	2.13	0.74
Sunset Creek	SE 30th	2361.19	25-year	157	64.42	67.72	66.73	3.3	0.006582	3.99	44.2	22.57	0.44	2.26	0.93
Sunset Creek	SE 30th	2361.19	100-year	212	64.42	67.98	67.1	3.56	0.008521	4.73	50.35	25.52	0.5	2.44	1.3
Sunset Creek	SE 30th	2341.739	1.01-year	52.48	64.47	66.46	65.91	1.99	0.015418	3.96	13.91	14.01	0.56	1.33	1.28
Sunset Creek	SE 30th	2341.739	2-year	79	64.47	66.78	66.34	2.31	0.016281	4.59	20.7	26.6	0.59	1.59	1.61
Sunset Creek	SE 30th	2341.739	10-year	126	64.47	66.99	66.99	2.52	0.024569	6.05	26.8	30.91	0.74	1.77	2.71
Sunset Creek	SE 30th	2341.739	25-year	157	64.47	67.2	67.2	2.73	0.023365	6.29	33.69	34.59	0.73	1.95	2.84
Sunset Creek	SE 30th	2341.739	100-year	212	64.47	67.45	67.45	2.98	0.02399	6.84	42.56	34.59	0.75	2.16	3.24
Sunset Creek	SE 30th	2313.296	1.01-year	52.48	64.36	65.6	65.6	1.24	0.03887	5.25	10.46	14.89	0.93	0.94	2.27
Sunset Creek	SE 30th	2313.296	2-year	79	64.36	65.99	65.99	1.63	0.056799	4.69	18.59	31.31	0.92	0.77	2.73
Sunset Creek	SE 30th	2313.296	10-year	126	64.36	66.45	66.22	2.09	0.022822	4.04	34.09	33.3	0.63	1.22	1.74
Sunset Creek	SE 30th	2313.296	25-year	157	64.36	66.7	66.34	2.34	0.017603	4	42.32	33.3	0.57	1.46	1.6
Sunset Creek	SE 30th	2313.296	100-year	212	64.36	67.07	66.54	2.71	0.013966	4.11	54.56	33.3	0.53	1.81	1.58

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	2297.254	1.01-year	52.48	62.97	65.57	64.4	2.6	0.003703	2.18	30.74	29.44	0.27	1.98	0.46
Sunset Creek	SE 30th	2297.254	2-year	79	62.97	65.91	64.75	2.94	0.004278	2.59	41.16	31.13	0.29	2.31	0.62
Sunset Creek	SE 30th	2297.254	10-year	126	62.97	66.36	65.17	3.39	0.00516	3.19	55.75	84.25	0.33	2.74	0.88
Sunset Creek	SE 30th	2297.254	25-year	157	62.97	66.6	65.43	3.63	0.005718	3.54	63.93	86.24	0.35	2.96	1.06
Sunset Creek	SE 30th	2297.254	100-year	212	62.97	66.96	65.86	3.99	0.006276	3.99	76.84	86.24	0.38	3.31	1.3
Sunset Creek	SE 30th	2285.55	1.01-year	52.48	63.26	65.57	64.58	2.31	0.002258	1.3	46.24	33.75	0.17	1.39	0.2
Sunset Creek	SE 30th	2285.55	2-year	79	63.26	65.92	64.72	2.66	0.002488	1.54	58.22	34.76	0.18	1.65	0.26
Sunset Creek	SE 30th	2285.55	10-year	126	63.26	66.39	64.94	3.13	0.002542	1.77	78.44	100.84	0.19	2.01	0.32
Sunset Creek	SE 30th	2285.55	25-year	157	63.26	66.63	65.06	3.37	0.002312	1.79	90.89	100.84	0.19	2.2	0.32
Sunset Creek	SE 30th	2285.55	100-year	212	63.26	67.01	65.26	3.75	0.001991	1.8	110.12	100.84	0.18	2.49	0.31
Sunset Creek	SE 30th	2261.889	1.01-year	52.48	63.31	65.44	64.72	2.13	0.004929	2.35	31.44	92.25	0.31	1.5	0.46
Sunset Creek	SE 30th	2261.889	2-year	79	63.31	65.77	64.95	2.46	0.005531	2.79	41.16	95.88	0.34	1.78	0.61
Sunset Creek	SE 30th	2261.889	10-year	126	63.31	66.21	65.27	2.9	0.006161	3.34	55.45	97.98	0.37	2.16	0.83
Sunset Creek	SE 30th	2261.889	25-year	157	63.31	66.44	65.45	3.13	0.006507	3.65	63.11	97.98	0.39	2.36	0.96
Sunset Creek	SE 30th	2261.889	100-year	212	63.31	66.8	65.74	3.49	0.007047	4.12	74.91	97.98	0.41	2.67	1.17
Sunset Creek	SE 30th	2238.42	1.01-year	52.48	63.48	65.28	64.66	1.8	0.007533	2.53	26.26	90.2	0.37	1.4	0.66
Sunset Creek	SE 30th	2238.42	2-year	79	63.48	65.59	64.95	2.11	0.007916	2.95	34.84	92.49	0.39	1.69	0.84
Sunset Creek	SE 30th	2238.42	10-year	126	63.48	66	65.27	2.52	0.008879	3.58	46.72	97.36	0.43	2.08	1.15
Sunset Creek	SE 30th	2238.42	25-year	157	63.48	66.21	65.44	2.73	0.009416	3.92	53.14	97.36	0.45	2.28	1.34
Sunset Creek	SE 30th	2238.42	100-year	212	63.48	66.54	65.7	3.06	0.010293	4.47	62.92	97.36	0.48	2.59	1.67
Sunset Creek	SE 30th	2205.456	1.01-year	52.48	63.19	65	64.55	1.81	0.008604	2.79	25.06	89.89	0.42	1.36	0.73
Sunset Creek	SE 30th	2205.456	2-year	79	63.19	65.28	64.77	2.09	0.009445	3.31	33.12	93.14	0.45	1.63	0.96
Sunset Creek	SE 30th	2205.456	10-year	126	63.19	65.65	65.08	2.46	0.010778	4.02	44.96	96.12	0.5	1.98	1.34
Sunset Creek	SE 30th	2205.456	25-year	157	63.19	65.84	65.19	2.65	0.01136	4.39	51.41	96.12	0.52	2.17	1.54
Sunset Creek	SE 30th	2205.456	100-year	212	63.19	66.13	65.58	2.94	0.012404	4.97	61.12	96.12	0.55	2.46	1.9
Sunset Creek	SE 30th	2189.813	1.01-year	52.48	63.33	64.84	64.55	1.76	0.009729	2.3	22.76	26.3	0.38	1.1	0.67
Sunset Creek	SE 30th	2189.813	2-year	79	63.33	65.11	64.72	2.03	0.010621	2.77	30.06	27.67	0.41	1.36	0.9
Sunset Creek	SE 30th	2189.813	10-year	126	63.33	65.48	64.99	2.4	0.011004	3.29	41.61	83.85	0.43	1.71	1.17
Sunset Creek	SE 30th	2189.813	25-year	157	63.33	65.69	65.16	2.61	0.010237	3.42	48.81	83.85	0.43	1.91	1.22
Sunset Creek	SE 30th	2189.813	100-year	212	63.33	66	65.5	2.92	0.00956	3.64	59.37	83.85	0.42	2.21	1.32
Sunset Creek	SE 30th	2175.255	1.01-year	52.48	62.85	64.4	64.38	1.55	0.043402	4.65	15.02	25.47	0.74	1.1	2.98
Sunset Creek	SE 30th	2175.255	2-year	79	62.85	64.58	64.58	1.73	0.050518	5.51	19.7	25.88	0.82	1.26	3.98
Sunset Creek	SE 30th	2175.255	10-year	126	62.85	64.88	64.88	2.03	0.053164	6.42	27.34	82.34	0.87	1.53	5.07
Sunset Creek	SE 30th	2175.255	25-year	157	62.85	65.03	65.03	2.18	0.056152	6.98	31.33	86.77	0.91	1.66	5.83
Sunset Creek	SE 30th	2175.255	100-year	212	62.85	65.37	65.28	2.52	0.047632	7.22	40.82	90.25	0.86	1.98	5.88
Sunset Creek	SE 30th	2121.292	1.01-year	52.48	61.77	63.42	63.08	1.65	0.012059	2.87	18.3	23.14	0.57	0.75	0.56
Sunset Creek	SE 30th	2121.292	2-year	79	61.77	63.76	63.31	1.99	0.008338	3.01	26.71	26	0.5	1.05	0.55
Sunset Creek	SE 30th	2121.292	10-year	126	61.77	64.22	63.6	2.45	0.006583	3.35	38.87	26.87	0.47	1.48	0.61
Sunset Creek	SE 30th	2121.292	25-year	157	61.77	64.56	63.75	2.79	0.005203	3.4	48.23	27.53	0.43	1.8	0.59
Sunset Creek	SE 30th	2121.292	100-year	212	61.77	65.18	64	3.41	0.003618	3.41	65.75	28.72	0.38	2.39	0.54
Sunset Creek	SE 30th	2107.746	1.01-year	52.48	61.82	62.85	62.85	1.03	0.029233	5.24	10.02	11.85	1	0.8	1.46
Sunset Creek	SE 30th	2107.746	2-year	79	61.82	63.12	63.12	1.3	0.028792	5.93	13.35	12.76	1	1.02	1.83
Sunset Creek	SE 30th	2107.746	10-year	126	61.82	63.85	63.63	2.03	0.012136	5.22	28.04	24.73	0.69	1.65	1.25
Sunset Creek	SE 30th	2107.746	25-year	157	61.82	64.33	63.84	2.51	0.007265	4.74	40.33	26.36	0.56	2.09	0.95
Sunset Creek	SE 30th	2107.746	100-year	212	61.82	65.04	64.14	3.22	0.004472	4.46	59.71	27.99	0.46	2.75	0.77
Sunset Creek	SE 30th	2098.229	1.01-year	100.32	60.13	62.65	62.12	2.52	0.010475	3.15	32.57	42.26	0.54	0.99	0.65
Sunset Creek	SE 30th	2098.229	2-year	151	60.13	63.04	62.51	2.91	0.007654	3.32	49.35	42.91	0.49	1.36	0.65
Sunset Creek	SE 30th	2098.229	10-year	236	60.13	63.64	62.88	3.51	0.005318	3.49	75.38	43.89	0.43	1.92	0.64
Sunset Creek	SE 30th	2098.229	25-year	297	60.13	64.04	63.06	3.91	0.004469	3.6	92.74	44.54	0.41	2.29	0.64
Sunset Creek	SE 30th	2098.229	100-year	412	60.13	64.71	63.38	4.58	0.003592	3.79	123.02	45.64	0.38	2.92	0.66
Sunset Creek	SE 30th	2070.489	1.01-year	100.32	60.45	62.56	61.73	2.11	0.003482	2.02	49.67	39.18	0.32	1.23	0.27
Sunset Creek	SE 30th	2070.489	2-year	151	60.45	62.98	61.98	2.53	0.003054	2.26	68.63	47.19	0.31	1.62	0.31
Sunset Creek	SE 30th	2070.489	10-year	236	60.45	63.6	62.31	3.15	0.002468	2.51	98.67	48.8	0.29	2.23	0.34
Sunset Creek	SE 30th	2070.489	25-year	297	60.45	64.01	62.49	3.56	0.00222	2.65	118.56	49.83	0.28	2.62	0.36
Sunset Creek	SE 30th	2070.489	100-year	412	60.45	64.69	62.82	4.24	0.001935	2.88	153.29	51.47	0.28	3.29	0.4
Sunset Creek	SE 30th	2050.566	1.01-year	100.32	59.65	62.37	61.97	2.72	0.009256	2.98	33.92	34.24	0.51	0.99	0.57
Sunset Creek	SE 30th	2050.566	2-year	151	59.65	62.82	62.19	3.17	0.006281	3.1	51.85	45.37	0.44	1.4	0.55
Sunset Creek	SE 30th	2050.566	10-year	236	59.65	63.49	62.51	3.84	0.004056	3.18	82.72	47.24	0.38	2.01	0.51
Sunset Creek	SE 30th	2050.566	25-year	297	59.65	63.9	62.75	4.25	0.003383	3.26	102.68	48.41	0.36	2.4	0.51
Sunset Creek	SE 30th	2050.566	100-year	412	59.65	64.6	63.07	4.95	0.002728	3.43	137.18	50.17	0.33	3.04	0.52
Sunset Creek	SE 30th	2036.451	1.01-year	100.32	60.13	62.26	61.72	2.13	0.008428	2.83	38.52	47.32	0.48	1.04	0.55
Sunset Creek	SE 30th	2036.451	2-year	151	60.13	62.77	62.03	2.64	0.004602	2.7	63.41	49	0.37	1.54	0.44
Sunset Creek	SE 30th	2036.451	10-year	236	60.13	63.47	62.39	3.34	0.003026	2.78	98.07	51.26	0.32	2.19	0.41
Sunset Creek	SE 30th	2036.451	25-year	297	60.13	63.89	62.57	3.76	0.002585	2.87	120.11	52.64	0.31	2.6	0.42
Sunset Creek	SE 30th	2036.451	100-year	412	60.13	64.6	62.85	4.47	0.002145	3.05	157.45	52.87	0.29	3.27	0.44
Sunset Creek	SE 30th	2016.641	1.01-year	100.32	59.66	62.2	61.35	2.54	0.003075	2.06	50.21	42.43	0.31	1.32	0.25
Sunset Creek	SE 30th	2016.641	2-year	151	59.66	62.74	61.64	3.08	0.002219	2.18	73.92	45.1	0.28	1.83	0.25
Sunset Creek	SE 30th	2016.641	10-year	236	59.66	63.43	61.94	3.77	0.00181	2.42	106.01	46.8	0.26	2.5	0.28
Sunset Creek	SE 30th	2016.641	25-year	297	59.66	63.86	62.14	4.2	0.001683	2.58	126.14	47.83	0.26	2.9	0.3
Sunset Creek	SE 30th	2016.641	100-year	412	59.66	64.57	62.47	4.91	0.001548	2.84	160.54	49.55	0.26	3.57	0.35

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	1988.07	1.01-year	100.32	59.15	62.15	61.01	3	0.001716	1.9	60.17	42	0.24	1.79	0.19
Sunset Creek	SE 30th	1988.07	2-year	151	59.15	62.69	61.27	3.54	0.001511	2.11	83.51	43.62	0.24	2.3	0.22
Sunset Creek	SE 30th	1988.07	10-year	236	59.15	63.39	61.63	4.24	0.001441	2.43	114.86	45.7	0.24	2.95	0.27
Sunset Creek	SE 30th	1988.07	25-year	297	59.15	63.82	61.84	4.67	0.001424	2.63	134.61	46.96	0.24	3.35	0.3
Sunset Creek	SE 30th	1988.07	100-year	412	59.15	64.53	62.24	5.38	0.001405	2.94	168.55	49.05	0.25	4.01	0.35
Sunset Creek	SE 30th	1968.444	1.01-year	100.32	59.73	62.1	61.04	2.37	0.001844	2.08	57.87	41.14	0.26	1.88	0.22
Sunset Creek	SE 30th	1968.444	2-year	151	59.73	62.65	61.33	2.92	0.001616	2.3	81.33	44.08	0.26	2.41	0.24
Sunset Creek	SE 30th	1968.444	10-year	236	59.73	63.35	61.71	3.62	0.001517	2.63	112.72	45.23	0.26	3.1	0.29
Sunset Creek	SE 30th	1968.444	25-year	297	59.73	63.78	61.92	4.05	0.001501	2.84	132.2	46.26	0.26	3.51	0.33
Sunset Creek	SE 30th	1968.444	100-year	412	59.73	64.48	62.27	4.75	0.001487	3.19	165.42	47.96	0.27	4.2	0.39
Sunset Creek	SE 30th	1954.61	1.01-year	100.32	59.63	61.99	61.33	2.36	0.008212	3.06	43.17	38.25	0.38	1.89	0.97
Sunset Creek	SE 30th	1954.61	2-year	151	59.63	62.57	61.66	2.94	0.005902	3.07	67.43	43.67	0.33	2.43	0.9
Sunset Creek	SE 30th	1954.61	10-year	236	59.63	63.29	62.03	3.66	0.00473	3.23	99.74	45.74	0.31	3.1	0.92
Sunset Creek	SE 30th	1954.61	25-year	297	59.63	63.73	62.3	4.1	0.004372	3.37	119.83	46.98	0.31	3.51	0.96
Sunset Creek	SE 30th	1954.61	100-year	412	59.63	64.44	62.62	4.81	0.003986	3.61	154.17	49.03	0.3	4.17	1.04
Sunset Creek	SE 30th	1928.749	1.01-year	100.32	59.16	61.96	60.54	2.8	0.001812	1.53	68.09	38.44	0.19	2.04	0.23
Sunset Creek	SE 30th	1928.749	2-year	151	59.16	62.54	60.77	3.38	0.001734	1.77	91.52	42.78	0.19	2.61	0.28
Sunset Creek	SE 30th	1928.749	10-year	236	59.16	63.26	61.1	4.1	0.001786	2.11	122.71	43.96	0.2	3.32	0.37
Sunset Creek	SE 30th	1928.749	25-year	297	59.16	63.69	61.31	4.53	0.001837	2.32	141.81	44.64	0.21	3.74	0.43
Sunset Creek	SE 30th	1928.749	100-year	412	59.16	64.4	61.66	5.24	0.001915	2.65	173.95	45.74	0.22	4.44	0.53
Sunset Creek	SE 30th	1881.347	1.01-year	100.32	58.45	61.71	60.37	3.26	0.005655	3.04	36.16	22.84	0.34	2.28	0.81
Sunset Creek	SE 30th	1881.347	2-year	151	58.45	62.25	60.8	3.8	0.006073	3.59	50.66	36.83	0.36	2.77	1.05
Sunset Creek	SE 30th	1881.347	10-year	236	58.45	62.96	61.48	4.51	0.005834	4.04	78.11	39.28	0.37	3.4	1.24
Sunset Creek	SE 30th	1881.347	25-year	297	58.45	63.39	61.9	4.94	0.005589	4.25	95.35	40.41	0.36	3.79	1.32
Sunset Creek	SE 30th	1881.347	100-year	412	58.45	64.1	62.64	5.65	0.005316	4.6	124.4	40.94	0.36	4.43	1.47
Sunset Creek	SE 30th	1868.66	1.01-year	100.32	59.05	61.67	60.65	2.62	0.004449	2.64	45.34	33.4	0.33	1.96	0.54
Sunset Creek	SE 30th	1868.66	2-year	151	59.05	62.24	61.01	3.19	0.003885	2.91	64.72	35.17	0.32	2.5	0.61
Sunset Creek	SE 30th	1868.66	10-year	236	59.05	62.95	61.52	3.9	0.003739	3.35	90.37	36.56	0.32	3.17	0.74
Sunset Creek	SE 30th	1868.66	25-year	297	59.05	63.38	61.76	4.33	0.003734	3.63	105.99	36.56	0.33	3.58	0.84
Sunset Creek	SE 30th	1868.66	100-year	412	59.05	64.07	62.15	5.02	0.003805	4.1	131.53	36.56	0.34	4.25	1.01
Sunset Creek	SE 30th	1856.084	1.01-year	100.32	58.51	61.54	60.64	3.03	0.009194	3.18	36.92	28.3	0.39	1.96	1.13
Sunset Creek	SE 30th	1856.084	2-year	151	58.51	62.12	61.06	3.61	0.007785	3.44	53.97	30.95	0.37	2.51	1.22
Sunset Creek	SE 30th	1856.084	10-year	236	58.51	62.83	61.6	4.32	0.007328	3.91	77.03	34.26	0.38	3.18	1.45
Sunset Creek	SE 30th	1856.084	25-year	297	58.51	63.25	61.86	4.74	0.007228	4.21	92.07	36.27	0.38	3.58	1.62
Sunset Creek	SE 30th	1856.084	100-year	412	58.51	63.96	62.31	5.45	0.00691	4.61	117.72	36.27	0.38	4.25	1.83
Sunset Creek	SE 30th	1817.494	1.01-year	100.32	58.15	61.26	59.86	3.11	0.004924	3.33	30.99	17.77	0.36	2.1	0.65
Sunset Creek	SE 30th	1817.494	2-year	151	58.15	61.77	60.34	3.62	0.005847	4.07	41.58	23.46	0.41	2.5	0.91
Sunset Creek	SE 30th	1817.494	10-year	236	58.15	62.37	61.03	4.22	0.00705	5.03	56.84	25.61	0.46	2.98	1.31
Sunset Creek	SE 30th	1817.494	25-year	297	58.15	62.73	61.59	4.58	0.007687	5.58	66.11	25.61	0.49	3.27	1.57
Sunset Creek	SE 30th	1817.494	100-year	412	58.15	63.33	62.25	5.18	0.008613	6.47	81.33	25.61	0.53	3.75	2.01
Sunset Creek	SE 30th	1805.019	1.01-year	100.32	58.22	61.22	59.92	3	0.004481	3.25	37.73	28.54	0.36	2.11	0.59
Sunset Creek	SE 30th	1805.019	2-year	151	58.22	61.74	60.37	3.52	0.004649	3.74	53.63	32.01	0.37	2.54	0.74
Sunset Creek	SE 30th	1805.019	10-year	236	58.22	62.39	61.23	4.17	0.004871	4.34	76.07	53.24	0.39	3.06	0.93
Sunset Creek	SE 30th	1805.019	25-year	297	58.22	62.78	61.56	4.56	0.00479	4.6	92.15	60.85	0.4	3.38	1.01
Sunset Creek	SE 30th	1805.019	100-year	412	58.22	63.46	62.1	5.24	0.004327	4.84	122.76	67.33	0.39	3.94	1.06
Sunset Creek	SE 30th	1791.536	1.01-year	100.32	58.58	61.12	60.26	2.54	0.005998	3.49	32.84	26.2	0.43	1.87	0.7
Sunset Creek	SE 30th	1791.536	2-year	151	58.58	61.65	60.74	3.07	0.005534	3.91	47.64	28.57	0.43	2.35	0.81
Sunset Creek	SE 30th	1791.536	10-year	236	58.58	62.25	61.28	3.67	0.005915	4.65	64.98	28.57	0.46	2.91	1.07
Sunset Creek	SE 30th	1791.536	25-year	297	58.58	62.61	61.59	4.03	0.006259	5.14	75.08	28.57	0.48	3.23	1.26
Sunset Creek	SE 30th	1791.536	100-year	412	58.58	63.18	62.03	4.6	0.006856	5.94	91.41	28.57	0.52	3.76	1.61
Sunset Creek	SE 30th	1777.213	1.01-year	100.32	58.04	61.1	59.79	3.06	0.00334	2.79	43.51	29.94	0.32	2.13	0.44
Sunset Creek	SE 30th	1777.213	2-year	151	58.04	61.64	60.25	3.6	0.003268	3.15	60.86	60.16	0.32	2.6	0.53
Sunset Creek	SE 30th	1777.213	10-year	236	58.04	62.27	60.89	4.23	0.003557	3.74	83.05	66.33	0.35	3.14	0.7
Sunset Creek	SE 30th	1777.213	25-year	297	58.04	62.64	61.24	4.6	0.003738	4.09	96.39	66.54	0.36	3.47	0.81
Sunset Creek	SE 30th	1777.213	100-year	412	58.04	63.24	61.67	5.2	0.004003	4.65	118.39	66.89	0.38	3.99	1
Sunset Creek	SE 30th	1749.718	1.01-year	100.32	57.73	60.91	59.77	3.18	0.005586	3.47	33.31	20.49	0.39	2.1	0.73
Sunset Creek	SE 30th	1749.718	2-year	151	57.73	61.39	60.31	3.66	0.006433	4.19	44.81	47.1	0.43	2.51	1.01
Sunset Creek	SE 30th	1749.718	10-year	236	57.73	61.91	60.9	4.18	0.008186	5.27	60.57	63.78	0.5	2.96	1.51
Sunset Creek	SE 30th	1749.718	25-year	297	57.73	62.21	61.31	4.48	0.009052	5.87	70.54	64.03	0.54	3.22	1.82
Sunset Creek	SE 30th	1749.718	100-year	412	57.73	62.72	61.95	4.99	0.010215	6.79	87.2	64.43	0.58	3.66	2.34
Sunset Creek	SE 30th	1689.563	1.01-year	100.32	57.21	60.02	59.59	2.81	0.020876	5.42	18.92	17.83	0.7	1.56	2.03
Sunset Creek	SE 30th	1689.563	2-year	151	57.21	60.43	60.37	3.22	0.020473	6.14	29.13	26.36	0.72	1.9	2.43
Sunset Creek	SE 30th	1689.563	10-year	236	57.21	61.02	60.84	3.81	0.016972	6.53	45.24	28.17	0.68	2.4	2.55
Sunset Creek	SE 30th	1689.563	25-year	297	57.21	61.38	61.07	4.17	0.015528	6.76	55.52	29.26	0.67	2.71	2.62
Sunset Creek	SE 30th	1689.563	100-year	412	57.21	61.97	61.51	4.76	0.013881	7.16	73.28	43.57	0.65	3.2	2.78
Sunset Creek	SE 30th	1668.393	1.01-year	100.32	56.93	59.91	59.04	2.98	0.008146	4.05	28.94	25.06	0.47	1.94	0.99
Sunset Creek	SE 30th	1668.393	2-year	151	56.93	60.35	59.81	3.42	0.008396	4.62	40.03	26.29	0.5	2.31	1.21
Sunset Creek	SE 30th	1668.393	10-year	236	56.93	60.91	60.31	3.98	0.008645	5.32	55.37	27.91	0.52	2.79	1.51
Sunset Creek	SE 30th	1668.393	25-year	297	56.93	61.26	60.56	4.33	0.008706	5.71	65.25	28.9	0.53	3.09	1.68
Sunset Creek	SE 30th	1668.393	100-year	412	56.93	61.84	61.01	4.91	0.008713	6.31	82.48	30.55	0.54	3.58	1.95

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	1626.318	1.01-year	100.32	56.89	59.64	58.71	2.75	0.006398	3.64	31.21	23.61	0.43	1.9	0.76
Sunset Creek	SE 30th	1626.318	2-year	151	56.89	60.03	59.27	3.14	0.007479	4.38	40.51	24.76	0.48	2.23	1.04
Sunset Creek	SE 30th	1626.318	10-year	236	56.89	60.51	59.87	3.62	0.009048	5.39	52.72	26.21	0.54	2.65	1.49
Sunset Creek	SE 30th	1626.318	25-year	297	56.89	60.8	60.15	3.91	0.009898	5.99	60.41	27.07	0.58	2.9	1.79
Sunset Creek	SE 30th	1626.318	100-year	412	56.89	61.3	60.62	4.41	0.010777	6.86	74.37	28.58	0.62	3.33	2.24
Sunset Creek	SE 30th	1613.357	1.01-year	100.32	56.46	59.63	58.27	3.17	0.003357	2.9	37.14	23.32	0.33	2.08	0.44
Sunset Creek	SE 30th	1613.357	2-year	151	56.46	60	58.69	3.54	0.004389	3.65	46.19	24.85	0.39	2.4	0.66
Sunset Creek	SE 30th	1613.357	10-year	236	56.46	60.47	59.4	4.01	0.0059	4.69	58.04	26.32	0.46	2.8	1.03
Sunset Creek	SE 30th	1613.357	25-year	297	56.46	60.74	59.77	4.28	0.006805	5.32	65.4	27.19	0.5	3.03	1.29
Sunset Creek	SE 30th	1613.357	100-year	412	56.46	61.23	60.29	4.77	0.00793	6.25	78.89	28.73	0.55	3.45	1.71
Sunset Creek	SE 30th	1592.728	1.01-year	100.32	56.02	59.65	57.91	3.63	0.001149	1.69	62.89	33.09	0.19	2.23	0.16
Sunset Creek	SE 30th	1592.728	2-year	151	56.02	60.04	58.23	4.02	0.001518	2.15	75.99	33.8	0.23	2.6	0.25
Sunset Creek	SE 30th	1592.728	10-year	236	56.02	60.54	58.66	4.52	0.002077	2.81	92.89	34.71	0.28	3.07	0.4
Sunset Creek	SE 30th	1592.728	25-year	297	56.02	60.83	58.92	4.81	0.00242	3.22	103.26	35.25	0.3	3.35	0.51
Sunset Creek	SE 30th	1592.728	100-year	412	56.02	61.35	59.38	5.33	0.002877	3.85	121.91	36.21	0.34	3.85	0.69
Sunset Creek	SE 30th	1583.59	1.01-year	100.32	56.87	59.48	58.8	2.61	0.008049	3.48	32.65	32.1	0.47	1.59	0.8
Sunset Creek	SE 30th	1583.59	2-year	151	56.87	59.81	59.2	2.94	0.00914	4.19	43.62	33.2	0.52	1.91	1.09
Sunset Creek	SE 30th	1583.59	10-year	236	56.87	60.21	59.7	3.34	0.011291	5.25	56.96	34.5	0.6	2.28	1.61
Sunset Creek	SE 30th	1583.59	25-year	297	56.87	60.43	59.97	3.56	0.012715	5.91	64.84	35.25	0.64	2.5	1.98
Sunset Creek	SE 30th	1583.59	100-year	412	56.87	60.87	60.38	4	0.013713	6.8	80.49	36.69	0.68	2.91	2.49
Sunset Creek	SE 30th	1583.5		Lat Struct											
Sunset Creek	SE 30th	1576.451	1.01-year	100.32	56.81	59.39	58.71	2.58	0.01288	3.58	28.97	25.93	0.53	1.27	1.02
Sunset Creek	SE 30th	1576.451	2-year	151	56.81	59.69	59.18	2.88	0.015583	4.33	37.2	28.01	0.6	1.47	1.43
Sunset Creek	SE 30th	1576.451	10-year	236	56.81	60.02	59.67	3.21	0.020105	5.52	46.94	31.92	0.7	1.76	2.2
Sunset Creek	SE 30th	1576.451	25-year	297	56.81	60.17	59.92	3.36	0.024449	6.39	51.81	33.88	0.78	1.89	2.89
Sunset Creek	SE 30th	1576.451	100-year	412	56.81	60.36	60.36	3.55	0.034449	8.04	58.39	36.3	0.94	2.06	4.43
Sunset Creek	SE 30th	1535.154	1.01-year	85.27	56.74	58.88	58.13	2.14	0.005952	2.09	44.51	64.82	0.32	1.3	0.48
Sunset Creek	SE 30th	1535.154	2-year	128.35	56.74	59.18	58.35	2.44	0.006312	2.43	65.06	75.59	0.34	1.55	0.61
Sunset Creek	SE 30th	1535.154	10-year	200.6	56.74	59.54	58.67	2.8	0.006603	2.81	96.09	107.2	0.36	1.86	0.77
Sunset Creek	SE 30th	1535.154	25-year	252.45	56.74	59.75	58.95	3.01	0.006459	2.98	118.93	107.2	0.36	2.06	0.83
Sunset Creek	SE 30th	1535.154	100-year	350.2	56.74	60.09	59.26	3.35	0.006347	3.26	155.06	107.2	0.37	2.39	0.95
Sunset Creek	SE 30th	1520.645	1.01-year	85.27	56.07	58.86	57.6	2.79	0.001622	1.56	72.98	107.62	0.21	1.52	0.15
Sunset Creek	SE 30th	1520.645	2-year	128.35	56.07	59.16	57.84	3.09	0.001767	1.81	105.43	109.75	0.23	1.79	0.2
Sunset Creek	SE 30th	1520.645	10-year	200.6	56.07	59.52	58.19	3.45	0.00202	2.16	144.8	109.75	0.25	2.11	0.27
Sunset Creek	SE 30th	1520.645	25-year	252.45	56.07	59.73	58.4	3.66	0.002178	2.38	167.84	109.75	0.26	2.3	0.31
Sunset Creek	SE 30th	1520.645	100-year	350.2	56.07	60.06	58.97	3.99	0.002455	2.74	204.17	109.75	0.28	2.6	0.4
Sunset Creek	SE 30th	1493.465	1.01-year	85.27	56.01	58.7	57.64	2.69	0.004145	2.89	40.53	62.58	0.35	1.9	0.49
Sunset Creek	SE 30th	1493.465	2-year	128.35	56.01	58.95	58.02	2.94	0.005351	3.54	61.32	88.29	0.41	2.12	0.71
Sunset Creek	SE 30th	1493.465	10-year	200.6	56.01	59.27	58.92	3.26	0.006281	4.18	89.8	88.29	0.45	2.42	0.95
Sunset Creek	SE 30th	1493.465	25-year	252.45	56.01	59.46	59.1	3.45	0.006746	4.54	106.66	88.29	0.47	2.59	1.09
Sunset Creek	SE 30th	1493.465	100-year	350.2	56.01	59.76	59.35	3.75	0.007605	5.14	132.59	88.29	0.51	2.86	1.36
Sunset Creek	SE 30th	1474.062	1.01-year	85.27	56.81	58.67	58.2	1.86	0.003919	2.28	70.18	110.27	0.33	1.37	0.33
Sunset Creek	SE 30th	1474.062	2-year	128.35	56.81	58.94	58.39	2.13	0.003902	2.54	99.13	110.27	0.34	1.61	0.39
Sunset Creek	SE 30th	1474.062	10-year	200.6	56.81	59.27	58.59	2.46	0.004071	2.92	135.6	110.27	0.36	1.92	0.49
Sunset Creek	SE 30th	1474.062	25-year	252.45	56.81	59.46	58.74	2.65	0.004232	3.16	156.98	110.27	0.37	2.1	0.55
Sunset Creek	SE 30th	1474.062	100-year	350.2	56.81	59.76	58.94	2.95	0.004639	3.59	189.85	110.27	0.4	2.38	0.69
Sunset Creek	SE 30th	1400.25	1.01-year	85.27	56.09	57.96	57.61	1.87	0.014145	4.19	31.41	78.66	0.61	1.34	1.19
Sunset Creek	SE 30th	1400.25	2-year	128.35	56.09	58.15	58.15	2.06	0.016614	4.89	46.97	83.59	0.67	1.51	1.57
Sunset Creek	SE 30th	1400.25	10-year	200.6	56.09	58.38	58.38	2.29	0.019637	5.79	65.88	83.59	0.74	1.71	2.1
Sunset Creek	SE 30th	1400.25	25-year	252.45	56.09	58.52	58.52	2.43	0.02105	6.28	77.39	83.59	0.78	1.84	2.42
Sunset Creek	SE 30th	1400.25	100-year	350.2	56.09	58.85	58.73	2.76	0.018143	6.45	105.04	83.59	0.74	2.14	2.42
Sunset Creek	SE 30th	1312.582	1.01-year	85.27	54.16	56.24	55.93	2.08	0.0213	5.36	15.98	11.67	0.75	1.36	1.81
Sunset Creek	SE 30th	1312.582	2-year	128.35	54.16	56.73	56.72	2.57	0.013865	5.05	46.93	86.52	0.62	1.73	1.5
Sunset Creek	SE 30th	1312.582	10-year	200.6	54.16	57.34	56.99	3.18	0.006623	4.16	100.75	87.46	0.45	2.25	0.93
Sunset Creek	SE 30th	1312.582	25-year	252.45	54.16	57.8	57.13	3.64	0.004257	3.71	140.95	87.46	0.37	2.64	0.7
Sunset Creek	SE 30th	1312.582	100-year	350.2	54.16	58.59	57.35	4.43	0.002582	3.35	209.85	87.46	0.3	3.31	0.53
Sunset Creek	SE 30th	1208.49	1.01-year	85.27	51.7	54.69	53.8	2.99	0.011975	4.59	18.56	8.69	0.55	1.56	1.17
Sunset Creek	SE 30th	1208.49	2-year	128.35	51.7	55.76	54.36	4.06	0.007418	3.96	43.63	47.17	0.45	1.82	0.84
Sunset Creek	SE 30th	1208.49	10-year	200.6	51.7	56.96	55.65	5.26	0.002698	3.01	107.59	54.66	0.29	2.6	0.44
Sunset Creek	SE 30th	1208.49	25-year	252.45	51.7	57.5	55.97	5.8	0.002206	3.01	137.02	54.66	0.27	3.02	0.42
Sunset Creek	SE 30th	1208.49	100-year	350.2	51.7	58.34	56.34	6.64	0.001853	3.15	183.05	54.66	0.26	3.67	0.42
Sunset Creek	SE 30th	1177.949	1.01-year	100.55	51.42	54.73	53.05	3.31	0.001847	2.77	36.25	13.04	0.29	2.11	0.24
Sunset Creek	SE 30th	1177.949	2-year	151.35	51.42	55.49	53.47	4.07	0.001659	3.06	67.13	50.14	0.29	2.67	0.28
Sunset Creek	SE 30th	1177.949	10-year	236.6	51.42	56.27	54.07	4.85	0.001625	3.46	106.13	50.15	0.29	3.26	0.33
Sunset Creek	SE 30th	1177.949	25-year	297.45	51.42	56.72	54.46	5.3	0.001634	3.7	128.59	50.15	0.3	3.6	0.37
Sunset Creek	SE 30th	1177.949	100-year	413.2	51.42	57.46	55.54	6.04	0.001653	4.1	165.82	50.15	0.31	4.16	0.43
Sunset Creek	SE 30th	1012.233	1.01-year	100.55	49.75	53.92	52.37	4.17	0.012251	4.21	23.87	7.7	0.42	1.6	1.23
Sunset Creek	SE 30th	1012.233	2-year	151.35	49.75	54.61	53	4.86	0.014792	4.99	32.94	19.55	0.46	1.82	1.68
Sunset Creek	SE 30th	1012.233	10-year	236.6	49.75	55.32	53.89	5.57	0.015391	5.74	47.5	21.31	0.49	2.18	2.09
Sunset Creek	SE 30th	1012.233	25-year	297.45	49.75	55.73	54.97	5.98	0.015626	6.14	56.34	22.3	0.5	2.38	2.32
Sunset Creek	SE 30th	1012.233	100-year	413.2	49.75	56.4	55.54	6.65	0.015675	6.72	72.28	25.48	0.51	2.72	2.66

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	852.3866	1.01-year	100.55	50.09	52.62	51.63	2.53	0.006318	3.4	29.59	14.77	0.42	1.78	0.7
Sunset Creek	SE 30th	852.3866	2-year	151.35	50.09	53.16	52.04	3.07	0.00678	3.98	39.22	20.86	0.45	2.16	0.91
Sunset Creek	SE 30th	852.3866	10-year	236.6	50.09	54.19	52.6	4.1	0.004971	4.03	66.57	32.49	0.39	2.84	0.88
Sunset Creek	SE 30th	852.3866	25-year	297.45	50.09	54.65	53	4.56	0.004727	4.18	81.9	33.02	0.39	3.14	0.93
Sunset Creek	SE 30th	852.3866	100-year	413.2	50.09	55.42	53.69	5.33	0.004455	4.42	107.51	33.91	0.38	3.61	1
Sunset Creek	SE 30th	834.4796	1.01-year	100.55	50.42	52.35	52.05	1.93	0.01469	4.18	24.06	20.51	0.68	1.14	1.04
Sunset Creek	SE 30th	834.4796	2-year	151.35	50.42	53.04	52.37	2.62	0.007447	3.91	39.73	25.09	0.51	1.75	0.81
Sunset Creek	SE 30th	834.4796	10-year	236.6	50.42	54.14	52.8	3.72	0.003764	3.62	71.26	32.4	0.38	2.65	0.62
Sunset Creek	SE 30th	834.4796	25-year	297.45	50.42	54.61	53.07	4.19	0.003505	3.79	86.83	33.42	0.37	3.02	0.66
Sunset Creek	SE 30th	834.4796	100-year	413.2	50.42	55.37	53.54	4.95	0.003281	4.09	112.53	33.91	0.36	3.6	0.74
Sunset Creek	SE 30th	816.2844	1.01-year	100.55	50.18	52.24	51.75	2.06	0.008119	3.12	32.26	26.81	0.5	1.17	0.59
Sunset Creek	SE 30th	816.2844	2-year	151.35	50.18	53.02	52.01	2.84	0.004056	2.78	54.43	30.02	0.36	1.73	0.44
Sunset Creek	SE 30th	816.2844	10-year	236.6	50.18	54.15	52.38	3.97	0.002	2.58	96.79	43.1	0.27	2.69	0.34
Sunset Creek	SE 30th	816.2844	25-year	297.45	50.18	54.63	52.61	4.45	0.001856	2.72	117.38	43.46	0.26	3.08	0.36
Sunset Creek	SE 30th	816.2844	100-year	413.2	50.18	55.4	53	5.22	0.001737	2.95	151.26	44.04	0.26	3.71	0.4
Sunset Creek	SE 30th	795.8286	1.01-year	100.55	50.27	52.19	51.34	1.92	0.00315	2.32	44.91	31.92	0.32	1.49	0.29
Sunset Creek	SE 30th	795.8286	2-year	151.35	50.27	53	51.59	2.73	0.001784	2.23	72.03	35.08	0.26	2.18	0.24
Sunset Creek	SE 30th	795.8286	10-year	236.6	50.27	54.14	51.96	3.87	0.001152	2.25	114.08	37.65	0.21	3.11	0.22
Sunset Creek	SE 30th	795.8286	25-year	297.45	50.27	54.62	52.18	4.35	0.001187	2.44	131.93	37.82	0.22	3.47	0.26
Sunset Creek	SE 30th	795.8286	100-year	413.2	50.27	55.38	52.55	5.11	0.001271	2.78	161.13	38.09	0.23	4.05	0.32
Sunset Creek	SE 30th	772.6812	1.01-year	100.55	49.8	52.11	51.34	2.31	0.00363	2.31	43.79	31.6	0.34	1.35	0.31
Sunset Creek	SE 30th	772.6812	2-year	151.35	49.8	52.96	51.57	3.16	0.001804	2.16	72.62	36.28	0.25	2.08	0.23
Sunset Creek	SE 30th	772.6812	10-year	236.6	49.8	54.12	51.89	4.32	0.001109	2.15	115.02	45.55	0.21	3.03	0.21
Sunset Creek	SE 30th	772.6812	25-year	297.45	49.8	54.59	52.11	4.79	0.001113	2.35	132.48	46.93	0.21	3.44	0.24
Sunset Creek	SE 30th	772.6812	100-year	413.2	49.8	55.36	52.47	5.56	0.001142	2.68	160.86	49.35	0.22	4.13	0.29
Sunset Creek	SE 30th	742.021	1.01-year	100.55	49.76	52.02	51.21	2.26	0.003164	2.1	47.78	33.86	0.31	1.33	0.26
Sunset Creek	SE 30th	742.021	2-year	151.35	49.76	52.92	51.43	3.16	0.001523	1.91	79.33	41.34	0.23	2.05	0.19
Sunset Creek	SE 30th	742.021	10-year	236.6	49.76	54.1	51.73	4.34	0.000905	1.94	122.07	51.49	0.19	3.11	0.18
Sunset Creek	SE 30th	742.021	25-year	297.45	49.76	54.57	51.93	4.81	0.000921	2.14	139.3	53.01	0.19	3.55	0.2
Sunset Creek	SE 30th	742.021	100-year	413.2	49.76	55.34	52.27	5.58	0.000966	2.47	167.27	53.01	0.2	4.27	0.26
Sunset Creek	SE 30th	704.0906		Bridge											
Sunset Creek	SE 30th	637.1669	1.01-year	100.55	49	51.91	50.27	2.91	0.000848	1.45	70.2	47.21	0.17	2.09	0.11
Sunset Creek	SE 30th	637.1669	2-year	151.35	49	52.51	50.53	3.51	0.000908	1.72	88.85	47.46	0.18	2.59	0.15
Sunset Creek	SE 30th	637.1669	10-year	236.6	49	53.12	50.86	4.12	0.001179	2.21	108.51	50.82	0.21	3.12	0.23
Sunset Creek	SE 30th	637.1669	25-year	297.45	49	53.46	51.05	4.46	0.001351	2.52	121.12	55.09	0.23	3.42	0.29
Sunset Creek	SE 30th	637.1669	100-year	413.2	49	54.01	51.41	5.01	0.001627	3.02	142.47	55.09	0.26	3.92	0.4
Sunset Creek	SE 30th	616.5581	1.01-year	100.55	48.88	51.91	49.89	3.03	0.000323	1.03	110.99	63.74	0.11	2.53	0.05
Sunset Creek	SE 30th	616.5581	2-year	151.35	48.88	52.51	50.12	3.63	0.00037	1.24	138.24	68.09	0.12	3.03	0.07
Sunset Creek	SE 30th	616.5581	10-year	236.6	48.88	53.13	50.44	4.25	0.000508	1.6	166.47	68.5	0.14	3.53	0.11
Sunset Creek	SE 30th	616.5581	25-year	297.45	48.88	53.48	50.61	4.6	0.000595	1.83	182.93	71.65	0.16	3.84	0.14
Sunset Creek	SE 30th	616.5581	100-year	413.2	48.88	54.04	50.91	5.16	0.000742	2.22	211.02	73.22	0.18	4.35	0.2
Sunset Creek	SE 30th	596.5916	1.01-year	100.55	48.52	51.89	49.66	3.37	0.000467	1.22	86.58	39.79	0.13	2.65	0.08
Sunset Creek	SE 30th	596.5916	2-year	151.35	48.52	52.49	49.91	3.97	0.000583	1.52	105.26	41.8	0.14	3.12	0.11
Sunset Creek	SE 30th	596.5916	10-year	236.6	48.52	53.09	50.27	4.57	0.000843	2.01	124.53	43.09	0.18	3.62	0.19
Sunset Creek	SE 30th	596.5916	25-year	297.45	48.52	53.42	50.49	4.9	0.001019	2.33	135.73	44.4	0.2	3.92	0.25
Sunset Creek	SE 30th	596.5916	100-year	413.2	48.52	53.95	50.89	5.43	0.001329	2.88	154.47	46.49	0.23	4.39	0.36
Sunset Creek	SE 30th	572.9708	1.01-year	100.55	47.8	51.79	50.11	3.99	0.007538	2.48	40.59	22.01	0.31	1.85	0.87
Sunset Creek	SE 30th	572.9708	2-year	151.35	47.8	52.36	50.59	4.56	0.007033	2.83	57.4	34.91	0.31	2.37	1.04
Sunset Creek	SE 30th	572.9708	10-year	236.6	47.8	52.92	51.28	5.12	0.007889	3.42	77.89	37.52	0.34	2.89	1.42
Sunset Creek	SE 30th	572.9708	25-year	297.45	47.8	53.24	51.64	5.44	0.008498	3.78	89.82	38.6	0.36	3.18	1.69
Sunset Creek	SE 30th	572.9708	100-year	413.2	47.8	53.73	52.3	5.93	0.009453	4.37	109.03	38.6	0.39	3.64	2.15
Sunset Creek	SE 30th	554.7107	1.01-year	100.55	47.62	51.53	49.85	3.91	0.008664	3.51	29.65	16.97	0.36	2.05	1.11
Sunset Creek	SE 30th	554.7107	2-year	151.35	47.62	52.02	50.4	4.4	0.010876	4.35	43.97	52.7	0.41	2.38	1.62
Sunset Creek	SE 30th	554.7107	10-year	236.6	47.62	52.65	51.17	5.03	0.009955	4.65	78.01	55.51	0.4	2.81	1.75
Sunset Creek	SE 30th	554.7107	25-year	297.45	47.62	53.01	52.36	5.39	0.009395	4.77	98.04	57.1	0.4	3.05	1.79
Sunset Creek	SE 30th	554.7107	100-year	413.2	47.62	53.57	52.75	5.95	0.008626	4.95	134.54	116.88	0.39	3.44	1.85
Sunset Creek	SE 30th	543.1325	1.01-year	100.55	47.65	51.52	49.72	3.87	0.003274	2.92	35.23	50.97	0.3	2.2	0.45
Sunset Creek	SE 30th	543.1325	2-year	151.35	47.65	52.04	50.19	4.39	0.003644	3.37	63.54	55.1	0.32	2.55	0.58
Sunset Creek	SE 30th	543.1325	10-year	236.6	47.65	52.64	50.87	4.99	0.003872	3.88	98.61	117.31	0.34	3	0.73
Sunset Creek	SE 30th	543.1325	25-year	297.45	47.65	52.98	51.29	5.33	0.003881	4.1	121.75	117.31	0.35	3.26	0.79
Sunset Creek	SE 30th	543.1325	100-year	413.2	47.65	53.53	52.3	5.88	0.003888	4.45	158.79	117.31	0.36	3.68	0.89
Sunset Creek	SE 30th	529.8341	1.01-year	100.55	47.8	51.47	49.72	3.67	0.003859	2.94	34.89	19.26	0.31	2.17	0.52
Sunset Creek	SE 30th	529.8341	2-year	151.35	47.8	51.99	50.2	4.19	0.004265	3.39	59.3	104.45	0.33	2.5	0.67
Sunset Creek	SE 30th	529.8341	10-year	236.6	47.8	52.59	50.88	4.79	0.004205	3.77	94.29	110.85	0.34	2.97	0.78
Sunset Creek	SE 30th	529.8341	25-year	297.45	47.8	52.94	51.3	5.14	0.004211	3.99	115.69	114.45	0.34	3.24	0.85
Sunset Creek	SE 30th	529.8341	100-year	413.2	47.8	53.48	52.33	5.68	0.004245	4.35	152.44	120.21	0.35	3.66	0.97
Sunset Creek	SE 30th	420.6496	1.01-year	100.55	47.11	51.29	48.76	4.18	0.001295	1.95	52.9	25.45	0.19	2.57	0.21
Sunset Creek	SE 30th	420.6496	2-year	151.35	47.11	51.75	49.16	4.64	0.001814	2.47	75.05	54.14	0.23	2.87	0.32
Sunset Creek	SE 30th	420.6496	10-year	236.6	47.11	52.3	49.73	5.19	0.002274	3.04	110.85	118.2	0.26	3.31	0.47
Sunset Creek	SE 30th	420.6496	25-year	297.45	47.11	52.62	50.1	5.51	0.002461	3.33	132.78	118.2	0.28	3.56	0.55
Sunset Creek	SE 30th	420.6496	100-year	413.2	47.11	53.14	50.75	6.03	0.002707	3.75	168.33	118.2	0.3	3.97	0.67

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	48.9477	1.01-year	100.55	47.18	50.65	49.5	3.47	0.002442	2.13	71.26	131.31	0.26	1.84	0.28
Sunset Creek	SE 30th	48.9477	2-year	151.35	47.18	50.98	49.88	3.8	0.002464	2.37	98.48	131.31	0.27	2.15	0.33
Sunset Creek	SE 30th	48.9477	10-year	236.6	47.18	51.5	50.55	4.32	0.002216	2.56	140.71	131.31	0.27	2.62	0.36
Sunset Creek	SE 30th	48.9477	25-year	297.45	47.18	51.8	50.7	4.62	0.002179	2.72	165.11	131.31	0.27	2.9	0.39
Sunset Creek	SE 30th	48.9477	100-year	413.2	47.18	52.3	50.92	5.12	0.00215	2.98	205.72	131.31	0.27	3.36	0.45
Richards Creek	Historical	1507.208	1.01-year	15.05	57.05	58.62	57.65	1.57	0.002703	0.91	16.56	17.45	0.16	0.89	0.15
Richards Creek	Historical	1507.208	2-year	22.65	57.05	58.81	57.8	1.76	0.003796	1.13	20.06	19	0.19	0.98	0.23
Richards Creek	Historical	1507.208	10-year	35.4	57.05	59.03	58	1.98	0.005265	1.45	24.62	23.46	0.23	1.14	0.37
Richards Creek	Historical	1507.208	25-year	44.55	57.05	59.13	58.13	2.08	0.006525	1.69	27.09	26.94	0.26	1.21	0.49
Richards Creek	Historical	1507.208	100-year	61.8	57.05	59.27	58.31	2.22	0.00875	2.09	31.13	30.61	0.31	1.34	0.73
Richards Creek	Historical	1481.097	1.01-year	15.05	57.41	58.45	58.08	1.04	0.012687	1.84	10.58	30.74	0.37	0.74	0.58
Richards Creek	Historical	1481.097	2-year	22.65	57.41	58.65	58.32	1.24	0.009489	1.77	20.33	70.02	0.32	0.88	0.52
Richards Creek	Historical	1481.097	10-year	35.4	57.41	58.91	58.51	1.5	0.005139	1.48	44.41	115.25	0.24	1.09	0.35
Richards Creek	Historical	1481.097	25-year	44.55	57.41	59	58.61	1.59	0.004818	1.51	56.33	131.14	0.24	1.18	0.36
Richards Creek	Historical	1481.097	100-year	61.8	57.41	59.14	58.72	1.73	0.004481	1.57	76.03	145.39	0.24	1.32	0.37
Richards Creek	Historical	1291.987	1.01-year	15.05	55.48	56.38	56.05	0.9	0.009455	1.94	7.75	12.07	0.43	0.63	0.37
Richards Creek	Historical	1291.987	2-year	22.65	55.48	56.5	56.19	1.02	0.012864	2.44	9.29	12.84	0.5	0.71	0.57
Richards Creek	Historical	1291.987	10-year	35.4	55.48	56.41	56.38	0.93	0.046361	4.38	8.09	12.25	0.95	0.65	1.87
Richards Creek	Historical	1291.987	25-year	44.55	55.48	56.5	56.5	1.02	0.050988	4.83	9.21	12.8	1	0.7	2.24
Richards Creek	Historical	1291.987	100-year	61.8	55.48	56.68	56.68	1.2	0.049454	5.28	11.71	13.74	1.01	0.83	2.56
Richards Creek	Historical	999.2128	1.01-year	15.05	51.78	52.33	52.21	0.55	0.021643	2.41	6.26	14.62	0.65	0.42	0.57
Richards Creek	Historical	999.2128	2-year	22.65	51.78	52.53	52.32	0.75	0.014271	2.42	9.35	15.49	0.55	0.59	0.53
Richards Creek	Historical	999.2128	10-year	35.4	51.78	53.02	52.47	1.24	0.005472	2.03	17.43	17.57	0.36	0.97	0.33
Richards Creek	Historical	999.2128	25-year	44.55	51.78	54.1	52.56	2.32	0.000868	1.14	38.96	21.98	0.15	1.7	0.09
Richards Creek	Historical	999.2128	100-year	61.8	51.78	56.66	52.72	4.88	0.000065	0.49	191.13	214.45	0.04	3.44	0.01
Richards Creek	Historical	968.151	1.01-year	15.05	51.3	52.1	51.71	0.8	0.00443	1.44	10.46	15.61	0.31	0.66	0.18
Richards Creek	Historical	968.151	2-year	22.65	51.3	52.38	51.82	1.08	0.003527	1.53	14.82	16.66	0.29	0.87	0.19
Richards Creek	Historical	968.151	10-year	35.4	51.3	52.95	51.97	1.65	0.001863	1.41	25.07	18.89	0.22	1.28	0.15
Richards Creek	Historical	968.151	25-year	44.55	51.3	54.09	52.06	2.79	0.000439	0.91	49.03	22.93	0.11	2.02	0.06
Richards Creek	Historical	968.151	100-year	61.8	51.3	56.66	52.22	5.36	0.000067	0.53	116.81	217.23	0.05	3.8	0.02
Richards Creek	Historical	913.9713		Culvert											
Richards Creek	Historical	875.7664	1.01-year	15.05	49.6	50.72	49.88	1.12	0.000498	0.6	24.93	27.65	0.11	0.88	0.03
Richards Creek	Historical	875.7664	2-year	22.65	49.6	51.06	49.97	1.46	0.000432	0.65	34.86	30.91	0.11	1.1	0.03
Richards Creek	Historical	875.7664	10-year	35.4	49.6	51.58	50.09	1.98	0.000351	0.68	52.33	35.78	0.1	1.42	0.03
Richards Creek	Historical	875.7664	25-year	44.55	49.6	51.89	50.17	2.29	0.000327	0.7	63.72	38.62	0.1	1.6	0.03
Richards Creek	Historical	875.7664	100-year	61.8	49.6	52.4	50.29	2.8	0.000295	0.73	84.69	122.23	0.09	1.89	0.03
Richards Creek	Historical	843.4692	1.01-year	15.05	49.48	50.71	49.76	1.23	0.000354	0.53	28.16	29.03	0.1	0.95	0.02
Richards Creek	Historical	843.4692	2-year	22.65	49.48	51.05	49.85	1.57	0.000328	0.59	38.63	32.37	0.09	1.17	0.02
Richards Creek	Historical	843.4692	10-year	35.4	49.48	51.57	49.97	2.09	0.000279	0.62	56.91	37.17	0.09	1.49	0.03
Richards Creek	Historical	843.4692	25-year	44.55	49.48	51.88	50.05	2.4	0.000266	0.65	68.73	45.43	0.09	1.67	0.03
Richards Creek	Historical	843.4692	100-year	61.8	49.48	52.39	50.17	2.91	0.000246	0.68	90.4	144.04	0.08	1.96	0.03
Richards Creek	Historical	240.4131	1.01-year	15.05	45.9	50.71	46.6	4.81	0.000001	0.1	402.64	212.34	0.01	3.72	0
Richards Creek	Historical	240.4131	2-year	22.65	45.9	51.05	46.73	5.15	0.000001	0.13	477.21	225.63	0.01	4.02	0
Richards Creek	Historical	240.4131	10-year	35.4	45.9	51.57	46.92	5.67	0.000002	0.17	600.43	238.56	0.01	4.49	0
Richards Creek	Historical	240.4131	25-year	44.55	45.9	51.88	47.05	5.98	0.000002	0.19	673.56	238.56	0.01	4.76	0
Richards Creek	Historical	240.4131	100-year	61.8	45.9	52.39	47.25	6.49	0.000002	0.22	795.71	238.56	0.02	5.21	0
Richards Creek	Lower	85.48712	1.01-year	120.25	47.08	50.66	49.54	3.58	0.001315	2.1	131.45	256.31	0.25	1.94	0.16
Richards Creek	Lower	85.48712	2-year	181	47.08	50.99	50.28	3.91	0.001313	2.31	184.23	256.31	0.26	2.25	0.18
Richards Creek	Lower	85.48712	10-year	297	47.08	51.51	50.56	4.43	0.00131	2.62	265.35	256.31	0.27	2.72	0.22
Richards Creek	Lower	85.48712	25-year	376	47.08	51.82	50.7	4.74	0.001309	2.8	312.53	256.31	0.27	3	0.25
Richards Creek	Lower	85.48712	100-year	525	47.08	52.32	50.93	5.24	0.001308	3.07	391.18	256.31	0.28	3.46	0.28
Richards Creek	Lower	26.62222	1.01-year	120.25	47	50.58	49.45	3.58	0.0013	2.09	132.08	256.31	0.25	1.94	0.16
Richards Creek	Lower	26.62222	2-year	181	47	50.92	50.2	3.92	0.001301	2.3	184.88	256.31	0.26	2.25	0.18
Richards Creek	Lower	26.62222	10-year	297	47	51.44	50.48	4.44	0.0013	2.62	266.03	256.31	0.27	2.73	0.22
Richards Creek	Lower	26.62222	25-year	376	47	51.74	50.62	4.74	0.001301	2.79	313.23	256.31	0.27	3	0.24
Richards Creek	Lower	26.62222	100-year	525	47	52.24	50.85	5.24	0.001301	3.07	391.89	256.31	0.28	3.46	0.28
Sunset Creek	SE 30th	420.6496	25-year	297.45	47.11	52.62	50.1	5.51	0.002455	3.33	132.7	118.2	0.28	3.56	0.55
Sunset Creek	SE 30th	420.6496	100-year	413.2	47.11	53.14	50.75	6.03	0.0027	3.76	168.24	118.2	0.3	3.97	0.67
Sunset Creek	SE 30th	48.9477	1.01-year	100.55	47.18	50.65	49.5	3.47	0.002442	2.13	71.26	131.31	0.26	1.84	0.28
Sunset Creek	SE 30th	48.9477	2-year	151.35	47.18	50.98	49.88	3.8	0.002464	2.37	98.48	131.31	0.27	2.15	0.33
Sunset Creek	SE 30th	48.9477	10-year	236.6	47.18	51.5	50.55	4.32	0.002216	2.56	140.71	131.31	0.27	2.62	0.36
Sunset Creek	SE 30th	48.9477	25-year	297.45	47.18	51.8	50.7	4.62	0.002179	2.72	165.11	131.31	0.27	2.9	0.39
Sunset Creek	SE 30th	48.9477	100-year	413.2	47.18	52.3	50.92	5.12	0.00215	2.98	205.72	131.31	0.27	3.36	0.45
Richards Creek	Historical	1507.208	1.01-year	15.05	57.05	58.62	57.65	1.57	0.002703	0.91	16.56	17.45	0.16	0.89	0.15
Richards Creek	Historical	1507.208	2-year	22.65	57.05	58.81	57.8	1.76	0.003796	1.13	20.06	19	0.19	0.98	0.23
Richards Creek	Historical	1507.208	10-year	35.4	57.05	59.03	58	1.98	0.005265	1.45	24.62	23.46	0.23	1.14	0.37
Richards Creek	Historical	1507.208	25-year	44.55	57.05	59.13	58.13	2.08	0.006525	1.69	27.09	26.94	0.26	1.21	0.49
Richards Creek	Historical	1507.208	100-year	61.8	57.05	59.27	58.31	2.22	0.00875	2.09	31.13	30.61	0.31	1.34	0.73

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Richards Creek	Historical	1481.097	1.01-year	15.05	57.41	58.45	58.08	1.04	0.012687	1.84	10.58	30.74	0.37	0.74	0.58
Richards Creek	Historical	1481.097	2-year	22.65	57.41	58.65	58.32	1.24	0.009489	1.77	20.33	70.02	0.32	0.88	0.52
Richards Creek	Historical	1481.097	10-year	35.4	57.41	58.91	58.51	1.5	0.005139	1.48	44.41	115.25	0.24	1.09	0.35
Richards Creek	Historical	1481.097	25-year	44.55	57.41	59	58.61	1.59	0.004818	1.51	56.33	131.14	0.24	1.18	0.36
Richards Creek	Historical	1481.097	100-year	61.8	57.41	59.14	58.72	1.73	0.004481	1.57	76.03	145.39	0.24	1.32	0.37
Richards Creek	Historical	1291.987	1.01-year	15.05	55.48	56.38	56.05	0.9	0.009455	1.94	7.75	12.07	0.43	0.63	0.37
Richards Creek	Historical	1291.987	2-year	22.65	55.48	56.5	56.19	1.02	0.012864	2.44	9.29	12.84	0.5	0.71	0.57
Richards Creek	Historical	1291.987	10-year	35.4	55.48	56.41	56.38	0.93	0.046361	4.38	8.09	12.25	0.95	0.65	1.87
Richards Creek	Historical	1291.987	25-year	44.55	55.48	56.5	56.5	1.02	0.050988	4.83	9.21	12.8	1	0.7	2.24
Richards Creek	Historical	1291.987	100-year	61.8	55.48	56.68	56.68	1.2	0.049454	5.28	11.71	13.74	1.01	0.83	2.56
Richards Creek	Historical	999.2128	1.01-year	15.05	51.78	52.33	52.21	0.55	0.021643	2.41	6.26	14.62	0.65	0.42	0.57
Richards Creek	Historical	999.2128	2-year	22.65	51.78	52.53	52.32	0.75	0.014271	2.42	9.35	15.49	0.55	0.59	0.53
Richards Creek	Historical	999.2128	10-year	35.4	51.78	53.02	52.47	1.24	0.005472	2.03	17.43	17.57	0.36	0.97	0.33
Richards Creek	Historical	999.2128	25-year	44.55	51.78	54.1	52.56	2.32	0.000868	1.14	38.96	21.98	0.15	1.7	0.09
Richards Creek	Historical	999.2128	100-year	61.8	51.78	56.66	52.72	4.88	0.000065	0.49	191.13	214.45	0.04	3.44	0.01
Richards Creek	Historical	968.151	1.01-year	15.05	51.3	52.1	51.71	0.8	0.00443	1.44	10.46	15.61	0.31	0.66	0.18
Richards Creek	Historical	968.151	2-year	22.65	51.3	52.38	51.82	1.08	0.003527	1.53	14.82	16.66	0.29	0.87	0.19
Richards Creek	Historical	968.151	10-year	35.4	51.3	52.95	51.97	1.65	0.001863	1.41	25.07	18.89	0.22	1.28	0.15
Richards Creek	Historical	968.151	25-year	44.55	51.3	54.09	52.06	2.79	0.000439	0.91	49.03	22.93	0.11	2.02	0.06
Richards Creek	Historical	968.151	100-year	61.8	51.3	56.66	52.22	5.36	0.000067	0.53	116.81	217.23	0.05	3.8	0.02
Richards Creek	Historical	913.9713		Culvert											
Richards Creek	Historical	875.7664	1.01-year	15.05	49.6	50.72	49.88	1.12	0.000498	0.6	24.93	27.65	0.11	0.88	0.03
Richards Creek	Historical	875.7664	2-year	22.65	49.6	51.06	49.97	1.46	0.000432	0.65	34.86	30.91	0.11	1.1	0.03
Richards Creek	Historical	875.7664	10-year	35.4	49.6	51.58	50.09	1.98	0.000351	0.68	52.33	35.78	0.1	1.42	0.03
Richards Creek	Historical	875.7664	25-year	44.55	49.6	51.89	50.17	2.29	0.000327	0.7	63.72	38.62	0.1	1.6	0.03
Richards Creek	Historical	875.7664	100-year	61.8	49.6	52.4	50.29	2.8	0.000295	0.73	84.69	122.23	0.09	1.89	0.03
Richards Creek	Historical	843.4692	1.01-year	15.05	49.48	50.71	49.76	1.23	0.000354	0.53	28.16	29.03	0.1	0.95	0.02
Richards Creek	Historical	843.4692	2-year	22.65	49.48	51.05	49.85	1.57	0.000328	0.59	38.63	32.37	0.09	1.17	0.02
Richards Creek	Historical	843.4692	10-year	35.4	49.48	51.57	49.97	2.09	0.000279	0.62	56.91	37.17	0.09	1.49	0.03
Richards Creek	Historical	843.4692	25-year	44.55	49.48	51.88	50.05	2.4	0.000266	0.65	68.73	45.43	0.09	1.67	0.03
Richards Creek	Historical	843.4692	100-year	61.8	49.48	52.39	50.17	2.91	0.000246	0.68	90.4	144.04	0.08	1.96	0.03
Richards Creek	Historical	240.4131	1.01-year	15.05	45.9	50.71	46.6	4.81	0.000001	0.1	402.64	212.34	0.01	3.72	0
Richards Creek	Historical	240.4131	2-year	22.65	45.9	51.05	46.73	5.15	0.000001	0.13	477.21	225.63	0.01	4.02	0
Richards Creek	Historical	240.4131	10-year	35.4	45.9	51.57	46.92	5.67	0.000002	0.17	600.43	238.56	0.01	4.49	0
Richards Creek	Historical	240.4131	25-year	44.55	45.9	51.88	47.05	5.98	0.000002	0.19	673.56	238.56	0.01	4.76	0
Richards Creek	Historical	240.4131	100-year	61.8	45.9	52.39	47.25	6.49	0.000002	0.22	795.71	238.56	0.02	5.21	0
Richards Creek	Lower	85.48712	1.01-year	120.25	47.08	50.66	49.54	3.58	0.001315	2.1	131.45	256.31	0.25	1.94	0.16
Richards Creek	Lower	85.48712	2-year	181	47.08	50.99	50.28	3.91	0.001313	2.31	184.23	256.31	0.26	2.25	0.18
Richards Creek	Lower	85.48712	10-year	297	47.08	51.51	50.56	4.43	0.00131	2.62	265.35	256.31	0.27	2.72	0.22
Richards Creek	Lower	85.48712	25-year	376	47.08	51.82	50.7	4.74	0.001309	2.8	312.53	256.31	0.27	3	0.25
Richards Creek	Lower	85.48712	100-year	525	47.08	52.32	50.93	5.24	0.001308	3.07	391.18	256.31	0.28	3.46	0.28
Richards Creek	Lower	26.62222	1.01-year	120.25	47	50.58	49.45	3.58	0.0013	2.09	132.08	256.31	0.25	1.94	0.16
Richards Creek	Lower	26.62222	2-year	181	47	50.92	50.2	3.92	0.001301	2.3	184.88	256.31	0.26	2.25	0.18
Richards Creek	Lower	26.62222	10-year	297	47	51.44	50.48	4.44	0.0013	2.62	266.03	256.31	0.27	2.73	0.22
Richards Creek	Lower	26.62222	25-year	376	47	51.74	50.62	4.74	0.001301	2.79	313.23	256.31	0.27	3	0.24
Richards Creek	Lower	26.62222	100-year	525	47	52.24	50.85	5.24	0.001301	3.07	391.89	256.31	0.28	3.46	0.28

PHASE I ALTERNATIVE 1 OUTPUT TABLE

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	3272.859	1.01-year	52.48	82.49	85.22	83.99	2.73	0.006909	2.99	17.54	7.87	0.35	1.53	0.66
Sunset Creek	SE 30th	3272.859	2-year	79	82.49	85.87	84.38	3.38	0.007726	3.46	22.83	8.32	0.37	1.77	0.86
Sunset Creek	SE 30th	3272.859	10-year	126	82.49	86.72	84.96	4.23	0.009492	4.19	30.1	8.9	0.4	2.06	1.22
Sunset Creek	SE 30th	3272.859	25-year	157	82.49	87.13	85.3	4.64	0.010441	4.63	34.08	10.3	0.42	2.24	1.46
Sunset Creek	SE 30th	3272.859	100-year	212	82.49	87.79	85.83	5.3	0.011482	5.24	41.64	12.71	0.45	2.52	1.81
Sunset Creek	SE 30th	3251.92	1.01-year	52.48	82.52	84.68	84.21	2.16	0.024525	5.08	10.33	5.78	0.67	1.2	1.84
Sunset Creek	SE 30th	3251.92	2-year	79	82.52	85.22	84.69	2.7	0.027799	5.84	13.53	6.22	0.7	1.39	2.41
Sunset Creek	SE 30th	3251.92	10-year	126	82.52	86	85.54	3.48	0.031764	6.33	19.9	8.8	0.74	1.5	2.97
Sunset Creek	SE 30th	3251.92	25-year	157	82.52	86.34	85.88	3.82	0.033201	6.84	22.96	9.05	0.76	1.64	3.39
Sunset Creek	SE 30th	3251.92	100-year	212	82.52	86.88	86.38	4.36	0.035496	7.59	27.92	9.43	0.78	1.84	4.08
Sunset Creek	SE 30th	3230.282	1.01-year	52.48	81.37	84.02	83.73	2.65	0.030615	5.49	9.55	6.31	0.79	1.09	2.08
Sunset Creek	SE 30th	3230.282	2-year	79	81.37	84.46	84.23	3.09	0.033662	6.29	12.56	7.21	0.84	1.24	2.61
Sunset Creek	SE 30th	3230.282	10-year	126	81.37	85.18	84.92	3.81	0.034461	6.77	18.62	9.27	0.84	1.45	3.12
Sunset Creek	SE 30th	3230.282	25-year	157	81.37	85.54	85.24	4.17	0.03394	7.15	21.97	9.59	0.83	1.61	3.42
Sunset Creek	SE 30th	3230.282	100-year	212	81.37	86.11	85.72	4.74	0.033218	7.67	27.63	10.1	0.82	1.86	3.85
Sunset Creek	SE 30th	3207.655	1.01-year	52.48	81.58	83.02	83.02	1.44	0.045494	6.27	8.36	6.93	1.01	0.98	2.8
Sunset Creek	SE 30th	3207.655	2-year	79	81.58	83.43	83.43	1.85	0.044215	7.02	11.25	7.41	1.01	1.19	3.29
Sunset Creek	SE 30th	3207.655	10-year	126	81.58	84.06	84.06	2.48	0.044338	7.75	16.25	8.79	1	1.42	3.92
Sunset Creek	SE 30th	3207.655	25-year	157	81.58	84.37	84.37	2.79	0.044896	8.25	19.02	9.07	1	1.57	4.39
Sunset Creek	SE 30th	3207.655	100-year	212	81.58	84.86	84.86	3.28	0.045967	8.98	23.6	9.51	1	1.78	5.12
Sunset Creek	SE 30th	3193.525	1.01-year	52.48	81.39	82.96	82.47	1.57	0.012631	3.2	16.4	13.89	0.52	0.99	0.78
Sunset Creek	SE 30th	3193.525	2-year	79	81.39	83.44	82.75	2.05	0.010801	3.36	23.53	15.91	0.49	1.2	0.81
Sunset Creek	SE 30th	3193.525	10-year	126	81.39	84.14	83.16	2.75	0.008933	3.52	35.78	18.79	0.45	1.5	0.84
Sunset Creek	SE 30th	3193.525	25-year	157	81.39	84.54	83.39	3.15	0.00785	3.62	43.42	19.42	0.43	1.74	0.85
Sunset Creek	SE 30th	3193.525	100-year	212	81.39	85.16	83.75	3.77	0.00686	3.82	55.51	19.91	0.4	2.11	0.9
Sunset Creek	SE 30th	3181.277	1.01-year	52.48	80.83	82.23	82.23	1.4	0.049653	6.06	8.66	7.7	1.01	0.97	3.01
Sunset Creek	SE 30th	3181.277	2-year	79	80.83	82.63	82.61	1.8	0.047241	6.68	11.83	8.35	0.99	1.19	3.51
Sunset Creek	SE 30th	3181.277	10-year	126	80.83	83.26	83.16	2.43	0.04141	7.2	17.49	9.4	0.93	1.5	3.89
Sunset Creek	SE 30th	3181.277	25-year	157	80.83	83.58	83.46	2.75	0.039203	7.67	20.55	10.44	0.92	1.73	4.22
Sunset Creek	SE 30th	3181.277	100-year	212	80.83	84.06	83.99	3.23	0.035379	8.35	26.15	12.35	0.91	2.12	4.68
Sunset Creek	SE 30th	3171.478	1.01-year	52.48	79.8	82.09	81.5	2.29	0.017938	4.34	12.08	6.96	0.58	1.29	1.44
Sunset Creek	SE 30th	3171.478	2-year	79	79.8	82.53	81.92	2.73	0.020229	5.19	15.34	7.97	0.63	1.55	1.96
Sunset Creek	SE 30th	3171.478	10-year	126	79.8	83.09	82.55	3.29	0.022901	6.46	20.2	9.36	0.7	1.96	2.8
Sunset Creek	SE 30th	3171.478	25-year	157	79.8	83.37	82.91	3.57	0.024983	7.2	22.91	10.06	0.74	2.16	3.37
Sunset Creek	SE 30th	3171.478	100-year	212	79.8	83.77	83.5	3.97	0.0285	8.38	27.21	11.07	0.81	2.46	4.38
Sunset Creek	SE 30th	3160.526	1.01-year	52.48	79.96	81.89	81.42	1.93	0.018375	4.34	12.09	7.93	0.62	1.24	1.42
Sunset Creek	SE 30th	3160.526	2-year	79	79.96	82.32	81.81	2.36	0.020239	5.05	15.65	8.81	0.66	1.47	1.86
Sunset Creek	SE 30th	3160.526	10-year	126	79.96	82.89	82.38	2.93	0.022223	6.07	21.16	10.52	0.7	1.82	2.53
Sunset Creek	SE 30th	3160.526	25-year	157	79.96	83.18	82.72	3.22	0.022836	6.66	24.36	11.4	0.73	2.05	2.92
Sunset Creek	SE 30th	3160.526	100-year	212	79.96	83.62	83.23	3.66	0.023797	7.55	29.71	12.74	0.76	2.4	3.56
Sunset Creek	SE 30th	3145.921	1.01-year	52.48	78.83	81.92	80.46	3.09	0.003732	2.52	21.19	10.58	0.29	1.92	0.45
Sunset Creek	SE 30th	3145.921	2-year	79	78.83	82.37	80.86	3.54	0.004594	3.15	26.22	11.91	0.33	2.29	0.66
Sunset Creek	SE 30th	3145.921	10-year	126	78.83	82.97	81.42	4.14	0.005759	4.01	33.92	13.69	0.38	2.78	1
Sunset Creek	SE 30th	3145.921	25-year	157	78.83	83.29	81.74	4.46	0.006411	4.49	38.41	14.63	0.41	3.04	1.22
Sunset Creek	SE 30th	3145.921	100-year	212	78.83	83.77	82.27	4.94	0.007307	5.21	45.89	16.07	0.45	3.44	1.57
Sunset Creek	SE 30th	3119.845	1.01-year	52.48	79.67	81.65	81.05	1.98	0.011764	3.56	14.77	10.26	0.51	1.32	0.97
Sunset Creek	SE 30th	3119.845	2-year	79	79.67	82.05	81.4	2.38	0.011998	4.21	19.08	11.5	0.54	1.67	1.25
Sunset Creek	SE 30th	3119.845	10-year	126	79.67	82.57	81.89	2.9	0.013116	5.17	25.47	13.13	0.59	2.13	1.74
Sunset Creek	SE 30th	3119.845	25-year	157	79.67	82.82	82.17	3.15	0.014262	5.77	28.89	13.92	0.62	2.35	2.1
Sunset Creek	SE 30th	3119.845	100-year	212	79.67	83.2	82.63	3.53	0.016027	6.69	34.41	15.12	0.68	2.69	2.69
Sunset Creek	SE 30th	3103.342	1.01-year	52.48	79.66	81.46	80.89	1.8	0.011936	3.47	15.11	10.95	0.52	1.24	0.92
Sunset Creek	SE 30th	3103.342	2-year	79	79.66	81.86	81.22	2.2	0.01343	4.03	19.62	12.1	0.56	1.44	1.21
Sunset Creek	SE 30th	3103.342	10-year	126	79.66	82.36	81.7	2.7	0.01577	4.81	26.17	13.61	0.61	1.7	1.67
Sunset Creek	SE 30th	3103.342	25-year	157	79.66	82.61	81.98	2.95	0.016334	5.31	29.67	14.35	0.63	1.92	1.95
Sunset Creek	SE 30th	3103.342	100-year	212	79.66	82.99	82.39	3.33	0.017504	6.1	35.2	15.45	0.67	2.24	2.45
Sunset Creek	SE 30th	3082.734	1.01-year	52.48	79.61	81.15	80.76	1.54	0.015717	3.74	14.02	11.68	0.6	1.11	1.09
Sunset Creek	SE 30th	3082.734	2-year	79	79.61	81.52	81.06	1.91	0.015628	4.26	18.63	13.16	0.61	1.37	1.33
Sunset Creek	SE 30th	3082.734	10-year	126	79.61	82	81.5	2.39	0.015851	5.1	25.43	15.76	0.64	1.78	1.76
Sunset Creek	SE 30th	3082.734	25-year	157	79.61	82.23	81.76	2.62	0.01654	5.61	29.26	17.06	0.67	1.99	2.06
Sunset Creek	SE 30th	3082.734	100-year	212	79.61	82.61	82.16	3	0.016909	6.32	36.13	19.16	0.7	2.34	2.47
Sunset Creek	SE 30th	3066.484	1.01-year	52.48	79.15	80.44	80.44	1.29	0.045593	5.66	9.27	9.44	1.01	0.91	2.59
Sunset Creek	SE 30th	3066.484	2-year	79	79.15	80.77	80.77	1.62	0.041061	6.3	12.68	11.37	0.98	1.17	2.99
Sunset Creek	SE 30th	3066.484	10-year	126	79.15	81.27	81.27	2.12	0.032155	6.97	19.39	15.18	0.92	1.63	3.27
Sunset Creek	SE 30th	3066.484	25-year	157	79.15	81.55	81.55	2.4	0.028891	7.28	23.84	16.54	0.89	1.88	3.4
Sunset Creek	SE 30th	3066.484	100-year	212	79.15	81.92	81.92	2.77	0.027733	7.96	30.23	17.83	0.9	2.23	3.85
Sunset Creek	SE 30th	3034.622	1.01-year	52.48	77.36	78.8	78.83	1.44	0.053489	6	8.75	8.57	1.05	0.94	3.13
Sunset Creek	SE 30th	3034.622	2-year	79	77.36	79.11	79.19	1.75	0.057465	6.84	11.54	9.56	1.1	1.1	3.94
Sunset Creek	SE 30th	3034.622	10-year	126	77.36	79.48	79.7	2.12	0.068201	8.2	15.36	10.77	1.21	1.29	5.48
Sunset Creek	SE 30th	3034.622	25-year	157	77.36	79.7	79.98	2.34	0.071417	8.82	17.81	11.47	1.25	1.39	6.22
Sunset Creek	SE 30th	3034.622	100-year	212	77.36	80.11	80.4	2.75	0.068713	9.35	22.66	12.75	1.24	1.59	6.81

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	3020.31	1.01-year	52.48	76.74	78.69	78.18	1.95	0.011941	3.74	14.04	11.02	0.58	1.14	0.85
Sunset Creek	SE 30th	3020.31	2-year	79	76.74	79.07	78.53	2.33	0.012354	4.22	18.74	13.76	0.63	1.24	0.96
Sunset Creek	SE 30th	3020.31	10-year	126	76.74	79.57	79.08	2.83	0.012503	4.77	26.69	17.98	0.67	1.45	1.13
Sunset Creek	SE 30th	3020.31	25-year	157	76.74	79.84	79.34	3.1	0.012582	5.03	31.75	19.91	0.68	1.59	1.25
Sunset Creek	SE 30th	3020.31	100-year	212	76.74	80.22	79.74	3.48	0.012788	5.51	39.63	21.2	0.67	1.94	1.55
Sunset Creek	SE 30th	2982.026	1.01-year	52.48	76.27	77.64	77.64	1.37	0.041864	5.49	9.57	10.28	1	0.86	2.24
Sunset Creek	SE 30th	2982.026	2-year	79	76.27	77.97	77.97	1.7	0.041566	5.98	13.22	12.11	1.01	1	2.6
Sunset Creek	SE 30th	2982.026	10-year	126	76.27	78.42	78.42	2.15	0.042101	6.55	19.23	14.7	1.01	1.2	3.15
Sunset Creek	SE 30th	2982.026	25-year	157	76.27	78.66	78.66	2.39	0.042096	6.84	22.94	16.1	1.01	1.3	3.42
Sunset Creek	SE 30th	2982.026	100-year	212	76.27	79.03	79.03	2.76	0.041059	7.23	29.3	18.1	1	1.48	3.78
Sunset Creek	SE 30th	2969.117	1.01-year	52.48	75.88	76.97	77.07	1.09	0.065542	5.54	9.48	14.93	1.22	0.62	2.54
Sunset Creek	SE 30th	2969.117	2-year	79	75.88	77.13	77.29	1.25	0.07752	6.56	12.04	16.63	1.36	0.71	3.42
Sunset Creek	SE 30th	2969.117	10-year	126	75.88	77.99	77.62	2.11	0.016637	4.66	27.04	18.12	0.67	1.39	1.44
Sunset Creek	SE 30th	2969.117	25-year	157	75.88	78.3	77.81	2.42	0.014764	4.81	32.64	18.59	0.64	1.61	1.49
Sunset Creek	SE 30th	2969.117	100-year	212	75.88	78.72	78.12	2.84	0.014239	5.23	40.57	19.24	0.63	1.9	1.69
Sunset Creek	SE 30th	2939.869	1.01-year	52.48	73.61	76.82	75.69	3.21	0.0053	2.32	22.64	14.71	0.33	1.38	0.46
Sunset Creek	SE 30th	2939.869	2-year	79	73.61	77.25	76.05	3.64	0.006353	2.69	29.37	16.87	0.36	1.56	0.62
Sunset Creek	SE 30th	2939.869	10-year	126	73.61	77.81	76.54	4.2	0.007148	3.22	39.19	18.18	0.39	1.91	0.85
Sunset Creek	SE 30th	2939.869	25-year	157	73.61	78.11	76.8	4.5	0.007632	3.51	44.79	18.85	0.4	2.09	1
Sunset Creek	SE 30th	2939.869	100-year	212	73.61	78.51	77.2	4.9	0.008977	4.04	52.43	19.74	0.44	2.32	1.3
Sunset Creek	SE 30th	2904.859	1.01-year	52.48	74.07	76.39	75.43	2.32	0.035368	2.86	18.34	15.88	0.47	1.03	2.28
Sunset Creek	SE 30th	2904.859	2-year	79	74.07	76.76	75.8	2.69	0.035055	3.22	24.51	17.55	0.48	1.25	2.74
Sunset Creek	SE 30th	2904.859	10-year	126	74.07	77.28	76.48	3.21	0.034618	3.67	34.34	19.94	0.49	1.54	3.34
Sunset Creek	SE 30th	2904.859	25-year	157	74.07	77.58	76.7	3.51	0.033762	3.86	41.26	28.12	0.49	1.7	3.59
Sunset Creek	SE 30th	2904.859	100-year	212	74.07	77.99	77.03	3.92	0.029905	4.01	54.84	34.28	0.48	1.98	3.69
Sunset Creek	SE 30th	2887.542	1.01-year	52.48	73.52	76	75.02	2.48	0.016879	2.48	21.15	16.68	0.39	1.13	1.19
Sunset Creek	SE 30th	2887.542	2-year	79	73.52	76.35	75.58	2.83	0.018402	2.91	27.15	17.78	0.41	1.36	1.56
Sunset Creek	SE 30th	2887.542	10-year	126	73.52	76.85	75.94	3.33	0.020043	3.46	36.45	19.36	0.44	1.66	2.08
Sunset Creek	SE 30th	2887.542	25-year	157	73.52	77.14	76.13	3.62	0.020645	3.73	42.11	20.26	0.46	1.83	2.36
Sunset Creek	SE 30th	2887.542	100-year	212	73.52	77.55	76.47	4.03	0.020458	4.12	54.02	31.33	0.46	2.14	2.74
Sunset Creek	SE 30th	2869.669	1.01-year	52.48	73.86	74.99	74.99	1.13	0.1141	5.38	9.76	11.01	1.01	0.84	6
Sunset Creek	SE 30th	2869.669	2-year	79	73.86	75.45	75.31	1.59	0.077457	5.1	15.48	13.75	0.85	1.07	5.16
Sunset Creek	SE 30th	2869.669	10-year	126	73.86	76.06	75.72	2.2	0.052374	5.13	24.65	16.55	0.73	1.46	4.78
Sunset Creek	SE 30th	2869.669	25-year	157	73.86	76.37	75.95	2.51	0.045904	5.28	30.08	18.64	0.7	1.69	4.84
Sunset Creek	SE 30th	2869.669	100-year	212	73.86	76.83	76.3	2.97	0.037413	5.55	40.53	26.66	0.65	2.13	4.96
Sunset Creek	SE 30th	2850.365	1.01-year	52.48	72.12	74.78	73.51	2.66	0.008736	2.49	21.71	12.12	0.3	1.82	0.99
Sunset Creek	SE 30th	2850.365	2-year	79	72.12	75.2	73.85	3.08	0.01057	3.08	27.12	14.28	0.34	2.16	1.43
Sunset Creek	SE 30th	2850.365	10-year	126	72.12	75.73	74.37	3.61	0.013553	3.95	34.65	18.53	0.39	2.6	2.2
Sunset Creek	SE 30th	2850.365	25-year	157	72.12	76	74.67	3.88	0.015301	4.43	38.77	20.55	0.42	2.83	2.7
Sunset Creek	SE 30th	2850.365	100-year	212	72.12	76.4	75.15	4.28	0.018224	5.21	45	23.52	0.47	3.16	3.6
Sunset Creek	SE 30th	2823.726	1.01-year	52.48	72.56	74.28	73.76	1.72	0.030413	3.5	15.05	12.75	0.54	1.22	2.31
Sunset Creek	SE 30th	2823.726	2-year	79	72.56	74.63	74.08	2.07	0.031689	4.05	20.53	17.35	0.56	1.48	2.92
Sunset Creek	SE 30th	2823.726	10-year	126	72.56	75.07	74.62	2.51	0.032689	4.79	28.7	19.84	0.59	1.86	3.79
Sunset Creek	SE 30th	2823.726	25-year	157	72.56	75.31	74.85	2.75	0.03308	5.19	33.61	21.42	0.61	2.08	4.29
Sunset Creek	SE 30th	2823.726	100-year	212	72.56	75.67	75.2	3.11	0.033877	5.79	41.7	23.79	0.63	2.4	5.08
Sunset Creek	SE 30th	2794.948	1.01-year	52.48	71.19	73.48	72.93	2.29	0.026466	3.4	16.43	16.14	0.5	1.29	2.14
Sunset Creek	SE 30th	2794.948	2-year	79	71.19	73.91	73.29	2.72	0.022648	3.64	24.42	20.59	0.48	1.62	2.29
Sunset Creek	SE 30th	2794.948	10-year	126	71.19	74.34	73.8	3.15	0.023419	4.28	34.12	23.97	0.51	2.01	2.94
Sunset Creek	SE 30th	2794.948	25-year	157	71.19	74.52	74.01	3.33	0.026305	4.77	38.53	25.36	0.54	2.17	3.57
Sunset Creek	SE 30th	2794.948	100-year	212	71.19	74.86	74.32	3.67	0.027583	5.34	47.48	27.94	0.57	2.48	4.27
Sunset Creek	SE 30th	2760.247	1.01-year	52.48	70.04	71.78	71.78	1.74	0.048937	6.25	8.4	7.05	1.01	1.02	3.11
Sunset Creek	SE 30th	2760.247	2-year	79	70.04	72.19	72.19	2.15	0.048803	6.92	11.41	7.83	1.01	1.22	3.71
Sunset Creek	SE 30th	2760.247	10-year	126	70.04	72.94	72.94	2.9	0.031018	6.76	20.98	19.47	0.83	1.68	3.25
Sunset Creek	SE 30th	2760.247	25-year	157	70.04	73.26	73.26	3.22	0.025632	6.75	27.92	23.44	0.77	1.93	3.1
Sunset Creek	SE 30th	2760.247	100-year	212	70.04	73.59	73.59	3.55	0.025171	7.29	35.9	25.15	0.78	2.2	3.46
Sunset Creek	SE 30th	2717.8	1.01-year	52.48	68.16	70.01	69.54	1.85	0.041141	3.97	13.22	11.12	0.64	1.03	2.64
Sunset Creek	SE 30th	2717.8	2-year	79	68.16	70.32	69.97	2.16	0.044974	4.72	16.73	11.64	0.69	1.22	3.44
Sunset Creek	SE 30th	2717.8	10-year	126	68.16	70.79	70.42	2.63	0.047176	5.63	22.36	12.43	0.74	1.5	4.42
Sunset Creek	SE 30th	2717.8	25-year	157	68.16	71.08	70.68	2.92	0.046411	6.04	26.01	12.91	0.75	1.66	4.81
Sunset Creek	SE 30th	2717.8	100-year	212	68.16	71.54	71.09	3.38	0.044965	6.6	32.14	13.69	0.76	1.91	5.35
Sunset Creek	SE 30th	2702.718	1.01-year	52.48	67.5	69.17	68.88	1.67	0.061046	4.65	11.28	10.94	0.81	0.91	3.45
Sunset Creek	SE 30th	2702.718	2-year	79	67.5	69.56	69.32	2.06	0.04975	5.03	15.7	11.63	0.76	1.16	3.61
Sunset Creek	SE 30th	2702.718	10-year	126	67.5	70.17	69.75	2.67	0.038815	5.44	23.17	12.71	0.71	1.53	3.71
Sunset Creek	SE 30th	2702.718	25-year	157	67.5	70.51	70.01	3.01	0.035882	5.7	27.56	13.31	0.7	1.72	3.85
Sunset Creek	SE 30th	2702.718	100-year	212	67.5	71.03	70.41	3.53	0.03306	6.11	34.71	14.23	0.69	1.99	4.11
Sunset Creek	SE 30th	2676.488	1.01-year	52.48	66.34	68.54	67.73	2.2	0.016763	3.07	17.07	11.62	0.45	1.25	1.3
Sunset Creek	SE 30th	2676.488	2-year	79	66.34	69.06	68.16	2.72	0.014684	3.38	23.37	12.48	0.44	1.55	1.42
Sunset Creek	SE 30th	2676.488	10-year	126	66.34	69.75	68.62	3.41	0.014239	3.9	32.32	13.62	0.45	1.92	1.71
Sunset Creek	SE 30th	2676.488	25-year	157	66.34	70.09	68.86	3.75	0.014742	4.23	37.1	14.19	0.46	2.09	1.93
Sunset Creek	SE 30th	2676.488	100-year	212	66.34	70.61	69.27	4.27	0.015594	4.74	44.73	15.05	0.48	2.34	2.28
Sunset Creek	SE 30th	2651.525	1.01-year	52.48	65.23	68.42	66.59	3.19	0.004261	1.84	28.58	14.64	0.23	1.66	0.44
Sunset Creek	SE 30th	2651.525	2-year	79	65.23	68.95	66.97	3.72	0.004596	2.16	36.62	15.74	0.25	1.96	0.56
Sunset Creek	SE 30th	2651.525	10-year	126	65.23	69.63	67.51	4.4	0.005276	2.63	47.93	17.17	0.28	2.31	0.76
Sunset Creek	SE 30th	2651.525	25-year	157	65.23	69.98	67.93	4.75	0.005807	2.91	53.9	17.88	0.3	2.48	0.9
Sunset Creek	SE 30th	2651.525	100-year	212	65.23	70.5	68.32	5.27	0.006582	3.34	63.47	18.96	0.32	2.74	1.12

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	2643.063	1.01-year	52.48	64.86	68.4	66.26	3.54	0.001902	1.79	29.38	12.66	0.21	1.78	0.21
Sunset Creek	SE 30th	2643.063	2-year	79	64.86	68.92	66.66	4.06	0.002418	2.19	36.13	13.25	0.23	2.04	0.31
Sunset Creek	SE 30th	2643.063	10-year	126	64.86	69.59	67.43	4.73	0.003312	2.79	45.23	14.01	0.27	2.35	0.49
Sunset Creek	SE 30th	2643.063	25-year	157	64.86	69.91	67.69	5.05	0.003944	3.15	49.85	14.38	0.3	2.5	0.61
Sunset Creek	SE 30th	2643.063	100-year	212	64.86	70.4	68.12	5.54	0.004993	3.72	57.04	14.94	0.34	2.7	0.84
Sunset Creek	SE 30th	2640.568	1.01-year	52.48	64.75	68.41	65.54	3.66	0.000159	1.1	47.6	13	0.1	2.34	0.02
Sunset Creek	SE 30th	2640.568	2-year	79	64.75	68.94	65.79	4.19	0.000247	1.45	54.43	13	0.12	2.55	0.04
Sunset Creek	SE 30th	2640.568	10-year	126	64.75	69.61	66.17	4.86	0.000399	1.99	63.21	13.58	0.16	2.86	0.07
Sunset Creek	SE 30th	2640.568	25-year	157	64.75	69.94	66.4	5.19	0.000497	2.33	67.51	14.2	0.18	3.05	0.09
Sunset Creek	SE 30th	2640.568	100-year	212	64.75	70.44	66.76	5.69	0.000668	2.87	73.99	15.13	0.21	3.35	0.14
Sunset Creek	SE 30th	2625.968		Bridge											
Sunset Creek	SE 30th	2611.37	1.01-year	52.48	63.5	68.42	64.29	4.92	0.00007	0.82	63.92	13	0.07	2.8	0.01
Sunset Creek	SE 30th	2611.37	2-year	79	63.5	68.95	64.54	5.45	0.000119	1.12	70.79	13	0.08	2.96	0.02
Sunset Creek	SE 30th	2611.37	10-year	126	63.5	69.62	64.92	6.12	0.000214	1.58	79.52	13.6	0.11	3.23	0.04
Sunset Creek	SE 30th	2611.37	25-year	157	63.5	69.94	65.15	6.44	0.000279	1.87	83.77	14.24	0.13	3.41	0.06
Sunset Creek	SE 30th	2611.37	100-year	212	63.5	70.43	65.51	6.93	0.0004	2.35	90.11	16.02	0.16	3.66	0.09
Sunset Creek	SE 30th	2610.895		Bridge											
Sunset Creek	SE 30th	2610.42	1.01-year	52.48	63.5	68.42	64.29	4.92	0.000048	0.82	63.92	13	0.07	2.8	0.01
Sunset Creek	SE 30th	2610.42	2-year	79	63.5	68.95	64.54	5.45	0.000083	1.12	70.79	13	0.08	2.96	0.02
Sunset Creek	SE 30th	2610.42	10-year	126	63.5	69.61	64.92	6.11	0.000149	1.59	79.48	13.62	0.11	3.23	0.03
Sunset Creek	SE 30th	2610.42	25-year	157	63.5	69.94	65.15	6.44	0.000194	1.87	83.77	14.29	0.13	3.41	0.04
Sunset Creek	SE 30th	2610.42	100-year	212	63.5	70.43	65.51	6.93	0.000278	2.35	90.09	16.12	0.16	3.66	0.06
Sunset Creek	SE 30th	2610.395		Bridge											
Sunset Creek	SE 30th	2610.37	1.01-year	52.48	63.5	68.42	64.29	4.92	0.000048	0.82	63.92	13	0.07	2.8	0.01
Sunset Creek	SE 30th	2610.37	2-year	79	63.5	68.95	64.54	5.45	0.000083	1.12	70.79	13	0.08	2.96	0.02
Sunset Creek	SE 30th	2610.37	10-year	126	63.5	69.61	64.92	6.11	0.000149	1.59	79.48	13.62	0.11	3.23	0.03
Sunset Creek	SE 30th	2610.37	25-year	157	63.5	69.94	65.15	6.44	0.000194	1.87	83.77	14.3	0.13	3.41	0.04
Sunset Creek	SE 30th	2610.37	100-year	212	63.5	70.43	65.51	6.93	0.000278	2.35	90.09	16.12	0.16	3.66	0.06
Sunset Creek	SE 30th	2596.365		Bridge											
Sunset Creek	SE 30th	2582.37	1.01-year	52.48	64	68.41	64.79	4.41	0.000065	0.91	57.36	13	0.08	2.63	0.01
Sunset Creek	SE 30th	2582.37	2-year	79	64	68.94	65.05	4.94	0.000108	1.23	64.2	13	0.1	2.81	0.02
Sunset Creek	SE 30th	2582.37	10-year	126	64	69.6	65.42	5.6	0.000189	1.73	72.75	14.87	0.13	3.08	0.04
Sunset Creek	SE 30th	2582.37	25-year	157	64	69.92	65.65	5.92	0.000244	2.04	76.94	17	0.15	3.26	0.05
Sunset Creek	SE 30th	2582.37	100-year	212	64	70.39	66.01	6.39	0.000345	2.55	83.03	20.79	0.18	3.52	0.08
Sunset Creek	SE 30th	2582.335		Bridge											
Sunset Creek	SE 30th	2582.32	1.01-year	52.48	64	68.41	64.79	4.41	0.000065	0.91	57.36	13	0.08	2.63	0.01
Sunset Creek	SE 30th	2582.32	2-year	79	64	68.94	65.05	4.94	0.000108	1.23	64.2	13	0.1	2.81	0.02
Sunset Creek	SE 30th	2582.32	10-year	126	64	69.6	65.42	5.6	0.000189	1.73	72.75	14.88	0.13	3.08	0.04
Sunset Creek	SE 30th	2582.32	25-year	157	64	69.92	65.65	5.92	0.000244	2.04	76.93	17	0.15	3.26	0.05
Sunset Creek	SE 30th	2582.32	100-year	212	64	70.39	66.01	6.39	0.000345	2.55	83.03	20.8	0.18	3.52	0.08
Sunset Creek	SE 30th	2581.843		Bridge											
Sunset Creek	SE 30th	2581.368	1.01-year	52.48	64	68.41	64.79	4.41	0.000094	0.91	57.36	13	0.08	2.63	0.02
Sunset Creek	SE 30th	2581.368	2-year	79	64	68.94	65.05	4.94	0.000156	1.23	64.2	13	0.1	2.81	0.03
Sunset Creek	SE 30th	2581.368	10-year	126	64	69.6	65.43	5.6	0.000273	1.73	72.75	14.98	0.13	3.08	0.05
Sunset Creek	SE 30th	2581.368	25-year	157	64	69.92	65.65	5.92	0.000351	2.04	76.93	17.14	0.15	3.26	0.07
Sunset Creek	SE 30th	2581.368	100-year	212	64	70.39	66.01	6.39	0.000497	2.55	83.01	21.01	0.18	3.52	0.11
Sunset Creek	SE 30th	2578.872	1.01-year	52.48	64	68.41	64.79	4.41	0.000124	0.78	66.87	17.33	0.07	2.99	0.02
Sunset Creek	SE 30th	2578.872	2-year	79	64	68.94	65.03	4.94	0.000195	1.04	75.91	17.84	0.09	3.31	0.04
Sunset Creek	SE 30th	2578.872	10-year	126	64	69.6	65.4	5.6	0.00033	1.44	87.37	18.49	0.11	3.7	0.08
Sunset Creek	SE 30th	2578.872	25-year	157	64	69.93	65.61	5.93	0.000428	1.69	93.05	18.81	0.13	3.88	0.1
Sunset Creek	SE 30th	2578.872	100-year	212	64	70.4	65.96	6.4	0.000593	2.09	101.51	21.19	0.15	4.2	0.16
Sunset Creek	SE 30th	2576.368	1.01-year	52.48	64.5	68.4	65.55	3.9	0.000831	1.11	47.21	15.43	0.11	2.47	0.13
Sunset Creek	SE 30th	2576.368	2-year	79	64.5	68.92	65.84	4.42	0.001227	1.42	55.47	16.27	0.14	2.71	0.21
Sunset Creek	SE 30th	2576.368	10-year	126	64.5	69.57	66.27	5.07	0.001756	1.9	67.11	19.79	0.17	3.21	0.35
Sunset Creek	SE 30th	2576.368	25-year	157	64.5	69.89	66.53	5.39	0.002098	2.19	73.69	21.68	0.18	3.46	0.45
Sunset Creek	SE 30th	2576.368	100-year	212	64.5	70.36	66.93	5.86	0.002669	2.64	84.37	24.42	0.21	3.83	0.64
Sunset Creek	SE 30th	2541.368	1.01-year	52.48	64.3	68.35	65.69	4.05	0.001192	1.43	36.65	12.32	0.15	2.22	0.17
Sunset Creek	SE 30th	2541.368	2-year	79	64.3	68.85	66.04	4.55	0.00179	1.84	42.93	13.03	0.18	2.43	0.27
Sunset Creek	SE 30th	2541.368	10-year	126	64.3	69.46	66.56	5.16	0.00264	2.46	51.93	17.45	0.22	2.82	0.46
Sunset Creek	SE 30th	2541.368	25-year	157	64.3	69.75	66.85	5.45	0.003173	2.84	57.37	20.01	0.25	3.03	0.6
Sunset Creek	SE 30th	2541.368	100-year	212	64.3	70.16	67.33	5.86	0.004062	3.42	66.04	21.7	0.28	3.34	0.85
Sunset Creek	SE 30th	2539.81	1.01-year	52.48	64.28	68.35	65.68	4.07	0.000929	1.44	36.39	12.11	0.15	2.22	0.13
Sunset Creek	SE 30th	2539.81	2-year	79	64.28	68.85	66.02	4.57	0.001398	1.86	42.54	12.79	0.18	2.42	0.21
Sunset Creek	SE 30th	2539.81	10-year	126	64.28	69.45	66.54	5.17	0.00208	2.5	51.06	15.93	0.22	2.81	0.36
Sunset Creek	SE 30th	2539.81	25-year	157	64.28	69.74	66.84	5.46	0.002521	2.88	55.88	17.47	0.25	3.01	0.47
Sunset Creek	SE 30th	2539.81	100-year	212	64.28	70.15	67.31	5.87	0.003292	3.5	63.2	19.12	0.29	3.31	0.68

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	2527.427	1.01-year	52.48	64.16	68.35	65.55	4.19	0.000765	1.33	39.57	13.29	0.14	2.29	0.11
Sunset Creek	SE 30th	2527.427	2-year	79	64.16	68.84	65.9	4.68	0.001094	1.71	46.5	15.83	0.16	2.57	0.18
Sunset Creek	SE 30th	2527.427	10-year	126	64.16	69.44	66.41	5.28	0.001564	2.28	57.77	21.57	0.2	3.03	0.3
Sunset Creek	SE 30th	2527.427	25-year	157	64.16	69.73	66.7	5.57	0.001868	2.61	64.2	22.63	0.22	3.25	0.38
Sunset Creek	SE 30th	2527.427	100-year	212	64.16	70.14	67.16	5.98	0.002398	3.14	73.7	26.33	0.26	3.57	0.53
Sunset Creek	SE 30th	2513.681	1.01-year	52.48	64.02	68.32	65.66	4.3	0.001053	1.51	34.8	11.7	0.15	2.16	0.14
Sunset Creek	SE 30th	2513.681	2-year	79	64.02	68.8	66.02	4.78	0.00162	1.94	40.73	14.17	0.19	2.32	0.23
Sunset Creek	SE 30th	2513.681	10-year	126	64.02	69.39	66.57	5.37	0.002372	2.55	52.43	35.62	0.24	2.64	0.39
Sunset Creek	SE 30th	2513.681	25-year	157	64.02	69.68	66.88	5.66	0.002711	2.87	60.3	39.54	0.26	2.85	0.48
Sunset Creek	SE 30th	2513.681	100-year	212	64.02	70.09	67.37	6.07	0.003184	3.32	73.62	44.84	0.28	3.15	0.63
Sunset Creek	SE 30th	2492.185	1.01-year	52.48	63.81	68.3	65.29	4.49	0.001146	1.51	34.71	11.31	0.15	2.18	0.16
Sunset Creek	SE 30th	2492.185	2-year	79	63.81	68.77	65.71	4.96	0.001856	1.94	40.8	15.02	0.2	2.24	0.26
Sunset Creek	SE 30th	2492.185	10-year	126	63.81	69.34	66.32	5.53	0.002559	2.54	54.44	39.04	0.24	2.64	0.42
Sunset Creek	SE 30th	2492.185	25-year	157	63.81	69.62	66.66	5.81	0.002793	2.79	66.31	42.47	0.25	2.85	0.5
Sunset Creek	SE 30th	2492.185	100-year	212	63.81	70.04	67.19	6.23	0.003008	3.1	84.07	42.47	0.26	3.15	0.59
Sunset Creek	SE 30th	2481.368	1.01-year	52.48	63.7	68.29	65.27	4.59	0.001352	1.53	34.21	11.24	0.16	2.17	0.18
Sunset Creek	SE 30th	2481.368	2-year	79	63.7	68.74	65.71	5.04	0.002208	1.98	40.26	15.87	0.2	2.3	0.32
Sunset Creek	SE 30th	2481.368	10-year	126	63.7	69.3	66.33	5.6	0.003218	2.62	52.02	32.53	0.24	2.65	0.53
Sunset Creek	SE 30th	2481.368	25-year	157	63.7	69.57	66.69	5.87	0.003663	2.94	62.31	38.47	0.26	2.85	0.65
Sunset Creek	SE 30th	2481.368	100-year	212	63.7	69.98	67.25	6.28	0.004202	3.36	77.72	38.48	0.29	3.15	0.83
Sunset Creek	SE 30th	2464.334	1.01-year	52.48	65.8	68.14	67.25	2.34	0.007215	2.83	18.54	11.65	0.4	1.39	0.63
Sunset Creek	SE 30th	2464.334	2-year	79	65.8	68.55	67.59	2.75	0.008068	3.36	24.17	16.03	0.42	1.69	0.85
Sunset Creek	SE 30th	2464.334	10-year	126	65.8	69.04	68.07	3.24	0.009874	4.15	33.38	21.38	0.47	2.04	1.26
Sunset Creek	SE 30th	2464.334	25-year	157	65.8	69.27	68.35	3.47	0.011047	4.63	38.6	26.2	0.5	2.21	1.53
Sunset Creek	SE 30th	2464.334	100-year	212	65.8	69.6	68.83	3.8	0.012181	5.27	48.59	32.21	0.54	2.5	1.9
Sunset Creek	SE 30th	2429.853	1.01-year	52.48	66.05	67.9	67.23	1.85	0.007127	2.71	19.88	16.76	0.4	1.28	0.57
Sunset Creek	SE 30th	2429.853	2-year	79	66.05	68.31	67.5	2.26	0.006992	3.09	27.43	20.07	0.41	1.61	0.7
Sunset Creek	SE 30th	2429.853	10-year	126	66.05	68.78	67.9	2.73	0.007716	3.74	38.45	28.92	0.44	2.01	0.97
Sunset Creek	SE 30th	2429.853	25-year	157	66.05	68.98	68.13	2.93	0.008643	4.18	44.22	29.86	0.47	2.18	1.18
Sunset Creek	SE 30th	2429.853	100-year	212	66.05	69.27	68.52	3.22	0.009971	4.84	53.02	29.86	0.51	2.44	1.52
Sunset Creek	SE 30th	2407.706	1.01-year	52.48	65.66	67.2	67.18	1.54	0.050024	5.41	9.7	10.14	0.97	0.9	2.81
Sunset Creek	SE 30th	2407.706	2-year	79	65.66	67.49	67.49	1.83	0.055912	6.15	12.85	11.41	1.01	1.07	3.72
Sunset Creek	SE 30th	2407.706	10-year	126	65.66	68.08	68.08	2.42	0.035381	6.11	23.27	26.99	0.83	1.53	3.38
Sunset Creek	SE 30th	2407.706	25-year	157	65.66	68.32	68.32	2.66	0.031455	6.25	30.63	31.58	0.8	1.73	3.4
Sunset Creek	SE 30th	2407.706	100-year	212	65.66	68.59	68.59	2.93	0.031333	6.82	39.24	31.58	0.82	1.98	3.88
Sunset Creek	SE 30th	2379.636	1.01-year	52.48	65.03	66.82	66.35	1.79	0.011821	2.88	18.23	17.64	0.49	1.02	0.75
Sunset Creek	SE 30th	2379.636	2-year	79	65.03	67.2	66.61	2.17	0.010089	3.17	25.26	19.24	0.47	1.35	0.85
Sunset Creek	SE 30th	2379.636	10-year	126	65.03	67.63	66.95	2.6	0.010673	3.82	34.07	22.65	0.5	1.73	1.15
Sunset Creek	SE 30th	2379.636	25-year	157	65.03	67.84	67.15	2.81	0.011446	4.24	38.98	25.69	0.53	1.92	1.37
Sunset Creek	SE 30th	2379.636	100-year	212	65.03	68.13	67.45	3.1	0.012803	4.92	47.18	30.11	0.57	2.2	1.76
Sunset Creek	SE 30th	2361.19	1.01-year	52.48	64.42	66.75	65.77	2.33	0.003291	2.31	24.33	17.71	0.31	1.57	0.32
Sunset Creek	SE 30th	2361.19	2-year	79	64.42	67.12	66.06	2.7	0.003979	2.78	31.28	20	0.34	1.84	0.46
Sunset Creek	SE 30th	2361.19	10-year	126	64.42	67.53	66.48	3.11	0.005537	3.55	39.95	22.43	0.4	2.13	0.74
Sunset Creek	SE 30th	2361.19	25-year	157	64.42	67.72	66.73	3.3	0.006582	3.99	44.2	22.57	0.44	2.26	0.93
Sunset Creek	SE 30th	2361.19	100-year	212	64.42	67.98	67.1	3.56	0.008521	4.73	50.35	25.52	0.5	2.44	1.3
Sunset Creek	SE 30th	2341.739	1.01-year	52.48	64.47	66.46	65.91	1.99	0.015418	3.96	13.91	14.01	0.56	1.33	1.28
Sunset Creek	SE 30th	2341.739	2-year	79	64.47	66.78	66.34	2.31	0.016281	4.59	20.7	26.6	0.59	1.59	1.61
Sunset Creek	SE 30th	2341.739	10-year	126	64.47	66.99	66.99	2.52	0.024569	6.05	26.8	30.91	0.74	1.77	2.71
Sunset Creek	SE 30th	2341.739	25-year	157	64.47	67.2	67.2	2.73	0.023365	6.29	33.69	34.59	0.73	1.95	2.84
Sunset Creek	SE 30th	2341.739	100-year	212	64.47	67.45	67.45	2.98	0.02399	6.84	42.56	34.59	0.75	2.16	3.24
Sunset Creek	SE 30th	2313.296	1.01-year	52.48	64.36	65.6	65.6	1.24	0.03887	5.25	10.46	14.89	0.93	0.94	2.27
Sunset Creek	SE 30th	2313.296	2-year	79	64.36	65.99	65.99	1.63	0.056799	4.69	18.59	31.31	0.92	0.77	2.73
Sunset Creek	SE 30th	2313.296	10-year	126	64.36	66.45	66.22	2.09	0.022822	4.04	34.09	33.3	0.63	1.22	1.74
Sunset Creek	SE 30th	2313.296	25-year	157	64.36	66.7	66.34	2.34	0.017603	4	42.32	33.3	0.57	1.46	1.6
Sunset Creek	SE 30th	2313.296	100-year	212	64.36	67.07	66.54	2.71	0.013966	4.11	54.56	33.3	0.53	1.81	1.58
Sunset Creek	SE 30th	2297.254	1.01-year	52.48	62.97	65.57	64.4	2.6	0.003703	2.18	30.74	29.44	0.27	1.98	0.46
Sunset Creek	SE 30th	2297.254	2-year	79	62.97	65.91	64.75	2.94	0.004278	2.59	41.16	31.13	0.29	2.31	0.62
Sunset Creek	SE 30th	2297.254	10-year	126	62.97	66.36	65.17	3.39	0.00516	3.19	55.75	84.25	0.33	2.74	0.88
Sunset Creek	SE 30th	2297.254	25-year	157	62.97	66.6	65.43	3.63	0.005718	3.54	63.93	86.24	0.35	2.96	1.06
Sunset Creek	SE 30th	2297.254	100-year	212	62.97	66.96	65.86	3.99	0.006276	3.99	76.84	86.24	0.38	3.31	1.3
Sunset Creek	SE 30th	2285.55	1.01-year	52.48	63.26	65.57	64.58	2.31	0.002258	1.3	46.24	33.75	0.17	1.39	0.2
Sunset Creek	SE 30th	2285.55	2-year	79	63.26	65.92	64.72	2.66	0.002488	1.54	58.22	34.76	0.18	1.65	0.26
Sunset Creek	SE 30th	2285.55	10-year	126	63.26	66.39	64.94	3.13	0.002542	1.77	78.44	100.84	0.19	2.01	0.32
Sunset Creek	SE 30th	2285.55	25-year	157	63.26	66.63	65.06	3.37	0.002312	1.79	90.89	100.84	0.19	2.2	0.32
Sunset Creek	SE 30th	2285.55	100-year	212	63.26	67.01	65.26	3.75	0.001991	1.8	110.12	100.84	0.18	2.49	0.31
Sunset Creek	SE 30th	2261.889	1.01-year	52.48	63.31	65.44	64.72	2.13	0.004929	2.35	31.44	92.25	0.31	1.5	0.46
Sunset Creek	SE 30th	2261.889	2-year	79	63.31	65.77	64.95	2.46	0.005531	2.79	41.16	95.88	0.34	1.78	0.61
Sunset Creek	SE 30th	2261.889	10-year	126	63.31	66.21	65.27	2.9	0.006161	3.34	55.45	97.98	0.37	2.16	0.83
Sunset Creek	SE 30th	2261.889	25-year	157	63.31	66.44	65.45	3.13	0.006507	3.65	63.11	97.98	0.39	2.36	0.96
Sunset Creek	SE 30th	2261.889	100-year	212	63.31	66.8	65.74	3.49	0.007047	4.12	74.91	97.98	0.41	2.67	1.17

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	2238.42	1.01-year	52.48	63.48	65.28	64.66	1.8	0.007533	2.53	26.26	90.2	0.37	1.4	0.66
Sunset Creek	SE 30th	2238.42	2-year	79	63.48	65.59	64.95	2.11	0.007916	2.95	34.84	92.49	0.39	1.69	0.84
Sunset Creek	SE 30th	2238.42	10-year	126	63.48	66	65.27	2.52	0.008879	3.58	46.72	97.36	0.43	2.08	1.15
Sunset Creek	SE 30th	2238.42	25-year	157	63.48	66.21	65.44	2.73	0.009416	3.92	53.14	97.36	0.45	2.28	1.34
Sunset Creek	SE 30th	2238.42	100-year	212	63.48	66.54	65.7	3.06	0.010293	4.47	62.92	97.36	0.48	2.59	1.67
Sunset Creek	SE 30th	2205.456	1.01-year	52.48	63.19	65	64.55	1.81	0.008604	2.79	25.06	89.89	0.42	1.36	0.73
Sunset Creek	SE 30th	2205.456	2-year	79	63.19	65.28	64.77	2.09	0.009445	3.31	33.12	93.14	0.45	1.63	0.96
Sunset Creek	SE 30th	2205.456	10-year	126	63.19	65.65	65.08	2.46	0.010778	4.02	44.96	96.12	0.5	1.98	1.34
Sunset Creek	SE 30th	2205.456	25-year	157	63.19	65.84	65.19	2.65	0.01136	4.39	51.41	96.12	0.52	2.17	1.54
Sunset Creek	SE 30th	2205.456	100-year	212	63.19	66.13	65.58	2.94	0.012404	4.97	61.12	96.12	0.55	2.46	1.9
Sunset Creek	SE 30th	2189.813	1.01-year	52.48	63.33	64.84	64.55	1.76	0.009729	2.3	22.76	26.3	0.38	1.1	0.67
Sunset Creek	SE 30th	2189.813	2-year	79	63.33	65.11	64.72	2.03	0.010621	2.77	30.06	27.67	0.41	1.36	0.9
Sunset Creek	SE 30th	2189.813	10-year	126	63.33	65.48	64.99	2.4	0.011004	3.29	41.61	83.85	0.43	1.71	1.17
Sunset Creek	SE 30th	2189.813	25-year	157	63.33	65.69	65.16	2.61	0.010237	3.42	48.81	83.85	0.43	1.91	1.22
Sunset Creek	SE 30th	2189.813	100-year	212	63.33	66	65.5	2.92	0.00956	3.64	59.37	83.85	0.42	2.21	1.32
Sunset Creek	SE 30th	2175.255	1.01-year	52.48	62.85	64.4	64.38	1.55	0.043402	4.65	15.02	25.47	0.74	1.1	2.98
Sunset Creek	SE 30th	2175.255	2-year	79	62.85	64.58	64.58	1.73	0.050518	5.51	19.7	25.88	0.82	1.26	3.98
Sunset Creek	SE 30th	2175.255	10-year	126	62.85	64.88	64.88	2.03	0.053164	6.42	27.34	82.34	0.87	1.53	5.07
Sunset Creek	SE 30th	2175.255	25-year	157	62.85	65.03	65.03	2.18	0.056152	6.98	31.33	86.77	0.91	1.66	5.83
Sunset Creek	SE 30th	2175.255	100-year	212	62.85	65.37	65.28	2.52	0.047632	7.22	40.82	90.25	0.86	1.98	5.88
Sunset Creek	SE 30th	2121.292	1.01-year	52.48	61.77	63.42	63.08	1.65	0.012059	2.87	18.3	23.14	0.57	0.75	0.56
Sunset Creek	SE 30th	2121.292	2-year	79	61.77	63.76	63.31	1.99	0.008338	3.01	26.71	26	0.5	1.05	0.55
Sunset Creek	SE 30th	2121.292	10-year	126	61.77	64.22	63.6	2.45	0.006583	3.35	38.87	26.87	0.47	1.48	0.61
Sunset Creek	SE 30th	2121.292	25-year	157	61.77	64.56	63.75	2.79	0.005203	3.4	48.23	27.53	0.43	1.8	0.59
Sunset Creek	SE 30th	2121.292	100-year	212	61.77	65.18	64	3.41	0.003618	3.41	65.75	28.72	0.38	2.39	0.54
Sunset Creek	SE 30th	2107.746	1.01-year	52.48	61.82	62.85	62.85	1.03	0.029233	5.24	10.02	11.85	1	0.8	1.46
Sunset Creek	SE 30th	2107.746	2-year	79	61.82	63.12	63.12	1.3	0.028792	5.93	13.35	12.76	1	1.02	1.83
Sunset Creek	SE 30th	2107.746	10-year	126	61.82	63.85	63.63	2.03	0.012136	5.22	28.04	24.73	0.69	1.65	1.25
Sunset Creek	SE 30th	2107.746	25-year	157	61.82	64.33	63.84	2.51	0.007265	4.74	40.33	26.36	0.56	2.09	0.95
Sunset Creek	SE 30th	2107.746	100-year	212	61.82	65.04	64.14	3.22	0.004472	4.46	59.71	27.99	0.46	2.75	0.77
Sunset Creek	SE 30th	2098.229	1.01-year	100.32	60.13	62.65	62.12	2.52	0.010475	3.15	32.57	42.26	0.54	0.99	0.65
Sunset Creek	SE 30th	2098.229	2-year	151	60.13	63.04	62.51	2.91	0.007654	3.32	49.35	42.91	0.49	1.36	0.65
Sunset Creek	SE 30th	2098.229	10-year	236	60.13	63.64	62.88	3.51	0.005318	3.49	75.38	43.89	0.43	1.92	0.64
Sunset Creek	SE 30th	2098.229	25-year	297	60.13	64.04	63.06	3.91	0.004469	3.6	92.74	44.54	0.41	2.29	0.64
Sunset Creek	SE 30th	2098.229	100-year	412	60.13	64.71	63.38	4.58	0.003592	3.79	123.02	45.64	0.38	2.92	0.66
Sunset Creek	SE 30th	2070.489	1.01-year	100.32	60.45	62.56	61.73	2.11	0.003482	2.02	49.67	39.18	0.32	1.23	0.27
Sunset Creek	SE 30th	2070.489	2-year	151	60.45	62.98	61.98	2.53	0.003054	2.26	68.63	47.19	0.31	1.62	0.31
Sunset Creek	SE 30th	2070.489	10-year	236	60.45	63.6	62.31	3.15	0.002468	2.51	98.67	48.8	0.29	2.23	0.34
Sunset Creek	SE 30th	2070.489	25-year	297	60.45	64.01	62.49	3.56	0.00222	2.65	118.56	49.83	0.28	2.62	0.36
Sunset Creek	SE 30th	2070.489	100-year	412	60.45	64.69	62.82	4.24	0.001935	2.88	153.29	51.47	0.28	3.29	0.4
Sunset Creek	SE 30th	2050.566	1.01-year	100.32	59.65	62.37	61.97	2.72	0.009256	2.98	33.92	34.24	0.51	0.99	0.57
Sunset Creek	SE 30th	2050.566	2-year	151	59.65	62.82	62.19	3.17	0.006281	3.1	51.85	45.37	0.44	1.4	0.55
Sunset Creek	SE 30th	2050.566	10-year	236	59.65	63.49	62.51	3.84	0.004056	3.18	82.72	47.24	0.38	2.01	0.51
Sunset Creek	SE 30th	2050.566	25-year	297	59.65	63.9	62.75	4.25	0.003383	3.26	102.68	48.41	0.36	2.4	0.51
Sunset Creek	SE 30th	2050.566	100-year	412	59.65	64.6	63.07	4.95	0.002728	3.43	137.18	50.17	0.33	3.04	0.52
Sunset Creek	SE 30th	2036.451	1.01-year	100.32	60.13	62.26	61.72	2.13	0.008428	2.83	38.52	47.32	0.48	1.04	0.55
Sunset Creek	SE 30th	2036.451	2-year	151	60.13	62.77	62.03	2.64	0.004602	2.7	63.41	49	0.37	1.54	0.44
Sunset Creek	SE 30th	2036.451	10-year	236	60.13	63.47	62.39	3.34	0.003026	2.78	98.07	51.26	0.32	2.19	0.41
Sunset Creek	SE 30th	2036.451	25-year	297	60.13	63.89	62.57	3.76	0.002585	2.87	120.11	52.64	0.31	2.6	0.42
Sunset Creek	SE 30th	2036.451	100-year	412	60.13	64.6	62.85	4.47	0.002145	3.05	157.45	52.87	0.29	3.27	0.44
Sunset Creek	SE 30th	2016.641	1.01-year	100.32	59.66	62.2	61.35	2.54	0.003075	2.06	50.21	42.43	0.31	1.32	0.25
Sunset Creek	SE 30th	2016.641	2-year	151	59.66	62.74	61.64	3.08	0.002219	2.18	73.92	45.1	0.28	1.83	0.25
Sunset Creek	SE 30th	2016.641	10-year	236	59.66	63.43	61.94	3.77	0.00181	2.42	106.01	46.8	0.26	2.5	0.28
Sunset Creek	SE 30th	2016.641	25-year	297	59.66	63.86	62.14	4.2	0.001683	2.58	126.14	47.83	0.26	2.9	0.3
Sunset Creek	SE 30th	2016.641	100-year	412	59.66	64.57	62.47	4.91	0.001548	2.84	160.54	49.55	0.26	3.57	0.35
Sunset Creek	SE 30th	1988.07	1.01-year	100.32	59.15	62.15	61.01	3	0.001716	1.9	60.17	42	0.24	1.79	0.19
Sunset Creek	SE 30th	1988.07	2-year	151	59.15	62.69	61.27	3.54	0.001511	2.11	83.51	43.62	0.24	2.3	0.22
Sunset Creek	SE 30th	1988.07	10-year	236	59.15	63.39	61.63	4.24	0.001441	2.43	114.86	45.7	0.24	2.95	0.27
Sunset Creek	SE 30th	1988.07	25-year	297	59.15	63.82	61.84	4.67	0.001424	2.63	134.61	46.96	0.24	3.35	0.3
Sunset Creek	SE 30th	1988.07	100-year	412	59.15	64.53	62.24	5.38	0.001405	2.94	168.55	49.05	0.25	4.01	0.35
Sunset Creek	SE 30th	1968.444	1.01-year	100.32	59.73	62.1	61.04	2.37	0.001844	2.08	57.87	41.14	0.26	1.88	0.22
Sunset Creek	SE 30th	1968.444	2-year	151	59.73	62.65	61.33	2.92	0.001616	2.3	81.33	44.08	0.26	2.41	0.24
Sunset Creek	SE 30th	1968.444	10-year	236	59.73	63.35	61.71	3.62	0.001517	2.63	112.72	45.23	0.26	3.1	0.29
Sunset Creek	SE 30th	1968.444	25-year	297	59.73	63.78	61.92	4.05	0.001501	2.84	132.2	46.26	0.26	3.51	0.33
Sunset Creek	SE 30th	1968.444	100-year	412	59.73	64.48	62.27	4.75	0.001487	3.19	165.42	47.96	0.27	4.2	0.39
Sunset Creek	SE 30th	1954.61	1.01-year	100.32	59.63	61.99	61.33	2.36	0.008212	3.06	43.17	38.25	0.38	1.89	0.97
Sunset Creek	SE 30th	1954.61	2-year	151	59.63	62.57	61.66	2.94	0.005902	3.07	67.43	43.67	0.33	2.43	0.9
Sunset Creek	SE 30th	1954.61	10-year	236	59.63	63.29	62.03	3.66	0.00473	3.23	99.74	45.74	0.31	3.1	0.92
Sunset Creek	SE 30th	1954.61	25-year	297	59.63	63.73	62.3	4.1	0.004372	3.37	119.83	46.98	0.31	3.51	0.96
Sunset Creek	SE 30th	1954.61	100-year	412	59.63	64.44	62.62	4.81	0.003986	3.61	154.17	49.03	0.3	4.17	1.04
Sunset Creek	SE 30th	1928.749	1.01-year	100.32	59.16	61.96	60.54	2.8	0.001812	1.53	68.09	38.44	0.19	2.04	0.23
Sunset Creek	SE 30th	1928.749	2-year	151	59.16	62.54	60.77	3.38	0.001734	1.77	91.52	42.78	0.19	2.61	0.28
Sunset Creek	SE 30th	1928.749	10-year	236	59.16	63.26	61.1	4.1	0.001786	2.11	122.71	43.96	0.2	3.32	0.37
Sunset Creek	SE 30th	1928.749	25-year	297	59.16	63.69	61.31	4.53	0.001837	2.32	141.81	44.64	0.21	3.74	0.43
Sunset Creek	SE 30th	1928.749	100-year	412	59.16	64.4	61.66	5.24	0.001915	2.65	173.95	45.74	0.22	4.44	0.53

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	1881.347	1.01-year	100.32	58.45	61.71	60.37	3.26	0.005655	3.04	36.16	22.84	0.34	2.28	0.81
Sunset Creek	SE 30th	1881.347	2-year	151	58.45	62.25	60.8	3.8	0.006073	3.59	50.66	36.83	0.36	2.77	1.05
Sunset Creek	SE 30th	1881.347	10-year	236	58.45	62.96	61.48	4.51	0.005834	4.04	78.11	39.28	0.37	3.4	1.24
Sunset Creek	SE 30th	1881.347	25-year	297	58.45	63.39	61.9	4.94	0.005589	4.25	95.35	40.41	0.36	3.79	1.32
Sunset Creek	SE 30th	1881.347	100-year	412	58.45	64.1	62.64	5.65	0.005316	4.6	124.4	40.94	0.36	4.43	1.47
Sunset Creek	SE 30th	1868.66	1.01-year	100.32	59.05	61.67	60.65	2.62	0.004449	2.64	45.34	33.4	0.33	1.96	0.54
Sunset Creek	SE 30th	1868.66	2-year	151	59.05	62.24	61.01	3.19	0.003885	2.91	64.72	35.17	0.32	2.5	0.61
Sunset Creek	SE 30th	1868.66	10-year	236	59.05	62.95	61.52	3.9	0.003739	3.35	90.37	36.56	0.32	3.17	0.74
Sunset Creek	SE 30th	1868.66	25-year	297	59.05	63.38	61.76	4.33	0.003734	3.63	105.99	36.56	0.33	3.58	0.84
Sunset Creek	SE 30th	1868.66	100-year	412	59.05	64.07	62.15	5.02	0.003805	4.1	131.53	36.56	0.34	4.25	1.01
Sunset Creek	SE 30th	1856.084	1.01-year	100.32	58.51	61.54	60.64	3.03	0.009194	3.18	36.92	28.3	0.39	1.96	1.13
Sunset Creek	SE 30th	1856.084	2-year	151	58.51	62.12	61.06	3.61	0.007785	3.44	53.97	30.95	0.37	2.51	1.22
Sunset Creek	SE 30th	1856.084	10-year	236	58.51	62.83	61.6	4.32	0.007328	3.91	77.03	34.26	0.38	3.18	1.45
Sunset Creek	SE 30th	1856.084	25-year	297	58.51	63.25	61.86	4.74	0.007228	4.21	92.07	36.27	0.38	3.58	1.62
Sunset Creek	SE 30th	1856.084	100-year	412	58.51	63.96	62.31	5.45	0.00691	4.61	117.72	36.27	0.38	4.25	1.83
Sunset Creek	SE 30th	1817.494	1.01-year	100.32	58.15	61.26	59.86	3.11	0.004924	3.33	30.99	17.77	0.36	2.1	0.65
Sunset Creek	SE 30th	1817.494	2-year	151	58.15	61.77	60.34	3.62	0.005847	4.07	41.58	23.46	0.41	2.5	0.91
Sunset Creek	SE 30th	1817.494	10-year	236	58.15	62.37	61.03	4.22	0.00705	5.03	56.84	25.61	0.46	2.98	1.31
Sunset Creek	SE 30th	1817.494	25-year	297	58.15	62.73	61.59	4.58	0.007687	5.58	66.11	25.61	0.49	3.27	1.57
Sunset Creek	SE 30th	1817.494	100-year	412	58.15	63.33	62.25	5.18	0.008613	6.47	81.33	25.61	0.53	3.75	2.01
Sunset Creek	SE 30th	1805.019	1.01-year	100.32	58.22	61.22	59.92	3	0.004481	3.25	37.73	28.54	0.36	2.11	0.59
Sunset Creek	SE 30th	1805.019	2-year	151	58.22	61.74	60.37	3.52	0.004649	3.74	53.63	32.01	0.37	2.54	0.74
Sunset Creek	SE 30th	1805.019	10-year	236	58.22	62.39	61.23	4.17	0.004871	4.34	76.07	53.24	0.39	3.06	0.93
Sunset Creek	SE 30th	1805.019	25-year	297	58.22	62.78	61.56	4.56	0.00479	4.6	92.15	60.85	0.4	3.38	1.01
Sunset Creek	SE 30th	1805.019	100-year	412	58.22	63.46	62.1	5.24	0.004327	4.84	122.76	67.33	0.39	3.94	1.06
Sunset Creek	SE 30th	1791.536	1.01-year	100.32	58.58	61.12	60.26	2.54	0.005998	3.49	32.84	26.2	0.43	1.87	0.7
Sunset Creek	SE 30th	1791.536	2-year	151	58.58	61.65	60.74	3.07	0.005534	3.91	47.64	28.57	0.43	2.35	0.81
Sunset Creek	SE 30th	1791.536	10-year	236	58.58	62.25	61.28	3.67	0.005915	4.65	64.98	28.57	0.46	2.91	1.07
Sunset Creek	SE 30th	1791.536	25-year	297	58.58	62.61	61.59	4.03	0.006259	5.14	75.08	28.57	0.48	3.23	1.26
Sunset Creek	SE 30th	1791.536	100-year	412	58.58	63.18	62.03	4.6	0.006856	5.94	91.41	28.57	0.52	3.76	1.61
Sunset Creek	SE 30th	1777.213	1.01-year	100.32	58.04	61.1	59.79	3.06	0.00334	2.79	43.51	29.94	0.32	2.13	0.44
Sunset Creek	SE 30th	1777.213	2-year	151	58.04	61.64	60.25	3.6	0.003268	3.15	60.86	60.16	0.32	2.6	0.53
Sunset Creek	SE 30th	1777.213	10-year	236	58.04	62.27	60.89	4.23	0.003557	3.74	83.05	66.33	0.35	3.14	0.7
Sunset Creek	SE 30th	1777.213	25-year	297	58.04	62.64	61.24	4.6	0.003738	4.09	96.39	66.54	0.36	3.47	0.81
Sunset Creek	SE 30th	1777.213	100-year	412	58.04	63.24	61.67	5.2	0.004003	4.65	118.39	66.89	0.38	3.99	1
Sunset Creek	SE 30th	1749.718	1.01-year	100.32	57.73	60.91	59.77	3.18	0.005586	3.47	33.31	20.49	0.39	2.1	0.73
Sunset Creek	SE 30th	1749.718	2-year	151	57.73	61.39	60.31	3.66	0.006433	4.19	44.81	47.1	0.43	2.51	1.01
Sunset Creek	SE 30th	1749.718	10-year	236	57.73	61.91	60.9	4.18	0.008186	5.27	60.57	63.78	0.5	2.96	1.51
Sunset Creek	SE 30th	1749.718	25-year	297	57.73	62.21	61.31	4.48	0.009052	5.87	70.54	64.03	0.54	3.22	1.82
Sunset Creek	SE 30th	1749.718	100-year	412	57.73	62.72	61.95	4.99	0.010215	6.79	87.2	64.43	0.58	3.66	2.34
Sunset Creek	SE 30th	1689.563	1.01-year	100.32	57.21	60.02	59.59	2.81	0.020876	5.42	18.92	17.83	0.7	1.56	2.03
Sunset Creek	SE 30th	1689.563	2-year	151	57.21	60.43	60.37	3.22	0.020473	6.14	29.13	26.36	0.72	1.9	2.43
Sunset Creek	SE 30th	1689.563	10-year	236	57.21	61.02	60.84	3.81	0.016972	6.53	45.24	28.17	0.68	2.4	2.55
Sunset Creek	SE 30th	1689.563	25-year	297	57.21	61.38	61.07	4.17	0.015528	6.76	55.52	29.26	0.67	2.71	2.62
Sunset Creek	SE 30th	1689.563	100-year	412	57.21	61.97	61.51	4.76	0.013881	7.16	73.28	43.57	0.65	3.2	2.78
Sunset Creek	SE 30th	1668.393	1.01-year	100.32	56.93	59.91	59.04	2.98	0.008146	4.05	28.94	25.06	0.47	1.94	0.99
Sunset Creek	SE 30th	1668.393	2-year	151	56.93	60.35	59.81	3.42	0.008396	4.62	40.03	26.29	0.5	2.31	1.21
Sunset Creek	SE 30th	1668.393	10-year	236	56.93	60.91	60.31	3.98	0.008645	5.32	55.37	27.91	0.52	2.79	1.51
Sunset Creek	SE 30th	1668.393	25-year	297	56.93	61.26	60.56	4.33	0.008706	5.71	65.25	28.9	0.53	3.09	1.68
Sunset Creek	SE 30th	1668.393	100-year	412	56.93	61.84	61.01	4.91	0.008713	6.31	82.48	30.55	0.54	3.58	1.95
Sunset Creek	SE 30th	1626.318	1.01-year	100.32	56.89	59.64	58.71	2.75	0.006398	3.64	31.21	23.61	0.43	1.9	0.76
Sunset Creek	SE 30th	1626.318	2-year	151	56.89	60.03	59.27	3.14	0.007479	4.38	40.51	24.76	0.48	2.23	1.04
Sunset Creek	SE 30th	1626.318	10-year	236	56.89	60.51	59.87	3.62	0.009048	5.39	52.72	26.21	0.54	2.65	1.49
Sunset Creek	SE 30th	1626.318	25-year	297	56.89	60.8	60.15	3.91	0.009898	5.99	60.41	27.07	0.58	2.9	1.79
Sunset Creek	SE 30th	1626.318	100-year	412	56.89	61.3	60.62	4.41	0.010777	6.86	74.37	28.58	0.62	3.33	2.24
Sunset Creek	SE 30th	1613.357	1.01-year	100.32	56.46	59.63	58.27	3.17	0.003357	2.9	37.14	23.32	0.33	2.08	0.44
Sunset Creek	SE 30th	1613.357	2-year	151	56.46	60	58.69	3.54	0.004389	3.65	46.19	24.85	0.39	2.4	0.66
Sunset Creek	SE 30th	1613.357	10-year	236	56.46	60.47	59.4	4.01	0.0059	4.69	58.04	26.32	0.46	2.8	1.03
Sunset Creek	SE 30th	1613.357	25-year	297	56.46	60.74	59.77	4.28	0.006805	5.32	65.4	27.19	0.5	3.03	1.29
Sunset Creek	SE 30th	1613.357	100-year	412	56.46	61.23	60.29	4.77	0.00793	6.25	78.89	28.73	0.55	3.45	1.71
Sunset Creek	SE 30th	1592.728	1.01-year	100.32	56.02	59.65	57.91	3.63	0.001149	1.69	62.89	33.09	0.19	2.23	0.16
Sunset Creek	SE 30th	1592.728	2-year	151	56.02	60.04	58.23	4.02	0.001518	2.15	75.99	33.8	0.23	2.6	0.25
Sunset Creek	SE 30th	1592.728	10-year	236	56.02	60.54	58.66	4.52	0.002077	2.81	92.89	34.71	0.28	3.07	0.4
Sunset Creek	SE 30th	1592.728	25-year	297	56.02	60.83	58.92	4.81	0.00242	3.22	103.26	35.25	0.3	3.35	0.51
Sunset Creek	SE 30th	1592.728	100-year	412	56.02	61.35	59.38	5.33	0.002877	3.85	121.91	36.21	0.34	3.85	0.69
Sunset Creek	SE 30th	1583.59	1.01-year	100.32	56.87	59.48	58.8	2.61	0.008049	3.48	32.65	32.1	0.47	1.59	0.8
Sunset Creek	SE 30th	1583.59	2-year	151	56.87	59.81	59.2	2.94	0.00914	4.19	43.62	33.2	0.52	1.91	1.09
Sunset Creek	SE 30th	1583.59	10-year	236	56.87	60.21	59.7	3.34	0.011291	5.25	56.96	34.5	0.6	2.28	1.61
Sunset Creek	SE 30th	1583.59	25-year	297	56.87	60.43	59.97	3.56	0.012715	5.91	64.84	35.25	0.64	2.5	1.98
Sunset Creek	SE 30th	1583.59	100-year	412	56.87	60.87	60.38	4	0.013713	6.8	80.49	36.69	0.68	2.91	2.49
Sunset Creek	SE 30th	1583.5		Lat Struct											

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	1576.451	1.01-year	100.32	56.81	59.39	58.71	2.58	0.01288	3.58	28.97	25.93	0.53	1.27	1.02
Sunset Creek	SE 30th	1576.451	2-year	151	56.81	59.69	59.18	2.88	0.015583	4.33	37.2	28.01	0.6	1.47	1.43
Sunset Creek	SE 30th	1576.451	10-year	236	56.81	60.02	59.67	3.21	0.020105	5.52	46.94	31.92	0.7	1.76	2.2
Sunset Creek	SE 30th	1576.451	25-year	297	56.81	60.17	59.92	3.36	0.024449	6.39	51.81	33.88	0.78	1.89	2.89
Sunset Creek	SE 30th	1576.451	100-year	412	56.81	60.36	60.36	3.55	0.034449	8.04	58.39	36.3	0.94	2.06	4.43
Sunset Creek	SE 30th	1535.154	1.01-year	85.27	56.74	58.88	58.13	2.14	0.005952	2.09	44.51	64.82	0.32	1.3	0.48
Sunset Creek	SE 30th	1535.154	2-year	128.35	56.74	59.18	58.35	2.44	0.006312	2.43	65.06	75.59	0.34	1.55	0.61
Sunset Creek	SE 30th	1535.154	10-year	200.6	56.74	59.54	58.67	2.8	0.006603	2.81	96.09	107.2	0.36	1.86	0.77
Sunset Creek	SE 30th	1535.154	25-year	252.45	56.74	59.75	58.95	3.01	0.006459	2.98	118.93	107.2	0.36	2.06	0.83
Sunset Creek	SE 30th	1535.154	100-year	350.2	56.74	60.09	59.26	3.35	0.006347	3.26	155.06	107.2	0.37	2.39	0.95
Sunset Creek	SE 30th	1520.645	1.01-year	85.27	56.07	58.86	57.6	2.79	0.001622	1.56	72.98	107.62	0.21	1.52	0.15
Sunset Creek	SE 30th	1520.645	2-year	128.35	56.07	59.16	57.84	3.09	0.001767	1.81	105.43	109.75	0.23	1.79	0.2
Sunset Creek	SE 30th	1520.645	10-year	200.6	56.07	59.52	58.19	3.45	0.00202	2.16	144.8	109.75	0.25	2.11	0.27
Sunset Creek	SE 30th	1520.645	25-year	252.45	56.07	59.73	58.4	3.66	0.002178	2.38	167.84	109.75	0.26	2.3	0.31
Sunset Creek	SE 30th	1520.645	100-year	350.2	56.07	60.06	58.97	3.99	0.002455	2.74	204.17	109.75	0.28	2.6	0.4
Sunset Creek	SE 30th	1493.465	1.01-year	85.27	56.01	58.7	57.64	2.69	0.004145	2.89	40.53	62.58	0.35	1.9	0.49
Sunset Creek	SE 30th	1493.465	2-year	128.35	56.01	58.95	58.02	2.94	0.005351	3.54	61.32	88.29	0.41	2.12	0.71
Sunset Creek	SE 30th	1493.465	10-year	200.6	56.01	59.27	58.92	3.26	0.006281	4.18	89.8	88.29	0.45	2.42	0.95
Sunset Creek	SE 30th	1493.465	25-year	252.45	56.01	59.46	59.1	3.45	0.006746	4.54	106.66	88.29	0.47	2.59	1.09
Sunset Creek	SE 30th	1493.465	100-year	350.2	56.01	59.76	59.35	3.75	0.007605	5.14	132.59	88.29	0.51	2.86	1.36
Sunset Creek	SE 30th	1474.062	1.01-year	85.27	56.81	58.67	58.2	1.86	0.003919	2.28	70.18	110.27	0.33	1.37	0.33
Sunset Creek	SE 30th	1474.062	2-year	128.35	56.81	58.94	58.39	2.13	0.003902	2.54	99.13	110.27	0.34	1.61	0.39
Sunset Creek	SE 30th	1474.062	10-year	200.6	56.81	59.27	58.59	2.46	0.004071	2.92	135.6	110.27	0.36	1.92	0.49
Sunset Creek	SE 30th	1474.062	25-year	252.45	56.81	59.46	58.74	2.65	0.004232	3.16	156.98	110.27	0.37	2.1	0.55
Sunset Creek	SE 30th	1474.062	100-year	350.2	56.81	59.76	58.94	2.95	0.004639	3.59	189.85	110.27	0.4	2.38	0.69
Sunset Creek	SE 30th	1400.25	1.01-year	85.27	56.09	57.96	57.61	1.87	0.014145	4.19	31.41	78.66	0.61	1.34	1.19
Sunset Creek	SE 30th	1400.25	2-year	128.35	56.09	58.15	58.15	2.06	0.016614	4.89	46.97	83.59	0.67	1.51	1.57
Sunset Creek	SE 30th	1400.25	10-year	200.6	56.09	58.38	58.38	2.29	0.019637	5.79	65.88	83.59	0.74	1.71	2.1
Sunset Creek	SE 30th	1400.25	25-year	252.45	56.09	58.52	58.52	2.43	0.02105	6.28	77.39	83.59	0.78	1.84	2.42
Sunset Creek	SE 30th	1400.25	100-year	350.2	56.09	58.85	58.73	2.76	0.018143	6.45	105.04	83.59	0.74	2.14	2.42
Sunset Creek	SE 30th	1312.582	1.01-year	85.27	54.16	56.24	55.93	2.08	0.0213	5.36	15.98	11.67	0.75	1.36	1.81
Sunset Creek	SE 30th	1312.582	2-year	128.35	54.16	56.73	56.72	2.57	0.013865	5.05	46.93	86.52	0.62	1.73	1.5
Sunset Creek	SE 30th	1312.582	10-year	200.6	54.16	57.34	56.99	3.18	0.006623	4.16	100.75	87.46	0.45	2.25	0.93
Sunset Creek	SE 30th	1312.582	25-year	252.45	54.16	57.8	57.13	3.64	0.004257	3.71	140.95	87.46	0.37	2.64	0.7
Sunset Creek	SE 30th	1312.582	100-year	350.2	54.16	58.59	57.35	4.43	0.002582	3.35	209.85	87.46	0.3	3.31	0.53
Sunset Creek	SE 30th	1208.49	1.01-year	85.27	51.7	54.69	53.8	2.99	0.011975	4.59	18.56	8.69	0.55	1.56	1.17
Sunset Creek	SE 30th	1208.49	2-year	128.35	51.7	55.76	54.36	4.06	0.007418	3.96	43.63	47.17	0.45	1.82	0.84
Sunset Creek	SE 30th	1208.49	10-year	200.6	51.7	56.96	55.65	5.26	0.002698	3.01	107.59	54.66	0.29	2.6	0.44
Sunset Creek	SE 30th	1208.49	25-year	252.45	51.7	57.5	55.97	5.8	0.002206	3.01	137.02	54.66	0.27	3.02	0.42
Sunset Creek	SE 30th	1208.49	100-year	350.2	51.7	58.34	56.34	6.64	0.001853	3.15	183.05	54.66	0.26	3.67	0.42
Sunset Creek	SE 30th	1177.949	1.01-year	100.55	51.42	54.73	53.05	3.31	0.001847	2.77	36.25	13.04	0.29	2.11	0.24
Sunset Creek	SE 30th	1177.949	2-year	151.35	51.42	55.49	53.47	4.07	0.001658	3.06	67.13	50.15	0.29	2.67	0.28
Sunset Creek	SE 30th	1177.949	10-year	236.6	51.42	56.27	54.07	4.85	0.001625	3.46	106.13	50.15	0.29	3.26	0.33
Sunset Creek	SE 30th	1177.949	25-year	297.45	51.42	56.72	54.46	5.3	0.001634	3.7	128.59	50.15	0.3	3.6	0.37
Sunset Creek	SE 30th	1177.949	100-year	413.2	51.42	57.46	55.54	6.04	0.001653	4.1	165.82	50.15	0.31	4.16	0.43
Sunset Creek	SE 30th	1012.233	1.01-year	100.55	49.75	53.92	52.37	4.17	0.012251	4.21	23.87	7.7	0.42	1.6	1.23
Sunset Creek	SE 30th	1012.233	2-year	151.35	49.75	54.61	53	4.86	0.01479	4.99	32.94	19.55	0.46	1.82	1.68
Sunset Creek	SE 30th	1012.233	10-year	236.6	49.75	55.32	53.89	5.57	0.015391	5.74	47.5	21.31	0.49	2.18	2.09
Sunset Creek	SE 30th	1012.233	25-year	297.45	49.75	55.73	54.97	5.98	0.015626	6.14	56.34	22.3	0.5	2.38	2.32
Sunset Creek	SE 30th	1012.233	100-year	413.2	49.75	56.4	55.54	6.65	0.015676	6.72	72.28	25.48	0.51	2.72	2.66
Sunset Creek	SE 30th	852.3866	1.01-year	100.55	50.09	52.62	51.63	2.53	0.006319	3.4	29.59	14.77	0.42	1.78	0.7
Sunset Creek	SE 30th	852.3866	2-year	151.35	50.09	53.16	52.04	3.07	0.006783	3.98	39.21	20.86	0.45	2.16	0.91
Sunset Creek	SE 30th	852.3866	10-year	236.6	50.09	54.19	52.6	4.1	0.004972	4.03	66.56	32.49	0.39	2.84	0.88
Sunset Creek	SE 30th	852.3866	25-year	297.45	50.09	54.65	53	4.56	0.004729	4.18	81.89	33.02	0.39	3.14	0.93
Sunset Creek	SE 30th	852.3866	100-year	413.2	50.09	55.42	53.69	5.33	0.004455	4.42	107.5	33.91	0.38	3.61	1
Sunset Creek	SE 30th	834.4796	1.01-year	100.55	50.42	52.35	52.05	1.93	0.014703	4.18	24.05	20.5	0.68	1.14	1.05
Sunset Creek	SE 30th	834.4796	2-year	151.35	50.42	53.04	52.37	2.62	0.007453	3.92	39.71	25.08	0.51	1.75	0.81
Sunset Creek	SE 30th	834.4796	10-year	236.6	50.42	54.14	52.8	3.72	0.003765	3.62	71.25	32.4	0.38	2.65	0.62
Sunset Creek	SE 30th	834.4796	25-year	297.45	50.42	54.61	53.07	4.19	0.003506	3.79	86.81	33.42	0.37	3.02	0.66
Sunset Creek	SE 30th	834.4796	100-year	413.2	50.42	55.37	53.54	4.95	0.003281	4.09	112.52	33.91	0.36	3.6	0.74
Sunset Creek	SE 30th	816.2844	1.01-year	100.55	50.18	52.24	51.75	2.06	0.008129	3.12	32.25	26.81	0.5	1.16	0.59
Sunset Creek	SE 30th	816.2844	2-year	151.35	50.18	53.02	52.01	2.84	0.00406	2.78	54.42	30.01	0.36	1.73	0.44
Sunset Creek	SE 30th	816.2844	10-year	236.6	50.18	54.15	52.38	3.97	0.002001	2.58	96.78	43.1	0.27	2.69	0.34
Sunset Creek	SE 30th	816.2844	25-year	297.45	50.18	54.63	52.61	4.45	0.001856	2.72	117.37	43.46	0.26	3.08	0.36
Sunset Creek	SE 30th	816.2844	100-year	413.2	50.18	55.4	53	5.22	0.001737	2.95	151.26	44.04	0.26	3.71	0.4
Sunset Creek	SE 30th	795.8286	1.01-year	100.55	50.27	52.19	51.34	1.92	0.003154	2.32	44.89	31.92	0.32	1.49	0.29
Sunset Creek	SE 30th	795.8286	2-year	151.35	50.27	53	51.59	2.73	0.001786	2.23	72.01	35.08	0.26	2.18	0.24
Sunset Creek	SE 30th	795.8286	10-year	236.6	50.27	54.14	51.96	3.87	0.001153	2.25	114.07	37.65	0.21	3.1	0.22
Sunset Creek	SE 30th	795.8286	25-year	297.45	50.27	54.62	52.18	4.35	0.001187	2.45	131.92	37.82	0.22	3.47	0.26
Sunset Creek	SE 30th	795.8286	100-year	413.2	50.27	55.38	52.55	5.11	0.001271	2.78	161.13	38.09	0.23	4.05	0.32

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	772.6812	1.01-year	100.55	49.8	52.11	51.34	2.31	0.003636	2.31	43.77	31.6	0.34	1.35	0.31
Sunset Creek	SE 30th	772.6812	2-year	151.35	49.8	52.96	51.57	3.16	0.001805	2.16	72.6	36.27	0.25	2.08	0.23
Sunset Creek	SE 30th	772.6812	10-year	236.6	49.8	54.12	51.89	4.32	0.001109	2.15	115.01	45.55	0.21	3.03	0.21
Sunset Creek	SE 30th	772.6812	25-year	297.45	49.8	54.59	52.11	4.79	0.001113	2.35	132.47	46.93	0.21	3.44	0.24
Sunset Creek	SE 30th	772.6812	100-year	413.2	49.8	55.36	52.47	5.56	0.001142	2.68	160.86	49.35	0.22	4.13	0.29
Sunset Creek	SE 30th	742.021	1.01-year	100.55	49.76	52.02	51.21	2.26	0.00317	2.11	47.75	33.86	0.31	1.33	0.26
Sunset Creek	SE 30th	742.021	2-year	151.35	49.76	52.92	51.43	3.16	0.001525	1.91	79.31	41.32	0.23	2.05	0.19
Sunset Creek	SE 30th	742.021	10-year	236.6	49.76	54.1	51.73	4.34	0.000905	1.94	122.06	51.49	0.19	3.11	0.18
Sunset Creek	SE 30th	742.021	25-year	297.45	49.76	54.57	51.93	4.81	0.000922	2.14	139.29	53.01	0.19	3.55	0.2
Sunset Creek	SE 30th	742.021	100-year	413.2	49.76	55.34	52.27	5.58	0.000966	2.47	167.27	53.01	0.2	4.27	0.26
Sunset Creek	SE 30th	704.0906		Bridge											
Sunset Creek	SE 30th	637.1669	1.01-year	100.55	49	51.91	50.27	2.91	0.000849	1.45	70.16	47.21	0.17	2.09	0.11
Sunset Creek	SE 30th	637.1669	2-year	151.35	49	52.5	50.53	3.5	0.000909	1.72	88.83	47.46	0.18	2.59	0.15
Sunset Creek	SE 30th	637.1669	10-year	236.6	49	53.12	50.86	4.12	0.001179	2.21	108.49	50.81	0.21	3.12	0.23
Sunset Creek	SE 30th	637.1669	25-year	297.45	49	53.46	51.05	4.46	0.001352	2.52	121.1	55.09	0.23	3.42	0.29
Sunset Creek	SE 30th	637.1669	100-year	413.2	49	54.01	51.41	5.01	0.001628	3.02	142.45	55.09	0.26	3.92	0.4
Sunset Creek	SE 30th	616.5581	1.01-year	100.55	48.88	51.91	49.89	3.03	0.000324	1.03	110.94	63.73	0.11	2.53	0.05
Sunset Creek	SE 30th	616.5581	2-year	151.35	48.88	52.51	50.12	3.63	0.000371	1.24	138.21	68.09	0.12	3.03	0.07
Sunset Creek	SE 30th	616.5581	10-year	236.6	48.88	53.13	50.44	4.25	0.000508	1.6	166.44	68.49	0.14	3.53	0.11
Sunset Creek	SE 30th	616.5581	25-year	297.45	48.88	53.48	50.61	4.6	0.000595	1.83	182.9	71.65	0.16	3.84	0.14
Sunset Creek	SE 30th	616.5581	100-year	413.2	48.88	54.03	50.91	5.15	0.000743	2.22	210.99	73.22	0.18	4.35	0.2
Sunset Creek	SE 30th	596.5916	1.01-year	100.55	48.52	51.89	49.66	3.37	0.000467	1.23	86.54	39.78	0.13	2.65	0.08
Sunset Creek	SE 30th	596.5916	2-year	151.35	48.52	52.49	49.91	3.97	0.000583	1.52	105.24	41.8	0.14	3.12	0.11
Sunset Creek	SE 30th	596.5916	10-year	236.6	48.52	53.09	50.27	4.57	0.000843	2.01	124.51	43.08	0.18	3.62	0.19
Sunset Creek	SE 30th	596.5916	25-year	297.45	48.52	53.42	50.49	4.9	0.001019	2.33	135.71	44.4	0.2	3.92	0.25
Sunset Creek	SE 30th	596.5916	100-year	413.2	48.52	53.95	50.89	5.43	0.00133	2.88	154.44	46.49	0.23	4.39	0.36
Sunset Creek	SE 30th	572.9708	1.01-year	100.55	47.8	51.78	50.11	3.98	0.007554	2.48	40.57	21.98	0.31	1.85	0.87
Sunset Creek	SE 30th	572.9708	2-year	151.35	47.8	52.36	50.59	4.56	0.00704	2.83	57.37	34.91	0.31	2.37	1.04
Sunset Creek	SE 30th	572.9708	10-year	236.6	47.8	52.92	51.28	5.12	0.007896	3.42	77.87	37.51	0.34	2.89	1.43
Sunset Creek	SE 30th	572.9708	25-year	297.45	47.8	53.24	51.64	5.44	0.008505	3.79	89.79	38.6	0.36	3.18	1.69
Sunset Creek	SE 30th	572.9708	100-year	413.2	47.8	53.73	52.3	5.93	0.009462	4.37	108.99	38.6	0.39	3.64	2.15
Sunset Creek	SE 30th	554.7107	1.01-year	100.55	47.62	51.53	49.85	3.91	0.008682	3.52	29.63	16.92	0.36	2.05	1.11
Sunset Creek	SE 30th	554.7107	2-year	151.35	47.62	52.02	50.4	4.4	0.010903	4.36	43.89	52.69	0.41	2.38	1.62
Sunset Creek	SE 30th	554.7107	10-year	236.6	47.62	52.65	51.17	5.03	0.009976	4.65	77.93	55.5	0.4	2.81	1.75
Sunset Creek	SE 30th	554.7107	25-year	297.45	47.62	53.01	52.36	5.39	0.009413	4.78	97.97	57.09	0.4	3.05	1.79
Sunset Creek	SE 30th	554.7107	100-year	413.2	47.62	53.57	52.75	5.95	0.00864	4.95	134.46	116.88	0.39	3.44	1.85
Sunset Creek	SE 30th	543.1325	1.01-year	100.55	47.65	51.51	49.72	3.86	0.003279	2.92	35.14	50	0.3	2.2	0.45
Sunset Creek	SE 30th	543.1325	2-year	151.35	47.65	52.04	50.19	4.39	0.003653	3.38	63.45	55.09	0.32	2.55	0.58
Sunset Creek	SE 30th	543.1325	10-year	236.6	47.65	52.64	50.87	4.99	0.00388	3.88	98.52	117.31	0.34	3	0.73
Sunset Creek	SE 30th	543.1325	25-year	297.45	47.65	52.98	51.29	5.33	0.003888	4.11	121.66	117.31	0.35	3.26	0.79
Sunset Creek	SE 30th	543.1325	100-year	413.2	47.65	53.53	52.3	5.88	0.003893	4.45	158.7	117.31	0.36	3.68	0.89
Sunset Creek	SE 30th	529.8341	1.01-year	100.55	47.8	51.47	49.72	3.67	0.003867	2.94	34.86	19.2	0.31	2.17	0.52
Sunset Creek	SE 30th	529.8341	2-year	151.35	47.8	51.99	50.2	4.19	0.004277	3.39	59.21	104.43	0.33	2.5	0.67
Sunset Creek	SE 30th	529.8341	10-year	236.6	47.8	52.59	50.88	4.79	0.004214	3.77	94.2	110.83	0.34	2.97	0.78
Sunset Creek	SE 30th	529.8341	25-year	297.45	47.8	52.93	51.3	5.13	0.004219	4	115.6	114.44	0.34	3.23	0.85
Sunset Creek	SE 30th	529.8341	100-year	413.2	47.8	53.48	52.33	5.68	0.004251	4.35	152.34	120.19	0.35	3.66	0.97
Sunset Creek	SE 30th	420.6496	1.01-year	100.55	47.11	51.29	48.76	4.18	0.001291	1.95	52.86	25.41	0.19	2.57	0.21
Sunset Creek	SE 30th	420.6496	2-year	151.35	47.11	51.75	49.16	4.64	0.001809	2.48	74.98	54.07	0.23	2.87	0.32
Sunset Creek	SE 30th	420.6496	10-year	236.6	47.11	52.3	49.73	5.19	0.002267	3.05	110.76	118.2	0.26	3.31	0.47
Sunset Creek	SE 30th	420.6496	25-year	297.45	47.11	52.62	50.1	5.51	0.002455	3.33	132.7	118.2	0.28	3.56	0.55
Sunset Creek	SE 30th	420.6496	100-year	413.2	47.11	53.14	50.75	6.03	0.0027	3.76	168.24	118.2	0.3	3.97	0.67
Sunset Creek	SE 30th	48.9477	1.01-year	100.55	47.18	50.65	49.5	3.47	0.002442	2.13	71.26	131.31	0.26	1.84	0.28
Sunset Creek	SE 30th	48.9477	2-year	151.35	47.18	50.98	49.88	3.8	0.002464	2.37	98.48	131.31	0.27	2.15	0.33
Sunset Creek	SE 30th	48.9477	10-year	236.6	47.18	51.5	50.55	4.32	0.002216	2.56	140.71	131.31	0.27	2.62	0.36
Sunset Creek	SE 30th	48.9477	25-year	297.45	47.18	51.8	50.7	4.62	0.002179	2.72	165.11	131.31	0.27	2.9	0.39
Sunset Creek	SE 30th	48.9477	100-year	413.2	47.18	52.3	50.92	5.12	0.00215	2.98	205.72	131.31	0.27	3.36	0.45
Richards Creek	Historical	1507.208	1.01-year	15.05	57.05	58.62	57.65	1.57	0.002703	0.91	16.56	17.45	0.16	0.89	0.15
Richards Creek	Historical	1507.208	2-year	22.65	57.05	58.81	57.8	1.76	0.003796	1.13	20.06	19	0.19	0.98	0.23
Richards Creek	Historical	1507.208	10-year	35.4	57.05	59.03	58	1.98	0.005265	1.45	24.62	23.46	0.23	1.14	0.37
Richards Creek	Historical	1507.208	25-year	44.55	57.05	59.13	58.13	2.08	0.006525	1.69	27.09	26.94	0.26	1.21	0.49
Richards Creek	Historical	1507.208	100-year	61.8	57.05	59.27	58.31	2.22	0.00875	2.09	31.13	30.61	0.31	1.34	0.73
Richards Creek	Historical	1481.097	1.01-year	15.05	57.41	58.45	58.08	1.04	0.012687	1.84	10.58	30.74	0.37	0.74	0.58
Richards Creek	Historical	1481.097	2-year	22.65	57.41	58.65	58.32	1.24	0.009489	1.77	20.33	70.02	0.32	0.88	0.52
Richards Creek	Historical	1481.097	10-year	35.4	57.41	58.91	58.51	1.5	0.005139	1.48	44.41	115.25	0.24	1.09	0.35
Richards Creek	Historical	1481.097	25-year	44.55	57.41	59	58.61	1.59	0.004818	1.51	56.33	131.14	0.24	1.18	0.36
Richards Creek	Historical	1481.097	100-year	61.8	57.41	59.14	58.72	1.73	0.004481	1.57	76.03	145.39	0.24	1.32	0.37
Richards Creek	Historical	1291.987	1.01-year	15.05	55.48	56.38	56.05	0.9	0.009455	1.94	7.75	12.07	0.43	0.63	0.37
Richards Creek	Historical	1291.987	2-year	22.65	55.48	56.5	56.19	1.02	0.012864	2.44	9.29	12.84	0.5	0.71	0.57
Richards Creek	Historical	1291.987	10-year	35.4	55.48	56.41	56.38	0.93	0.046361	4.38	8.09	12.25	0.95	0.65	1.87
Richards Creek	Historical	1291.987	25-year	44.55	55.48	56.5	56.5	1.02	0.050988	4.83	9.21	12.8	1	0.7	2.24
Richards Creek	Historical	1291.987	100-year	61.8	55.48	56.68	56.68	1.2	0.049454	5.28	11.71	13.74	1.01	0.83	2.56

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Richards Creek	Historical	999.2128	1.01-year	15.05	51.78	52.33	52.21	0.55	0.021643	2.41	6.26	14.62	0.65	0.42	0.57
Richards Creek	Historical	999.2128	2-year	22.65	51.78	52.53	52.32	0.75	0.014271	2.42	9.35	15.49	0.55	0.59	0.53
Richards Creek	Historical	999.2128	10-year	35.4	51.78	53.02	52.47	1.24	0.005472	2.03	17.43	17.57	0.36	0.97	0.33
Richards Creek	Historical	999.2128	25-year	44.55	51.78	54.1	52.56	2.32	0.000868	1.14	38.96	21.98	0.15	1.7	0.09
Richards Creek	Historical	999.2128	100-year	61.8	51.78	56.66	52.72	4.88	0.000065	0.49	191.13	214.45	0.04	3.44	0.01
Richards Creek	Historical	968.151	1.01-year	15.05	51.3	52.1	51.71	0.8	0.00443	1.44	10.46	15.61	0.31	0.66	0.18
Richards Creek	Historical	968.151	2-year	22.65	51.3	52.38	51.82	1.08	0.003527	1.53	14.82	16.66	0.29	0.87	0.19
Richards Creek	Historical	968.151	10-year	35.4	51.3	52.95	51.97	1.65	0.001863	1.41	25.07	18.89	0.22	1.28	0.15
Richards Creek	Historical	968.151	25-year	44.55	51.3	54.09	52.06	2.79	0.000439	0.91	49.03	22.93	0.11	2.02	0.06
Richards Creek	Historical	968.151	100-year	61.8	51.3	56.66	52.22	5.36	0.000067	0.53	116.81	217.23	0.05	3.8	0.02
Richards Creek	Historical	913.9713		Culvert											
Richards Creek	Historical	875.7664	1.01-year	15.05	49.6	50.72	49.88	1.12	0.000498	0.6	24.93	27.65	0.11	0.88	0.03
Richards Creek	Historical	875.7664	2-year	22.65	49.6	51.06	49.97	1.46	0.000432	0.65	34.86	30.91	0.11	1.1	0.03
Richards Creek	Historical	875.7664	10-year	35.4	49.6	51.58	50.09	1.98	0.000351	0.68	52.33	35.78	0.1	1.42	0.03
Richards Creek	Historical	875.7664	25-year	44.55	49.6	51.89	50.17	2.29	0.000327	0.7	63.72	38.62	0.1	1.6	0.03
Richards Creek	Historical	875.7664	100-year	61.8	49.6	52.4	50.29	2.8	0.000295	0.73	84.69	122.23	0.09	1.89	0.03
Richards Creek	Historical	843.4692	1.01-year	15.05	49.48	50.71	49.76	1.23	0.000354	0.53	28.16	29.03	0.1	0.95	0.02
Richards Creek	Historical	843.4692	2-year	22.65	49.48	51.05	49.85	1.57	0.000328	0.59	38.63	32.37	0.09	1.17	0.02
Richards Creek	Historical	843.4692	10-year	35.4	49.48	51.57	49.97	2.09	0.000279	0.62	56.91	37.17	0.09	1.49	0.03
Richards Creek	Historical	843.4692	25-year	44.55	49.48	51.88	50.05	2.4	0.000266	0.65	68.73	45.43	0.09	1.67	0.03
Richards Creek	Historical	843.4692	100-year	61.8	49.48	52.39	50.17	2.91	0.000246	0.68	90.4	144.04	0.08	1.96	0.03
Richards Creek	Historical	240.4131	1.01-year	15.05	45.9	50.71	46.6	4.81	0.000001	0.1	402.64	212.34	0.01	3.72	0
Richards Creek	Historical	240.4131	2-year	22.65	45.9	51.05	46.73	5.15	0.000001	0.13	477.21	225.63	0.01	4.02	0
Richards Creek	Historical	240.4131	10-year	35.4	45.9	51.57	46.92	5.67	0.000002	0.17	600.43	238.56	0.01	4.49	0
Richards Creek	Historical	240.4131	25-year	44.55	45.9	51.88	47.05	5.98	0.000002	0.19	673.56	238.56	0.01	4.76	0
Richards Creek	Historical	240.4131	100-year	61.8	45.9	52.39	47.25	6.49	0.000002	0.22	795.71	238.56	0.02	5.21	0
Richards Creek	Lower	85.48712	1.01-year	120.25	47.08	50.66	49.54	3.58	0.001315	2.1	131.45	256.31	0.25	1.94	0.16
Richards Creek	Lower	85.48712	2-year	181	47.08	50.99	50.28	3.91	0.001313	2.31	184.23	256.31	0.26	2.25	0.18
Richards Creek	Lower	85.48712	10-year	297	47.08	51.51	50.56	4.43	0.00131	2.62	265.35	256.31	0.27	2.72	0.22
Richards Creek	Lower	85.48712	25-year	376	47.08	51.82	50.7	4.74	0.001309	2.8	312.53	256.31	0.27	3	0.25
Richards Creek	Lower	85.48712	100-year	525	47.08	52.32	50.93	5.24	0.001308	3.07	391.18	256.31	0.28	3.46	0.28
Richards Creek	Lower	26.62222	1.01-year	120.25	47	50.58	49.45	3.58	0.0013	2.09	132.08	256.31	0.25	1.94	0.16
Richards Creek	Lower	26.62222	2-year	181	47	50.92	50.2	3.92	0.001301	2.3	184.88	256.31	0.26	2.25	0.18
Richards Creek	Lower	26.62222	10-year	297	47	51.44	50.48	4.44	0.0013	2.62	266.03	256.31	0.27	2.73	0.22
Richards Creek	Lower	26.62222	25-year	376	47	51.74	50.62	4.74	0.001301	2.79	313.23	256.31	0.27	3	0.24
Richards Creek	Lower	26.62222	100-year	525	47	52.24	50.85	5.24	0.001301	3.07	391.89	256.31	0.28	3.46	0.28

PHASE I ALTERNATIVE 1
AGGRADATION OUTPUT TABLE

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	3272.859	1.01-year	52.48	82.49	85.22	83.99	2.73	0.006909	2.99	17.54	7.87	0.35	1.53	0.66
Sunset Creek	SE 30th	3272.859	2-year	79	82.49	85.87	84.38	3.38	0.007726	3.46	22.83	8.32	0.37	1.77	0.86
Sunset Creek	SE 30th	3272.859	10-year	126	82.49	86.72	84.96	4.23	0.009492	4.19	30.1	8.9	0.4	2.06	1.22
Sunset Creek	SE 30th	3272.859	25-year	157	82.49	87.13	85.3	4.64	0.010441	4.63	34.08	10.3	0.42	2.24	1.46
Sunset Creek	SE 30th	3272.859	100-year	212	82.49	87.79	85.83	5.3	0.011482	5.24	41.64	12.71	0.45	2.52	1.81
Sunset Creek	SE 30th	3251.92	1.01-year	52.48	82.52	84.68	84.21	2.16	0.024525	5.08	10.33	5.78	0.67	1.2	1.84
Sunset Creek	SE 30th	3251.92	2-year	79	82.52	85.22	84.69	2.7	0.027799	5.84	13.53	6.22	0.7	1.39	2.41
Sunset Creek	SE 30th	3251.92	10-year	126	82.52	86	85.54	3.48	0.031764	6.33	19.9	8.8	0.74	1.5	2.97
Sunset Creek	SE 30th	3251.92	25-year	157	82.52	86.34	85.88	3.82	0.033201	6.84	22.96	9.05	0.76	1.64	3.39
Sunset Creek	SE 30th	3251.92	100-year	212	82.52	86.88	86.38	4.36	0.035496	7.59	27.92	9.43	0.78	1.84	4.08
Sunset Creek	SE 30th	3230.282	1.01-year	52.48	81.37	84.02	83.73	2.65	0.030615	5.49	9.55	6.31	0.79	1.09	2.08
Sunset Creek	SE 30th	3230.282	2-year	79	81.37	84.46	84.23	3.09	0.033662	6.29	12.56	7.21	0.84	1.24	2.61
Sunset Creek	SE 30th	3230.282	10-year	126	81.37	85.18	84.92	3.81	0.034461	6.77	18.62	9.27	0.84	1.45	3.12
Sunset Creek	SE 30th	3230.282	25-year	157	81.37	85.54	85.24	4.17	0.03394	7.15	21.97	9.59	0.83	1.61	3.42
Sunset Creek	SE 30th	3230.282	100-year	212	81.37	86.11	85.72	4.74	0.033218	7.67	27.63	10.1	0.82	1.86	3.85
Sunset Creek	SE 30th	3207.655	1.01-year	52.48	81.58	83.02	83.02	1.44	0.045494	6.27	8.36	6.93	1.01	0.98	2.8
Sunset Creek	SE 30th	3207.655	2-year	79	81.58	83.43	83.43	1.85	0.044215	7.02	11.25	7.41	1.01	1.19	3.29
Sunset Creek	SE 30th	3207.655	10-year	126	81.58	84.06	84.06	2.48	0.044338	7.75	16.25	8.79	1	1.42	3.92
Sunset Creek	SE 30th	3207.655	25-year	157	81.58	84.37	84.37	2.79	0.044896	8.25	19.02	9.07	1	1.57	4.39
Sunset Creek	SE 30th	3207.655	100-year	212	81.58	84.86	84.86	3.28	0.045967	8.98	23.6	9.51	1	1.78	5.12
Sunset Creek	SE 30th	3193.525	1.01-year	52.48	81.39	82.96	82.47	1.57	0.012631	3.2	16.4	13.89	0.52	0.99	0.78
Sunset Creek	SE 30th	3193.525	2-year	79	81.39	83.44	82.75	2.05	0.010801	3.36	23.53	15.91	0.49	1.2	0.81
Sunset Creek	SE 30th	3193.525	10-year	126	81.39	84.14	83.16	2.75	0.008933	3.52	35.78	18.79	0.45	1.5	0.84
Sunset Creek	SE 30th	3193.525	25-year	157	81.39	84.54	83.39	3.15	0.00785	3.62	43.42	19.42	0.43	1.74	0.85
Sunset Creek	SE 30th	3193.525	100-year	212	81.39	85.16	83.75	3.77	0.00686	3.82	55.51	19.91	0.4	2.11	0.9
Sunset Creek	SE 30th	3181.277	1.01-year	52.48	80.83	82.23	82.23	1.4	0.049653	6.06	8.66	7.7	1.01	0.97	3.01
Sunset Creek	SE 30th	3181.277	2-year	79	80.83	82.63	82.61	1.8	0.047241	6.68	11.83	8.35	0.99	1.19	3.51
Sunset Creek	SE 30th	3181.277	10-year	126	80.83	83.26	83.16	2.43	0.04141	7.2	17.49	9.4	0.93	1.5	3.89
Sunset Creek	SE 30th	3181.277	25-year	157	80.83	83.58	83.46	2.75	0.039203	7.67	20.55	10.44	0.92	1.73	4.22
Sunset Creek	SE 30th	3181.277	100-year	212	80.83	84.06	83.99	3.23	0.035379	8.35	26.15	12.35	0.91	2.12	4.68
Sunset Creek	SE 30th	3171.478	1.01-year	52.48	79.8	82.09	81.5	2.29	0.017938	4.34	12.08	6.96	0.58	1.29	1.44
Sunset Creek	SE 30th	3171.478	2-year	79	79.8	82.53	81.92	2.73	0.020229	5.19	15.34	7.97	0.63	1.55	1.96
Sunset Creek	SE 30th	3171.478	10-year	126	79.8	83.09	82.55	3.29	0.022901	6.46	20.2	9.36	0.7	1.96	2.8
Sunset Creek	SE 30th	3171.478	25-year	157	79.8	83.37	82.91	3.57	0.024983	7.2	22.91	10.06	0.74	2.16	3.37
Sunset Creek	SE 30th	3171.478	100-year	212	79.8	83.77	83.5	3.97	0.0285	8.38	27.21	11.07	0.81	2.46	4.38
Sunset Creek	SE 30th	3160.526	1.01-year	52.48	79.96	81.89	81.42	1.93	0.018375	4.34	12.09	7.93	0.62	1.24	1.42
Sunset Creek	SE 30th	3160.526	2-year	79	79.96	82.32	81.81	2.36	0.020239	5.05	15.65	8.81	0.66	1.47	1.86
Sunset Creek	SE 30th	3160.526	10-year	126	79.96	82.89	82.38	2.93	0.022223	6.07	21.16	10.52	0.7	1.82	2.53
Sunset Creek	SE 30th	3160.526	25-year	157	79.96	83.18	82.72	3.22	0.022836	6.66	24.36	11.4	0.73	2.05	2.92
Sunset Creek	SE 30th	3160.526	100-year	212	79.96	83.62	83.23	3.66	0.023797	7.55	29.71	12.74	0.76	2.4	3.56
Sunset Creek	SE 30th	3145.921	1.01-year	52.48	78.83	81.92	80.46	3.09	0.003732	2.52	21.19	10.58	0.29	1.92	0.45
Sunset Creek	SE 30th	3145.921	2-year	79	78.83	82.37	80.86	3.54	0.004594	3.15	26.22	11.91	0.33	2.29	0.66
Sunset Creek	SE 30th	3145.921	10-year	126	78.83	82.97	81.42	4.14	0.005759	4.01	33.92	13.69	0.38	2.78	1
Sunset Creek	SE 30th	3145.921	25-year	157	78.83	83.29	81.74	4.46	0.006411	4.49	38.41	14.63	0.41	3.04	1.22
Sunset Creek	SE 30th	3145.921	100-year	212	78.83	83.77	82.27	4.94	0.007307	5.21	45.89	16.07	0.45	3.44	1.57
Sunset Creek	SE 30th	3119.845	1.01-year	52.48	79.67	81.65	81.05	1.98	0.011764	3.56	14.77	10.26	0.51	1.32	0.97
Sunset Creek	SE 30th	3119.845	2-year	79	79.67	82.05	81.4	2.38	0.011998	4.21	19.08	11.5	0.54	1.67	1.25
Sunset Creek	SE 30th	3119.845	10-year	126	79.67	82.57	81.89	2.9	0.013116	5.17	25.47	13.13	0.59	2.13	1.74
Sunset Creek	SE 30th	3119.845	25-year	157	79.67	82.82	82.17	3.15	0.014262	5.77	28.89	13.92	0.62	2.35	2.1
Sunset Creek	SE 30th	3119.845	100-year	212	79.67	83.2	82.63	3.53	0.016027	6.69	34.41	15.12	0.68	2.69	2.69
Sunset Creek	SE 30th	3103.342	1.01-year	52.48	79.66	81.46	80.89	1.8	0.011936	3.47	15.11	10.95	0.52	1.24	0.92
Sunset Creek	SE 30th	3103.342	2-year	79	79.66	81.86	81.22	2.2	0.01343	4.03	19.62	12.1	0.56	1.44	1.21
Sunset Creek	SE 30th	3103.342	10-year	126	79.66	82.36	81.7	2.7	0.01577	4.81	26.17	13.61	0.61	1.7	1.67
Sunset Creek	SE 30th	3103.342	25-year	157	79.66	82.61	81.98	2.95	0.016334	5.31	29.67	14.35	0.63	1.92	1.95
Sunset Creek	SE 30th	3103.342	100-year	212	79.66	82.99	82.39	3.33	0.017504	6.1	35.2	15.45	0.67	2.24	2.45
Sunset Creek	SE 30th	3082.734	1.01-year	52.48	79.61	81.15	80.76	1.54	0.015717	3.74	14.02	11.68	0.6	1.11	1.09
Sunset Creek	SE 30th	3082.734	2-year	79	79.61	81.52	81.06	1.91	0.015628	4.26	18.63	13.16	0.61	1.37	1.33
Sunset Creek	SE 30th	3082.734	10-year	126	79.61	82	81.5	2.39	0.015851	5.1	25.43	15.76	0.64	1.78	1.76
Sunset Creek	SE 30th	3082.734	25-year	157	79.61	82.23	81.76	2.62	0.01654	5.61	29.26	17.06	0.67	1.99	2.06
Sunset Creek	SE 30th	3082.734	100-year	212	79.61	82.61	82.16	3	0.016909	6.32	36.13	19.16	0.7	2.34	2.47
Sunset Creek	SE 30th	3066.484	1.01-year	52.48	79.15	80.44	80.44	1.29	0.045593	5.66	9.27	9.44	1.01	0.91	2.59
Sunset Creek	SE 30th	3066.484	2-year	79	79.15	80.77	80.77	1.62	0.041061	6.3	12.68	11.37	0.98	1.17	2.99
Sunset Creek	SE 30th	3066.484	10-year	126	79.15	81.27	81.27	2.12	0.032155	6.97	19.39	15.18	0.92	1.63	3.27
Sunset Creek	SE 30th	3066.484	25-year	157	79.15	81.55	81.55	2.4	0.028891	7.28	23.84	16.54	0.89	1.88	3.4
Sunset Creek	SE 30th	3066.484	100-year	212	79.15	81.92	81.92	2.77	0.027733	7.96	30.23	17.83	0.9	2.23	3.85
Sunset Creek	SE 30th	3034.622	1.01-year	52.48	77.36	78.8	78.83	1.44	0.053489	6	8.75	8.57	1.05	0.94	3.13
Sunset Creek	SE 30th	3034.622	2-year	79	77.36	79.11	79.19	1.75	0.057465	6.84	11.54	9.56	1.1	1.1	3.94
Sunset Creek	SE 30th	3034.622	10-year	126	77.36	79.48	79.7	2.12	0.068201	8.2	15.36	10.77	1.21	1.29	5.48
Sunset Creek	SE 30th	3034.622	25-year	157	77.36	79.7	79.98	2.34	0.071417	8.82	17.81	11.47	1.25	1.39	6.22
Sunset Creek	SE 30th	3034.622	100-year	212	77.36	80.11	80.4	2.75	0.068713	9.35	22.66	12.75	1.24	1.59	6.81

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	3020.31	1.01-year	52.48	76.74	78.69	78.18	1.95	0.011941	3.74	14.04	11.02	0.58	1.14	0.85
Sunset Creek	SE 30th	3020.31	2-year	79	76.74	79.07	78.53	2.33	0.012354	4.22	18.74	13.76	0.63	1.24	0.96
Sunset Creek	SE 30th	3020.31	10-year	126	76.74	79.57	79.08	2.83	0.012503	4.77	26.69	17.98	0.67	1.45	1.13
Sunset Creek	SE 30th	3020.31	25-year	157	76.74	79.84	79.34	3.1	0.012582	5.03	31.75	19.91	0.68	1.59	1.25
Sunset Creek	SE 30th	3020.31	100-year	212	76.74	80.22	79.74	3.48	0.012788	5.51	39.63	21.2	0.67	1.94	1.55
Sunset Creek	SE 30th	2982.026	1.01-year	52.48	76.27	77.64	77.64	1.37	0.041864	5.49	9.57	10.28	1	0.86	2.24
Sunset Creek	SE 30th	2982.026	2-year	79	76.27	77.97	77.97	1.7	0.041566	5.98	13.22	12.11	1.01	1	2.6
Sunset Creek	SE 30th	2982.026	10-year	126	76.27	78.42	78.42	2.15	0.042101	6.55	19.23	14.7	1.01	1.2	3.15
Sunset Creek	SE 30th	2982.026	25-year	157	76.27	78.66	78.66	2.39	0.042096	6.84	22.94	16.1	1.01	1.3	3.42
Sunset Creek	SE 30th	2982.026	100-year	212	76.27	79.03	79.03	2.76	0.041059	7.23	29.3	18.1	1	1.48	3.78
Sunset Creek	SE 30th	2969.117	1.01-year	52.48	75.88	76.97	77.07	1.09	0.065542	5.54	9.48	14.93	1.22	0.62	2.54
Sunset Creek	SE 30th	2969.117	2-year	79	75.88	77.13	77.29	1.25	0.07752	6.56	12.04	16.63	1.36	0.71	3.42
Sunset Creek	SE 30th	2969.117	10-year	126	75.88	77.99	77.62	2.11	0.016637	4.66	27.04	18.12	0.67	1.39	1.44
Sunset Creek	SE 30th	2969.117	25-year	157	75.88	78.3	77.81	2.42	0.014764	4.81	32.64	18.59	0.64	1.61	1.49
Sunset Creek	SE 30th	2969.117	100-year	212	75.88	78.72	78.12	2.84	0.014239	5.23	40.57	19.24	0.63	1.9	1.69
Sunset Creek	SE 30th	2939.869	1.01-year	52.48	73.61	76.82	75.69	3.21	0.0053	2.32	22.64	14.71	0.33	1.38	0.46
Sunset Creek	SE 30th	2939.869	2-year	79	73.61	77.25	76.05	3.64	0.006353	2.69	29.37	16.87	0.36	1.56	0.62
Sunset Creek	SE 30th	2939.869	10-year	126	73.61	77.81	76.54	4.2	0.007148	3.22	39.19	18.18	0.39	1.91	0.85
Sunset Creek	SE 30th	2939.869	25-year	157	73.61	78.11	76.8	4.5	0.007632	3.51	44.79	18.85	0.4	2.09	1
Sunset Creek	SE 30th	2939.869	100-year	212	73.61	78.51	77.2	4.9	0.008977	4.04	52.43	19.74	0.44	2.32	1.3
Sunset Creek	SE 30th	2904.859	1.01-year	52.48	74.07	76.39	75.43	2.32	0.035368	2.86	18.34	15.88	0.47	1.03	2.28
Sunset Creek	SE 30th	2904.859	2-year	79	74.07	76.76	75.8	2.69	0.035055	3.22	24.51	17.55	0.48	1.25	2.74
Sunset Creek	SE 30th	2904.859	10-year	126	74.07	77.28	76.48	3.21	0.034618	3.67	34.34	19.94	0.49	1.54	3.34
Sunset Creek	SE 30th	2904.859	25-year	157	74.07	77.58	76.7	3.51	0.033762	3.86	41.26	28.12	0.49	1.7	3.59
Sunset Creek	SE 30th	2904.859	100-year	212	74.07	77.99	77.03	3.92	0.029905	4.01	54.84	34.28	0.48	1.98	3.69
Sunset Creek	SE 30th	2887.542	1.01-year	52.48	73.52	76	75.02	2.48	0.016879	2.48	21.15	16.68	0.39	1.13	1.19
Sunset Creek	SE 30th	2887.542	2-year	79	73.52	76.35	75.58	2.83	0.018402	2.91	27.15	17.78	0.41	1.36	1.56
Sunset Creek	SE 30th	2887.542	10-year	126	73.52	76.85	75.94	3.33	0.020043	3.46	36.45	19.36	0.44	1.66	2.08
Sunset Creek	SE 30th	2887.542	25-year	157	73.52	77.14	76.13	3.62	0.020645	3.73	42.11	20.26	0.46	1.83	2.36
Sunset Creek	SE 30th	2887.542	100-year	212	73.52	77.55	76.47	4.03	0.020458	4.12	54.02	31.33	0.46	2.14	2.74
Sunset Creek	SE 30th	2869.669	1.01-year	52.48	73.86	74.99	74.99	1.13	0.1141	5.38	9.76	11.01	1.01	0.84	6
Sunset Creek	SE 30th	2869.669	2-year	79	73.86	75.45	75.31	1.59	0.077459	5.1	15.48	13.75	0.85	1.07	5.16
Sunset Creek	SE 30th	2869.669	10-year	126	73.86	76.06	75.72	2.2	0.052374	5.13	24.65	16.55	0.73	1.46	4.78
Sunset Creek	SE 30th	2869.669	25-year	157	73.86	76.37	75.95	2.51	0.045904	5.28	30.08	18.64	0.7	1.69	4.84
Sunset Creek	SE 30th	2869.669	100-year	212	73.86	76.83	76.3	2.97	0.037413	5.55	40.53	26.66	0.65	2.13	4.96
Sunset Creek	SE 30th	2850.365	1.01-year	52.48	72.12	74.78	73.51	2.66	0.008736	2.49	21.71	12.12	0.3	1.82	0.99
Sunset Creek	SE 30th	2850.365	2-year	79	72.12	75.2	73.85	3.08	0.01057	3.08	27.12	14.28	0.34	2.16	1.43
Sunset Creek	SE 30th	2850.365	10-year	126	72.12	75.73	74.37	3.61	0.013553	3.95	34.65	18.53	0.39	2.6	2.2
Sunset Creek	SE 30th	2850.365	25-year	157	72.12	76	74.67	3.88	0.015301	4.43	38.77	20.55	0.42	2.83	2.7
Sunset Creek	SE 30th	2850.365	100-year	212	72.12	76.4	75.15	4.28	0.018224	5.21	45	23.52	0.47	3.16	3.6
Sunset Creek	SE 30th	2823.726	1.01-year	52.48	72.56	74.28	73.76	1.72	0.030403	3.5	15.06	12.75	0.54	1.22	2.31
Sunset Creek	SE 30th	2823.726	2-year	79	72.56	74.63	74.08	2.07	0.031696	4.05	20.53	17.34	0.56	1.48	2.92
Sunset Creek	SE 30th	2823.726	10-year	126	72.56	75.07	74.62	2.51	0.032689	4.79	28.7	19.84	0.59	1.86	3.79
Sunset Creek	SE 30th	2823.726	25-year	157	72.56	75.31	74.85	2.75	0.033081	5.19	33.61	21.42	0.61	2.08	4.29
Sunset Creek	SE 30th	2823.726	100-year	212	72.56	75.67	75.2	3.11	0.033877	5.79	41.7	23.79	0.63	2.4	5.08
Sunset Creek	SE 30th	2794.948	1.01-year	52.48	71.19	73.48	72.93	2.29	0.026541	3.4	16.41	16.13	0.5	1.29	2.14
Sunset Creek	SE 30th	2794.948	2-year	79	71.19	73.91	73.29	2.72	0.022601	3.63	24.43	20.59	0.48	1.62	2.28
Sunset Creek	SE 30th	2794.948	10-year	126	71.19	74.34	73.8	3.15	0.023419	4.28	34.12	23.97	0.51	2.01	2.94
Sunset Creek	SE 30th	2794.948	25-year	157	71.19	74.52	74.01	3.33	0.026284	4.77	38.54	25.36	0.54	2.18	3.57
Sunset Creek	SE 30th	2794.948	100-year	212	71.19	74.86	74.32	3.67	0.027583	5.34	47.48	27.94	0.57	2.48	4.27
Sunset Creek	SE 30th	2760.247	1.01-year	52.48	70.04	71.78	71.78	1.74	0.048942	6.25	8.4	7.05	1.01	1.02	3.11
Sunset Creek	SE 30th	2760.247	2-year	79	70.04	72.19	72.19	2.15	0.048735	6.92	11.42	7.83	1.01	1.22	3.7
Sunset Creek	SE 30th	2760.247	10-year	126	70.04	72.94	72.94	2.9	0.031018	6.76	20.98	19.47	0.83	1.68	3.25
Sunset Creek	SE 30th	2760.247	25-year	157	70.04	73.26	73.26	3.22	0.025632	6.75	27.92	23.44	0.77	1.93	3.1
Sunset Creek	SE 30th	2760.247	100-year	212	70.04	73.59	73.59	3.55	0.025171	7.29	35.9	25.15	0.78	2.2	3.46
Sunset Creek	SE 30th	2717.8	1.01-year	52.48	68.16	69.97	69.53	1.81	0.045432	4.28	12.26	10.54	0.7	0.99	2.8
Sunset Creek	SE 30th	2717.8	2-year	79	68.16	70.28	70.01	2.12	0.048804	5.06	15.61	10.98	0.75	1.18	3.61
Sunset Creek	SE 30th	2717.8	10-year	126	68.16	70.82	70.46	2.66	0.045144	5.79	21.77	11.74	0.75	1.5	4.23
Sunset Creek	SE 30th	2717.8	25-year	157	68.16	71.15	70.72	2.99	0.04275	6.12	25.67	12.2	0.74	1.68	4.48
Sunset Creek	SE 30th	2717.8	100-year	212	68.16	71.69	71.14	3.53	0.038666	6.52	32.52	12.97	0.73	1.96	4.72
Sunset Creek	SE 30th	2702.718	1.01-year	52.48	67.5	69.23	68.88	1.73	0.050955	4.39	11.95	11.05	0.74	0.95	3.02
Sunset Creek	SE 30th	2702.718	2-year	79	67.5	69.73	69.32	2.23	0.034335	4.46	17.72	11.93	0.64	1.27	2.72
Sunset Creek	SE 30th	2702.718	10-year	126	67.5	70.44	69.77	2.94	0.025414	4.72	26.69	13.19	0.58	1.68	2.67
Sunset Creek	SE 30th	2702.718	25-year	157	67.5	70.82	70.01	3.32	0.023397	4.93	31.83	13.86	0.57	1.89	2.76
Sunset Creek	SE 30th	2702.718	100-year	212	67.5	71.44	70.41	3.94	0.020645	5.2	40.77	14.96	0.56	2.2	2.84
Sunset Creek	SE 30th	2676.488	1.01-year	52.48	66.34	68.96	67.73	2.62	0.007731	2.38	22.04	12.3	0.31	1.49	0.72
Sunset Creek	SE 30th	2676.488	2-year	79	66.34	69.49	68.16	3.15	0.007867	2.74	28.8	13.18	0.33	1.78	0.88
Sunset Creek	SE 30th	2676.488	10-year	126	66.34	70.22	68.6	3.88	0.008247	3.24	38.93	14.4	0.35	2.16	1.11
Sunset Creek	SE 30th	2676.488	25-year	157	66.34	70.6	68.86	4.26	0.008659	3.53	44.54	15.03	0.36	2.34	1.26
Sunset Creek	SE 30th	2676.488	100-year	212	66.34	71.23	69.27	4.89	0.008905	3.9	54.32	16.07	0.37	2.63	1.46

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	2651.525	1.01-year	52.48	66.05	68.83	67.37	2.78	0.004638	1.91	27.5	15.07	0.25	1.62	0.47
Sunset Creek	SE 30th	2651.525	2-year	79	66.05	69.37	67.82	3.32	0.004739	2.2	35.88	16.26	0.26	1.93	0.57
Sunset Creek	SE 30th	2651.525	10-year	126	66.05	70.1	68.22	4.05	0.004954	2.6	48.51	17.92	0.28	2.33	0.72
Sunset Creek	SE 30th	2651.525	25-year	157	66.05	70.48	68.46	4.43	0.005195	2.83	55.49	18.77	0.29	2.52	0.82
Sunset Creek	SE 30th	2651.525	100-year	212	66.05	71.12	68.84	5.07	0.005281	3.12	67.91	20.19	0.3	2.84	0.94
Sunset Creek	SE 30th	2643.063	1.01-year	52.48	66.05	68.79	67.47	2.74	0.002823	2.07	25.4	12.75	0.26	1.65	0.29
Sunset Creek	SE 30th	2643.063	2-year	79	66.05	69.31	67.76	3.26	0.003263	2.45	32.25	13.42	0.28	1.94	0.4
Sunset Creek	SE 30th	2643.063	10-year	126	66.05	70.03	68.19	3.98	0.003942	2.99	42.21	14.33	0.31	2.3	0.57
Sunset Creek	SE 30th	2643.063	25-year	157	66.05	70.39	68.44	4.34	0.004425	3.3	47.52	14.8	0.32	2.47	0.68
Sunset Creek	SE 30th	2643.063	100-year	212	66.05	71.01	68.84	4.96	0.004968	3.73	56.83	15.58	0.34	2.75	0.85
Sunset Creek	SE 30th	2640.568	1.01-year	52.48	66.05	68.8	66.85	2.75	0.000364	1.47	35.8	13	0.16	1.93	0.04
Sunset Creek	SE 30th	2640.568	2-year	79	66.05	69.33	67.09	3.28	0.000493	1.85	42.64	13.06	0.18	2.19	0.07
Sunset Creek	SE 30th	2640.568	10-year	126	66.05	70.05	67.47	4	0.000647	2.42	52	14.4	0.21	2.67	0.11
Sunset Creek	SE 30th	2640.568	25-year	157	66.05	70.42	67.7	4.37	0.000751	2.77	56.76	15.08	0.23	2.91	0.14
Sunset Creek	SE 30th	2640.568	100-year	212	66.05	71.03	68.07	4.98	0.000884	3.28	64.76	16.23	0.26	3.32	0.18
Sunset Creek	SE 30th	2625.968		Bridge											
Sunset Creek	SE 30th	2611.37	1.01-year	52.48	66.05	68.79	66.84	2.74	0.000368	1.47	35.66	13	0.16	1.93	0.04
Sunset Creek	SE 30th	2611.37	2-year	79	66.05	69.31	67.09	3.26	0.000504	1.86	42.37	13.02	0.18	2.17	0.07
Sunset Creek	SE 30th	2611.37	10-year	126	66.05	69.97	67.47	3.92	0.000691	2.47	50.98	14.34	0.22	2.61	0.11
Sunset Creek	SE 30th	2611.37	25-year	157	66.05	70.29	67.7	4.24	0.000825	2.85	55.16	15.52	0.24	2.83	0.15
Sunset Creek	SE 30th	2611.37	100-year	212	66.05	70.8	68.07	4.75	0.001033	3.43	61.75	18.21	0.28	3.17	0.2
Sunset Creek	SE 30th	2610.895		Bridge											
Sunset Creek	SE 30th	2610.42	1.01-year	52.48	66.05	68.79	66.84	2.74	0.000255	1.47	35.65	13	0.16	1.93	0.03
Sunset Creek	SE 30th	2610.42	2-year	79	66.05	69.31	67.09	3.26	0.00035	1.86	42.36	13.02	0.18	2.17	0.05
Sunset Creek	SE 30th	2610.42	10-year	126	66.05	69.97	67.47	3.92	0.000481	2.47	50.95	14.39	0.22	2.61	0.08
Sunset Creek	SE 30th	2610.42	25-year	157	66.05	70.29	67.7	4.24	0.000575	2.85	55.12	15.59	0.24	2.83	0.1
Sunset Creek	SE 30th	2610.42	100-year	212	66.05	70.79	68.07	4.74	0.000721	3.44	61.67	18.38	0.28	3.16	0.14
Sunset Creek	SE 30th	2610.395		Bridge											
Sunset Creek	SE 30th	2610.37	1.01-year	52.48	66.05	68.79	66.84	2.74	0.000255	1.47	35.65	13	0.16	1.93	0.03
Sunset Creek	SE 30th	2610.37	2-year	79	66.05	69.31	67.09	3.26	0.00035	1.86	42.36	13.02	0.18	2.17	0.05
Sunset Creek	SE 30th	2610.37	10-year	126	66.05	69.97	67.47	3.92	0.000481	2.47	50.95	14.39	0.22	2.61	0.08
Sunset Creek	SE 30th	2610.37	25-year	157	66.05	70.29	67.7	4.24	0.000575	2.85	55.11	15.59	0.24	2.83	0.1
Sunset Creek	SE 30th	2610.37	100-year	212	66.05	70.79	68.07	4.74	0.000721	3.44	61.67	18.39	0.28	3.16	0.14
Sunset Creek	SE 30th	2596.365		Bridge											
Sunset Creek	SE 30th	2582.37	1.01-year	52.48	66.05	68.79	66.84	2.74	0.000258	1.48	35.56	13	0.16	1.93	0.03
Sunset Creek	SE 30th	2582.37	2-year	79	66.05	69.3	67.09	3.25	0.000353	1.87	42.23	13	0.18	2.17	0.05
Sunset Creek	SE 30th	2582.37	10-year	126	66.05	69.92	67.47	3.87	0.000503	2.51	50.27	16.99	0.22	2.58	0.08
Sunset Creek	SE 30th	2582.37	25-year	157	66.05	70.21	67.7	4.16	0.000614	2.9	54.05	19.22	0.25	2.77	0.11
Sunset Creek	SE 30th	2582.37	100-year	212	66.05	70.64	68.07	4.59	0.000804	3.55	59.68	23.76	0.29	3.06	0.15
Sunset Creek	SE 30th	2582.335		Bridge											
Sunset Creek	SE 30th	2582.32	1.01-year	52.48	66.05	68.79	66.84	2.74	0.000258	1.48	35.56	13	0.16	1.93	0.03
Sunset Creek	SE 30th	2582.32	2-year	79	66.05	69.3	67.09	3.25	0.000353	1.87	42.23	13	0.18	2.17	0.05
Sunset Creek	SE 30th	2582.32	10-year	126	66.05	69.92	67.47	3.87	0.000503	2.51	50.27	16.99	0.22	2.58	0.08
Sunset Creek	SE 30th	2582.32	25-year	157	66.05	70.21	67.7	4.16	0.000614	2.91	54.04	19.23	0.25	2.77	0.11
Sunset Creek	SE 30th	2582.32	100-year	212	66.05	70.64	68.07	4.59	0.000804	3.55	59.67	23.77	0.29	3.06	0.15
Sunset Creek	SE 30th	2581.843		Bridge											
Sunset Creek	SE 30th	2581.368	1.01-year	52.48	66.05	68.78	66.84	2.73	0.000371	1.48	35.55	13	0.16	1.92	0.04
Sunset Creek	SE 30th	2581.368	2-year	79	66.05	69.3	67.1	3.25	0.000509	1.87	42.22	13	0.18	2.17	0.07
Sunset Creek	SE 30th	2581.368	10-year	126	66.05	69.91	67.47	3.86	0.000726	2.51	50.24	17.12	0.22	2.58	0.12
Sunset Creek	SE 30th	2581.368	25-year	157	66.05	70.2	67.7	4.15	0.000886	2.91	54	19.36	0.25	2.77	0.15
Sunset Creek	SE 30th	2581.368	100-year	212	66.05	70.63	68.06	4.58	0.001163	3.56	59.59	23.97	0.29	3.06	0.22
Sunset Creek	SE 30th	2578.872	1.01-year	52.48	66.05	68.79	66.83	2.74	0.00048	1.28	41.06	16.99	0.14	2.08	0.06
Sunset Creek	SE 30th	2578.872	2-year	79	66.05	69.3	67.07	3.25	0.000608	1.58	49.88	17.74	0.16	2.45	0.09
Sunset Creek	SE 30th	2578.872	10-year	126	66.05	69.93	67.44	3.88	0.000867	2.07	60.72	18.65	0.2	2.88	0.16
Sunset Creek	SE 30th	2578.872	25-year	157	66.05	70.22	67.65	4.17	0.001042	2.38	65.96	19.87	0.22	3.11	0.2
Sunset Creek	SE 30th	2578.872	100-year	212	66.05	70.67	67.99	4.62	0.001307	2.87	73.91	24.34	0.25	3.47	0.28
Sunset Creek	SE 30th	2576.368	1.01-year	52.48	66.05	68.77	67	2.72	0.002151	1.52	34.42	15.85	0.18	1.92	0.26
Sunset Creek	SE 30th	2576.368	2-year	79	66.05	69.29	67.28	3.24	0.002515	1.85	42.99	18.08	0.2	2.3	0.36
Sunset Creek	SE 30th	2576.368	10-year	126	66.05	69.9	67.7	3.85	0.003083	2.36	55.31	21.75	0.23	2.84	0.55
Sunset Creek	SE 30th	2576.368	25-year	157	66.05	70.2	67.93	4.15	0.00352	2.67	61.91	23.48	0.25	3.1	0.68
Sunset Creek	SE 30th	2576.368	100-year	212	66.05	70.64	68.31	4.59	0.004168	3.14	72.77	25.38	0.28	3.49	0.91
Sunset Creek	SE 30th	2541.368	1.01-year	52.48	66.05	68.65	67.16	2.6	0.003291	2.04	25.67	12.53	0.25	1.75	0.36
Sunset Creek	SE 30th	2541.368	2-year	79	66.05	69.13	67.48	3.08	0.004031	2.48	31.97	14.43	0.28	2.04	0.51
Sunset Creek	SE 30th	2541.368	10-year	126	66.05	69.7	67.97	3.65	0.004948	3.16	41.6	19.62	0.32	2.51	0.78
Sunset Creek	SE 30th	2541.368	25-year	157	66.05	69.95	68.24	3.9	0.005702	3.58	46.73	20.82	0.35	2.73	0.97
Sunset Creek	SE 30th	2541.368	100-year	212	66.05	70.32	68.67	4.27	0.006873	4.23	54.86	22.36	0.39	3.05	1.31

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	2539.81	1.01-year	52.48	66.05	68.64	67.17	2.59	0.002588	2.08	25.27	12.3	0.26	1.74	0.28
Sunset Creek	SE 30th	2539.81	2-year	79	66.05	69.12	67.49	3.07	0.003182	2.52	31.39	13.78	0.29	2.02	0.4
Sunset Creek	SE 30th	2539.81	10-year	126	66.05	69.68	67.98	3.63	0.00397	3.23	40.11	17.41	0.33	2.49	0.62
Sunset Creek	SE 30th	2539.81	25-year	157	66.05	69.93	68.25	3.88	0.004643	3.69	44.43	17.66	0.36	2.7	0.78
Sunset Creek	SE 30th	2539.81	100-year	212	66.05	70.28	68.68	4.23	0.005794	4.42	51.14	20.21	0.41	3	1.09
Sunset Creek	SE 30th	2527.427	1.01-year	52.48	66.05	68.62	67.15	2.57	0.002329	1.95	26.94	13.81	0.25	1.74	0.25
Sunset Creek	SE 30th	2527.427	2-year	79	66.05	69.1	67.46	3.05	0.002524	2.34	34.58	18.22	0.26	2.16	0.34
Sunset Creek	SE 30th	2527.427	10-year	126	66.05	69.66	67.92	3.61	0.003021	2.95	46.28	22.54	0.3	2.66	0.5
Sunset Creek	SE 30th	2527.427	25-year	157	66.05	69.91	68.18	3.86	0.003455	3.32	51.94	22.84	0.32	2.88	0.62
Sunset Creek	SE 30th	2527.427	100-year	212	66.05	70.27	68.59	4.22	0.004193	3.93	61.09	28.4	0.36	3.2	0.84
Sunset Creek	SE 30th	2513.681	1.01-year	52.48	66.05	68.56	67.22	2.51	0.003324	2.25	23.32	12.14	0.29	1.65	0.34
Sunset Creek	SE 30th	2513.681	2-year	79	66.05	69.02	67.56	2.97	0.004009	2.69	29.97	18.57	0.32	1.91	0.48
Sunset Creek	SE 30th	2513.681	10-year	126	66.05	69.58	68.05	3.53	0.004476	3.25	43.2	38.29	0.35	2.34	0.65
Sunset Creek	SE 30th	2513.681	25-year	157	66.05	69.83	68.32	3.78	0.004796	3.57	50.72	41.51	0.36	2.56	0.77
Sunset Creek	SE 30th	2513.681	100-year	212	66.05	70.21	68.78	4.16	0.005122	4	63.58	44.84	0.38	2.89	0.92
Sunset Creek	SE 30th	2492.185	1.01-year	52.48	66.05	68.4	67.43	2.35	0.007724	2.85	18.41	12.39	0.41	1.33	0.64
Sunset Creek	SE 30th	2492.185	2-year	79	66.05	68.85	67.8	2.8	0.007957	3.26	24.51	15.9	0.43	1.61	0.8
Sunset Creek	SE 30th	2492.185	10-year	126	66.05	69.4	68.38	3.35	0.007403	3.75	39.37	41.55	0.43	2.09	0.97
Sunset Creek	SE 30th	2492.185	25-year	157	66.05	69.7	68.65	3.65	0.006489	3.8	51.79	42.47	0.41	2.35	0.95
Sunset Creek	SE 30th	2492.185	100-year	212	66.05	70.11	69.2	4.06	0.005646	3.91	69.58	42.47	0.39	2.73	0.96
Sunset Creek	SE 30th	2481.368	1.01-year	52.48	66.05	68.33	67.35	2.28	0.007353	2.77	18.95	11.41	0.38	1.47	0.67
Sunset Creek	SE 30th	2481.368	2-year	79	66.05	68.75	67.7	2.7	0.008863	3.25	24.76	16.01	0.41	1.69	0.94
Sunset Creek	SE 30th	2481.368	10-year	126	66.05	69.29	68.2	3.24	0.009658	3.92	35.75	31.01	0.45	2.12	1.28
Sunset Creek	SE 30th	2481.368	25-year	157	66.05	69.56	68.51	3.51	0.009459	4.16	45.93	38.47	0.45	2.36	1.39
Sunset Creek	SE 30th	2481.368	100-year	212	66.05	69.96	68.98	3.91	0.008886	4.44	61.52	38.48	0.45	2.72	1.51
Sunset Creek	SE 30th	2464.334	1.01-year	52.48	66.05	68.16	67.42	2.11	0.009084	3.05	17.22	11.77	0.44	1.32	0.75
Sunset Creek	SE 30th	2464.334	2-year	79	66.05	68.56	67.75	2.51	0.009723	3.58	22.8	16.12	0.46	1.62	0.98
Sunset Creek	SE 30th	2464.334	10-year	126	66.05	69.05	68.21	3	0.011428	4.36	31.95	21.41	0.51	1.97	1.41
Sunset Creek	SE 30th	2464.334	25-year	157	66.05	69.27	68.5	3.22	0.012584	4.84	37.15	26.24	0.54	2.15	1.69
Sunset Creek	SE 30th	2464.334	100-year	212	66.05	69.6	68.97	3.55	0.01357	5.46	47.14	32.21	0.57	2.44	2.07
Sunset Creek	SE 30th	2429.853	1.01-year	52.48	66.05	67.9	67.23	1.85	0.007127	2.71	19.88	16.76	0.4	1.28	0.57
Sunset Creek	SE 30th	2429.853	2-year	79	66.05	68.31	67.5	2.26	0.006992	3.09	27.43	20.07	0.41	1.61	0.7
Sunset Creek	SE 30th	2429.853	10-year	126	66.05	68.78	67.9	2.73	0.007716	3.74	38.45	28.92	0.44	2.01	0.97
Sunset Creek	SE 30th	2429.853	25-year	157	66.05	68.98	68.13	2.93	0.008643	4.18	44.22	29.86	0.47	2.18	1.18
Sunset Creek	SE 30th	2429.853	100-year	212	66.05	69.27	68.52	3.22	0.009971	4.84	53.02	29.86	0.51	2.44	1.52
Sunset Creek	SE 30th	2407.706	1.01-year	52.48	65.66	67.2	67.18	1.54	0.050024	5.41	9.7	10.14	0.97	0.9	2.81
Sunset Creek	SE 30th	2407.706	2-year	79	65.66	67.49	67.49	1.83	0.055912	6.15	12.85	11.41	1.01	1.07	3.72
Sunset Creek	SE 30th	2407.706	10-year	126	65.66	68.08	68.08	2.42	0.035381	6.11	23.27	26.99	0.83	1.53	3.38
Sunset Creek	SE 30th	2407.706	25-year	157	65.66	68.32	68.32	2.66	0.031455	6.25	30.63	31.58	0.8	1.73	3.4
Sunset Creek	SE 30th	2407.706	100-year	212	65.66	68.59	68.59	2.93	0.031333	6.82	39.24	31.58	0.82	1.98	3.88
Sunset Creek	SE 30th	2379.636	1.01-year	52.48	65.03	66.82	66.35	1.79	0.011821	2.88	18.23	17.64	0.49	1.02	0.75
Sunset Creek	SE 30th	2379.636	2-year	79	65.03	67.2	66.61	2.17	0.010089	3.17	25.26	19.24	0.47	1.35	0.85
Sunset Creek	SE 30th	2379.636	10-year	126	65.03	67.63	66.95	2.6	0.010673	3.82	34.07	22.65	0.5	1.73	1.15
Sunset Creek	SE 30th	2379.636	25-year	157	65.03	67.84	67.15	2.81	0.011446	4.24	38.98	25.69	0.53	1.92	1.37
Sunset Creek	SE 30th	2379.636	100-year	212	65.03	68.13	67.45	3.1	0.012803	4.92	47.18	30.11	0.57	2.2	1.76
Sunset Creek	SE 30th	2361.19	1.01-year	52.48	64.42	66.75	65.77	2.33	0.003291	2.31	24.33	17.71	0.31	1.57	0.32
Sunset Creek	SE 30th	2361.19	2-year	79	64.42	67.12	66.06	2.7	0.003979	2.78	31.28	20	0.34	1.84	0.46
Sunset Creek	SE 30th	2361.19	10-year	126	64.42	67.53	66.48	3.11	0.005537	3.55	39.95	22.43	0.4	2.13	0.74
Sunset Creek	SE 30th	2361.19	25-year	157	64.42	67.72	66.73	3.3	0.006582	3.99	44.2	22.57	0.44	2.26	0.93
Sunset Creek	SE 30th	2361.19	100-year	212	64.42	67.98	67.1	3.56	0.008521	4.73	50.35	25.52	0.5	2.44	1.3
Sunset Creek	SE 30th	2341.739	1.01-year	52.48	64.47	66.46	65.91	1.99	0.015418	3.96	13.91	14.01	0.56	1.33	1.28
Sunset Creek	SE 30th	2341.739	2-year	79	64.47	66.78	66.34	2.31	0.016281	4.59	20.7	26.6	0.59	1.59	1.61
Sunset Creek	SE 30th	2341.739	10-year	126	64.47	66.99	66.99	2.52	0.024569	6.05	26.8	30.91	0.74	1.77	2.71
Sunset Creek	SE 30th	2341.739	25-year	157	64.47	67.2	67.2	2.73	0.023365	6.29	33.69	34.59	0.73	1.95	2.84
Sunset Creek	SE 30th	2341.739	100-year	212	64.47	67.45	67.45	2.98	0.02399	6.84	42.56	34.59	0.75	2.16	3.24
Sunset Creek	SE 30th	2313.296	1.01-year	52.48	64.36	65.6	65.6	1.24	0.03887	5.25	10.46	14.89	0.93	0.94	2.27
Sunset Creek	SE 30th	2313.296	2-year	79	64.36	65.99	65.99	1.63	0.056799	4.69	18.59	31.31	0.92	0.77	2.73
Sunset Creek	SE 30th	2313.296	10-year	126	64.36	66.45	66.22	2.09	0.022822	4.04	34.09	33.3	0.63	1.22	1.74
Sunset Creek	SE 30th	2313.296	25-year	157	64.36	66.7	66.34	2.34	0.017603	4	42.32	33.3	0.57	1.46	1.6
Sunset Creek	SE 30th	2313.296	100-year	212	64.36	67.07	66.54	2.71	0.013966	4.11	54.56	33.3	0.53	1.81	1.58
Sunset Creek	SE 30th	2297.254	1.01-year	52.48	62.97	65.57	64.4	2.6	0.003703	2.18	30.74	29.44	0.27	1.98	0.46
Sunset Creek	SE 30th	2297.254	2-year	79	62.97	65.91	64.75	2.94	0.004278	2.59	41.16	31.13	0.29	2.31	0.62
Sunset Creek	SE 30th	2297.254	10-year	126	62.97	66.36	65.17	3.39	0.00516	3.19	55.75	84.25	0.33	2.74	0.88
Sunset Creek	SE 30th	2297.254	25-year	157	62.97	66.6	65.43	3.63	0.005718	3.54	63.93	86.24	0.35	2.96	1.06
Sunset Creek	SE 30th	2297.254	100-year	212	62.97	66.96	65.86	3.99	0.006276	3.99	76.84	86.24	0.38	3.31	1.3
Sunset Creek	SE 30th	2285.55	1.01-year	52.48	63.26	65.57	64.58	2.31	0.002258	1.3	46.24	33.75	0.17	1.39	0.2
Sunset Creek	SE 30th	2285.55	2-year	79	63.26	65.92	64.72	2.66	0.002488	1.54	58.22	34.76	0.18	1.65	0.26
Sunset Creek	SE 30th	2285.55	10-year	126	63.26	66.39	64.94	3.13	0.002542	1.77	78.44	100.84	0.19	2.01	0.32
Sunset Creek	SE 30th	2285.55	25-year	157	63.26	66.63	65.06	3.37	0.002312	1.79	90.89	100.84	0.19	2.2	0.32
Sunset Creek	SE 30th	2285.55	100-year	212	63.26	67.01	65.26	3.75	0.001991	1.8	110.12	100.84	0.18	2.49	0.31

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	2261.889	1.01-year	52.48	63.31	65.44	64.72	2.13	0.004929	2.35	31.44	92.25	0.31	1.5	0.46
Sunset Creek	SE 30th	2261.889	2-year	79	63.31	65.77	64.95	2.46	0.005531	2.79	41.16	95.88	0.34	1.78	0.61
Sunset Creek	SE 30th	2261.889	10-year	126	63.31	66.21	65.27	2.9	0.006161	3.34	55.45	97.98	0.37	2.16	0.83
Sunset Creek	SE 30th	2261.889	25-year	157	63.31	66.44	65.45	3.13	0.006507	3.65	63.11	97.98	0.39	2.36	0.96
Sunset Creek	SE 30th	2261.889	100-year	212	63.31	66.8	65.74	3.49	0.007047	4.12	74.91	97.98	0.41	2.67	1.17
Sunset Creek	SE 30th	2238.42	1.01-year	52.48	63.48	65.28	64.66	1.8	0.007533	2.53	26.26	90.2	0.37	1.4	0.66
Sunset Creek	SE 30th	2238.42	2-year	79	63.48	65.59	64.95	2.11	0.007916	2.95	34.84	92.49	0.39	1.69	0.84
Sunset Creek	SE 30th	2238.42	10-year	126	63.48	66	65.27	2.52	0.008879	3.58	46.72	97.36	0.43	2.08	1.15
Sunset Creek	SE 30th	2238.42	25-year	157	63.48	66.21	65.44	2.73	0.009416	3.92	53.14	97.36	0.45	2.28	1.34
Sunset Creek	SE 30th	2238.42	100-year	212	63.48	66.54	65.7	3.06	0.010293	4.47	62.92	97.36	0.48	2.59	1.67
Sunset Creek	SE 30th	2205.456	1.01-year	52.48	63.19	65	64.55	1.81	0.008604	2.79	25.06	89.89	0.42	1.36	0.73
Sunset Creek	SE 30th	2205.456	2-year	79	63.19	65.28	64.77	2.09	0.009445	3.31	33.12	93.14	0.45	1.63	0.96
Sunset Creek	SE 30th	2205.456	10-year	126	63.19	65.65	65.08	2.46	0.010778	4.02	44.96	96.12	0.5	1.98	1.34
Sunset Creek	SE 30th	2205.456	25-year	157	63.19	65.84	65.19	2.65	0.01136	4.39	51.41	96.12	0.52	2.17	1.54
Sunset Creek	SE 30th	2205.456	100-year	212	63.19	66.13	65.58	2.94	0.012404	4.97	61.12	96.12	0.55	2.46	1.9
Sunset Creek	SE 30th	2189.813	1.01-year	52.48	63.33	64.84	64.55	1.76	0.009729	2.3	22.76	26.3	0.38	1.1	0.67
Sunset Creek	SE 30th	2189.813	2-year	79	63.33	65.11	64.72	2.03	0.010621	2.77	30.06	27.67	0.41	1.36	0.9
Sunset Creek	SE 30th	2189.813	10-year	126	63.33	65.48	64.99	2.4	0.011004	3.29	41.61	83.85	0.43	1.71	1.17
Sunset Creek	SE 30th	2189.813	25-year	157	63.33	65.69	65.16	2.61	0.010237	3.42	48.81	83.85	0.43	1.91	1.22
Sunset Creek	SE 30th	2189.813	100-year	212	63.33	66	65.5	2.92	0.00956	3.64	59.37	83.85	0.42	2.21	1.32
Sunset Creek	SE 30th	2175.255	1.01-year	52.48	62.85	64.4	64.38	1.55	0.043402	4.65	15.02	25.47	0.74	1.1	2.98
Sunset Creek	SE 30th	2175.255	2-year	79	62.85	64.58	64.58	1.73	0.050518	5.51	19.7	25.88	0.82	1.26	3.98
Sunset Creek	SE 30th	2175.255	10-year	126	62.85	64.88	64.88	2.03	0.053164	6.42	27.34	82.34	0.87	1.53	5.07
Sunset Creek	SE 30th	2175.255	25-year	157	62.85	65.03	65.03	2.18	0.056152	6.98	31.33	86.77	0.91	1.66	5.83
Sunset Creek	SE 30th	2175.255	100-year	212	62.85	65.37	65.28	2.52	0.047632	7.22	40.82	90.25	0.86	1.98	5.88
Sunset Creek	SE 30th	2121.292	1.01-year	52.48	61.77	63.42	63.08	1.65	0.012059	2.87	18.3	23.14	0.57	0.75	0.56
Sunset Creek	SE 30th	2121.292	2-year	79	61.77	63.76	63.31	1.99	0.008338	3.01	26.71	26	0.5	1.05	0.55
Sunset Creek	SE 30th	2121.292	10-year	126	61.77	64.22	63.6	2.45	0.006583	3.35	38.87	26.87	0.47	1.48	0.61
Sunset Creek	SE 30th	2121.292	25-year	157	61.77	64.56	63.75	2.79	0.005203	3.4	48.23	27.53	0.43	1.8	0.59
Sunset Creek	SE 30th	2121.292	100-year	212	61.77	65.18	64	3.41	0.003618	3.41	65.75	28.72	0.38	2.39	0.54
Sunset Creek	SE 30th	2107.746	1.01-year	52.48	61.82	62.85	62.85	1.03	0.029233	5.24	10.02	11.85	1	0.8	1.46
Sunset Creek	SE 30th	2107.746	2-year	79	61.82	63.12	63.12	1.3	0.028792	5.93	13.35	12.76	1	1.02	1.83
Sunset Creek	SE 30th	2107.746	10-year	126	61.82	63.85	63.63	2.03	0.012136	5.22	28.04	24.73	0.69	1.65	1.25
Sunset Creek	SE 30th	2107.746	25-year	157	61.82	64.33	63.84	2.51	0.007265	4.74	40.33	26.36	0.56	2.09	0.95
Sunset Creek	SE 30th	2107.746	100-year	212	61.82	65.04	64.14	3.22	0.004472	4.46	59.71	27.99	0.46	2.75	0.77
Sunset Creek	SE 30th	2098.229	1.01-year	100.32	60.13	62.65	62.12	2.52	0.010475	3.15	32.57	42.26	0.54	0.99	0.65
Sunset Creek	SE 30th	2098.229	2-year	151	60.13	63.04	62.51	2.91	0.007654	3.32	49.35	42.91	0.49	1.36	0.65
Sunset Creek	SE 30th	2098.229	10-year	236	60.13	63.64	62.88	3.51	0.005318	3.49	75.38	43.89	0.43	1.92	0.64
Sunset Creek	SE 30th	2098.229	25-year	297	60.13	64.04	63.06	3.91	0.004469	3.6	92.74	44.54	0.41	2.29	0.64
Sunset Creek	SE 30th	2098.229	100-year	412	60.13	64.71	63.38	4.58	0.003592	3.79	123.02	45.64	0.38	2.92	0.66
Sunset Creek	SE 30th	2070.489	1.01-year	100.32	60.45	62.56	61.73	2.11	0.003482	2.02	49.67	39.18	0.32	1.23	0.27
Sunset Creek	SE 30th	2070.489	2-year	151	60.45	62.98	61.98	2.53	0.003054	2.26	68.63	47.19	0.31	1.62	0.31
Sunset Creek	SE 30th	2070.489	10-year	236	60.45	63.6	62.31	3.15	0.002468	2.51	98.67	48.8	0.29	2.23	0.34
Sunset Creek	SE 30th	2070.489	25-year	297	60.45	64.01	62.49	3.56	0.00222	2.65	118.56	49.83	0.28	2.62	0.36
Sunset Creek	SE 30th	2070.489	100-year	412	60.45	64.69	62.82	4.24	0.001935	2.88	153.29	51.47	0.28	3.29	0.4
Sunset Creek	SE 30th	2050.566	1.01-year	100.32	59.65	62.37	61.97	2.72	0.009256	2.98	33.92	34.24	0.51	0.99	0.57
Sunset Creek	SE 30th	2050.566	2-year	151	59.65	62.82	62.19	3.17	0.006281	3.1	51.85	45.37	0.44	1.4	0.55
Sunset Creek	SE 30th	2050.566	10-year	236	59.65	63.49	62.51	3.84	0.004056	3.18	82.72	47.24	0.38	2.01	0.51
Sunset Creek	SE 30th	2050.566	25-year	297	59.65	63.9	62.75	4.25	0.003383	3.26	102.68	48.41	0.36	2.4	0.51
Sunset Creek	SE 30th	2050.566	100-year	412	59.65	64.6	63.07	4.95	0.002728	3.43	137.18	50.17	0.33	3.04	0.52
Sunset Creek	SE 30th	2036.451	1.01-year	100.32	60.13	62.26	61.72	2.13	0.008428	2.83	38.52	47.32	0.48	1.04	0.55
Sunset Creek	SE 30th	2036.451	2-year	151	60.13	62.77	62.03	2.64	0.004602	2.7	63.41	49	0.37	1.54	0.44
Sunset Creek	SE 30th	2036.451	10-year	236	60.13	63.47	62.39	3.34	0.003026	2.78	98.07	51.26	0.32	2.19	0.41
Sunset Creek	SE 30th	2036.451	25-year	297	60.13	63.89	62.57	3.76	0.002585	2.87	120.11	52.64	0.31	2.6	0.42
Sunset Creek	SE 30th	2036.451	100-year	412	60.13	64.6	62.85	4.47	0.002145	3.05	157.45	52.87	0.29	3.27	0.44
Sunset Creek	SE 30th	2016.641	1.01-year	100.32	59.66	62.2	61.35	2.54	0.003075	2.06	50.21	42.43	0.31	1.32	0.25
Sunset Creek	SE 30th	2016.641	2-year	151	59.66	62.74	61.64	3.08	0.002219	2.18	73.92	45.1	0.28	1.83	0.25
Sunset Creek	SE 30th	2016.641	10-year	236	59.66	63.43	61.94	3.77	0.00181	2.42	106.01	46.8	0.26	2.5	0.28
Sunset Creek	SE 30th	2016.641	25-year	297	59.66	63.86	62.14	4.2	0.001683	2.58	126.14	47.83	0.26	2.9	0.3
Sunset Creek	SE 30th	2016.641	100-year	412	59.66	64.57	62.47	4.91	0.001548	2.84	160.54	49.55	0.26	3.57	0.35
Sunset Creek	SE 30th	1988.07	1.01-year	100.32	59.15	62.15	61.01	3	0.001716	1.9	60.17	42	0.24	1.79	0.19
Sunset Creek	SE 30th	1988.07	2-year	151	59.15	62.69	61.27	3.54	0.001511	2.11	83.51	43.62	0.24	2.3	0.22
Sunset Creek	SE 30th	1988.07	10-year	236	59.15	63.39	61.63	4.24	0.001441	2.43	114.86	45.7	0.24	2.95	0.27
Sunset Creek	SE 30th	1988.07	25-year	297	59.15	63.82	61.84	4.67	0.001424	2.63	134.61	46.96	0.24	3.35	0.3
Sunset Creek	SE 30th	1988.07	100-year	412	59.15	64.53	62.24	5.38	0.001405	2.94	168.55	49.05	0.25	4.01	0.35
Sunset Creek	SE 30th	1968.444	1.01-year	100.32	59.73	62.1	61.04	2.37	0.001844	2.08	57.87	41.14	0.26	1.88	0.22
Sunset Creek	SE 30th	1968.444	2-year	151	59.73	62.65	61.33	2.92	0.001616	2.3	81.33	44.08	0.26	2.41	0.24
Sunset Creek	SE 30th	1968.444	10-year	236	59.73	63.35	61.71	3.62	0.001517	2.63	112.72	45.23	0.26	3.1	0.29
Sunset Creek	SE 30th	1968.444	25-year	297	59.73	63.78	61.92	4.05	0.001501	2.84	132.2	46.26	0.26	3.51	0.33
Sunset Creek	SE 30th	1968.444	100-year	412	59.73	64.48	62.27	4.75	0.001487	3.19	165.42	47.96	0.27	4.2	0.39

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	1954.61	1.01-year	100.32	59.63	61.99	61.33	2.36	0.008212	3.06	43.17	38.25	0.38	1.89	0.97
Sunset Creek	SE 30th	1954.61	2-year	151	59.63	62.57	61.66	2.94	0.005902	3.07	67.43	43.67	0.33	2.43	0.9
Sunset Creek	SE 30th	1954.61	10-year	236	59.63	63.29	62.03	3.66	0.00473	3.23	99.74	45.74	0.31	3.1	0.92
Sunset Creek	SE 30th	1954.61	25-year	297	59.63	63.73	62.3	4.1	0.004372	3.37	119.83	46.98	0.31	3.51	0.96
Sunset Creek	SE 30th	1954.61	100-year	412	59.63	64.44	62.62	4.81	0.003986	3.61	154.17	49.03	0.3	4.17	1.04
Sunset Creek	SE 30th	1928.749	1.01-year	100.32	59.16	61.96	60.54	2.8	0.001812	1.53	68.09	38.44	0.19	2.04	0.23
Sunset Creek	SE 30th	1928.749	2-year	151	59.16	62.54	60.77	3.38	0.001734	1.77	91.52	42.78	0.19	2.61	0.28
Sunset Creek	SE 30th	1928.749	10-year	236	59.16	63.26	61.1	4.1	0.001786	2.11	122.71	43.96	0.2	3.32	0.37
Sunset Creek	SE 30th	1928.749	25-year	297	59.16	63.69	61.31	4.53	0.001837	2.32	141.81	44.64	0.21	3.74	0.43
Sunset Creek	SE 30th	1928.749	100-year	412	59.16	64.4	61.66	5.24	0.001915	2.65	173.95	45.74	0.22	4.44	0.53
Sunset Creek	SE 30th	1881.347	1.01-year	100.32	58.45	61.71	60.37	3.26	0.005655	3.04	36.16	22.84	0.34	2.28	0.81
Sunset Creek	SE 30th	1881.347	2-year	151	58.45	62.25	60.8	3.8	0.006073	3.59	50.66	36.83	0.36	2.77	1.05
Sunset Creek	SE 30th	1881.347	10-year	236	58.45	62.96	61.48	4.51	0.005834	4.04	78.11	39.28	0.37	3.4	1.24
Sunset Creek	SE 30th	1881.347	25-year	297	58.45	63.39	61.9	4.94	0.005589	4.25	95.35	40.41	0.36	3.79	1.32
Sunset Creek	SE 30th	1881.347	100-year	412	58.45	64.1	62.64	5.65	0.005316	4.6	124.4	40.94	0.36	4.43	1.47
Sunset Creek	SE 30th	1868.66	1.01-year	100.32	59.05	61.67	60.65	2.62	0.004449	2.64	45.34	33.4	0.33	1.96	0.54
Sunset Creek	SE 30th	1868.66	2-year	151	59.05	62.24	61.01	3.19	0.003885	2.91	64.72	35.17	0.32	2.5	0.61
Sunset Creek	SE 30th	1868.66	10-year	236	59.05	62.95	61.52	3.9	0.003739	3.35	90.37	36.56	0.32	3.17	0.74
Sunset Creek	SE 30th	1868.66	25-year	297	59.05	63.38	61.76	4.33	0.003734	3.63	105.99	36.56	0.33	3.58	0.84
Sunset Creek	SE 30th	1868.66	100-year	412	59.05	64.07	62.15	5.02	0.003805	4.1	131.53	36.56	0.34	4.25	1.01
Sunset Creek	SE 30th	1856.084	1.01-year	100.32	58.51	61.54	60.64	3.03	0.009194	3.18	36.92	28.3	0.39	1.96	1.13
Sunset Creek	SE 30th	1856.084	2-year	151	58.51	62.12	61.06	3.61	0.007785	3.44	53.97	30.95	0.37	2.51	1.22
Sunset Creek	SE 30th	1856.084	10-year	236	58.51	62.83	61.6	4.32	0.007328	3.91	77.03	34.26	0.38	3.18	1.45
Sunset Creek	SE 30th	1856.084	25-year	297	58.51	63.25	61.86	4.74	0.007228	4.21	92.07	36.27	0.38	3.58	1.62
Sunset Creek	SE 30th	1856.084	100-year	412	58.51	63.96	62.31	5.45	0.00691	4.61	117.72	36.27	0.38	4.25	1.83
Sunset Creek	SE 30th	1817.494	1.01-year	100.32	58.15	61.26	59.86	3.11	0.004924	3.33	30.99	17.77	0.36	2.1	0.65
Sunset Creek	SE 30th	1817.494	2-year	151	58.15	61.77	60.34	3.62	0.005847	4.07	41.58	23.46	0.41	2.5	0.91
Sunset Creek	SE 30th	1817.494	10-year	236	58.15	62.37	61.03	4.22	0.00705	5.03	56.84	25.61	0.46	2.98	1.31
Sunset Creek	SE 30th	1817.494	25-year	297	58.15	62.73	61.59	4.58	0.007687	5.58	66.11	25.61	0.49	3.27	1.57
Sunset Creek	SE 30th	1817.494	100-year	412	58.15	63.33	62.25	5.18	0.008613	6.47	81.33	25.61	0.53	3.75	2.01
Sunset Creek	SE 30th	1805.019	1.01-year	100.32	58.22	61.22	59.92	3	0.004481	3.25	37.73	28.54	0.36	2.11	0.59
Sunset Creek	SE 30th	1805.019	2-year	151	58.22	61.74	60.37	3.52	0.004649	3.74	53.63	32.01	0.37	2.54	0.74
Sunset Creek	SE 30th	1805.019	10-year	236	58.22	62.39	61.23	4.17	0.004871	4.34	76.07	53.24	0.39	3.06	0.93
Sunset Creek	SE 30th	1805.019	25-year	297	58.22	62.78	61.56	4.56	0.00479	4.6	92.15	60.85	0.4	3.38	1.01
Sunset Creek	SE 30th	1805.019	100-year	412	58.22	63.46	62.1	5.24	0.004327	4.84	122.76	67.33	0.39	3.94	1.06
Sunset Creek	SE 30th	1791.536	1.01-year	100.32	58.58	61.12	60.26	2.54	0.005998	3.49	32.84	26.2	0.43	1.87	0.7
Sunset Creek	SE 30th	1791.536	2-year	151	58.58	61.65	60.74	3.07	0.005534	3.91	47.64	28.57	0.43	2.35	0.81
Sunset Creek	SE 30th	1791.536	10-year	236	58.58	62.25	61.28	3.67	0.005915	4.65	64.98	28.57	0.46	2.91	1.07
Sunset Creek	SE 30th	1791.536	25-year	297	58.58	62.61	61.59	4.03	0.006259	5.14	75.08	28.57	0.48	3.23	1.26
Sunset Creek	SE 30th	1791.536	100-year	412	58.58	63.18	62.03	4.6	0.006856	5.94	91.41	28.57	0.52	3.76	1.61
Sunset Creek	SE 30th	1777.213	1.01-year	100.32	58.04	61.1	59.79	3.06	0.00334	2.79	43.51	29.94	0.32	2.13	0.44
Sunset Creek	SE 30th	1777.213	2-year	151	58.04	61.64	60.25	3.6	0.003268	3.15	60.86	60.16	0.32	2.6	0.53
Sunset Creek	SE 30th	1777.213	10-year	236	58.04	62.27	60.89	4.23	0.003557	3.74	83.05	66.33	0.35	3.14	0.7
Sunset Creek	SE 30th	1777.213	25-year	297	58.04	62.64	61.24	4.6	0.003738	4.09	96.39	66.54	0.36	3.47	0.81
Sunset Creek	SE 30th	1777.213	100-year	412	58.04	63.24	61.67	5.2	0.004003	4.65	118.39	66.89	0.38	3.99	1
Sunset Creek	SE 30th	1749.718	1.01-year	100.32	57.73	60.91	59.77	3.18	0.005586	3.47	33.31	20.49	0.39	2.1	0.73
Sunset Creek	SE 30th	1749.718	2-year	151	57.73	61.39	60.31	3.66	0.006433	4.19	44.81	47.1	0.43	2.51	1.01
Sunset Creek	SE 30th	1749.718	10-year	236	57.73	61.91	60.9	4.18	0.008186	5.27	60.57	63.78	0.5	2.96	1.51
Sunset Creek	SE 30th	1749.718	25-year	297	57.73	62.21	61.31	4.48	0.009052	5.87	70.54	64.03	0.54	3.22	1.82
Sunset Creek	SE 30th	1749.718	100-year	412	57.73	62.72	61.95	4.99	0.010215	6.79	87.2	64.43	0.58	3.66	2.34
Sunset Creek	SE 30th	1689.563	1.01-year	100.32	57.21	60.02	59.59	2.81	0.020876	5.42	18.92	17.83	0.7	1.56	2.03
Sunset Creek	SE 30th	1689.563	2-year	151	57.21	60.43	60.37	3.22	0.020473	6.14	29.13	26.36	0.72	1.9	2.43
Sunset Creek	SE 30th	1689.563	10-year	236	57.21	61.02	60.84	3.81	0.016972	6.53	45.24	28.17	0.68	2.4	2.55
Sunset Creek	SE 30th	1689.563	25-year	297	57.21	61.38	61.07	4.17	0.015528	6.76	55.52	29.26	0.67	2.71	2.62
Sunset Creek	SE 30th	1689.563	100-year	412	57.21	61.97	61.51	4.76	0.013881	7.16	73.28	43.57	0.65	3.2	2.78
Sunset Creek	SE 30th	1668.393	1.01-year	100.32	56.93	59.91	59.04	2.98	0.008146	4.05	28.94	25.06	0.47	1.94	0.99
Sunset Creek	SE 30th	1668.393	2-year	151	56.93	60.35	59.81	3.42	0.008396	4.62	40.03	26.29	0.5	2.31	1.21
Sunset Creek	SE 30th	1668.393	10-year	236	56.93	60.91	60.31	3.98	0.008645	5.32	55.37	27.91	0.52	2.79	1.51
Sunset Creek	SE 30th	1668.393	25-year	297	56.93	61.26	60.56	4.33	0.008706	5.71	65.25	28.9	0.53	3.09	1.68
Sunset Creek	SE 30th	1668.393	100-year	412	56.93	61.84	61.01	4.91	0.008713	6.31	82.48	30.55	0.54	3.58	1.95
Sunset Creek	SE 30th	1626.318	1.01-year	100.32	56.89	59.64	58.71	2.75	0.006398	3.64	31.21	23.61	0.43	1.9	0.76
Sunset Creek	SE 30th	1626.318	2-year	151	56.89	60.03	59.27	3.14	0.007479	4.38	40.51	24.76	0.48	2.23	1.04
Sunset Creek	SE 30th	1626.318	10-year	236	56.89	60.51	59.87	3.62	0.009048	5.39	52.72	26.21	0.54	2.65	1.49
Sunset Creek	SE 30th	1626.318	25-year	297	56.89	60.8	60.15	3.91	0.009898	5.99	60.41	27.07	0.58	2.9	1.79
Sunset Creek	SE 30th	1626.318	100-year	412	56.89	61.3	60.62	4.41	0.010777	6.86	74.37	28.58	0.62	3.33	2.24
Sunset Creek	SE 30th	1613.357	1.01-year	100.32	56.46	59.63	58.27	3.17	0.003357	2.9	37.14	23.32	0.33	2.08	0.44
Sunset Creek	SE 30th	1613.357	2-year	151	56.46	60	58.69	3.54	0.004389	3.65	46.19	24.85	0.39	2.4	0.66
Sunset Creek	SE 30th	1613.357	10-year	236	56.46	60.47	59.4	4.01	0.0059	4.69	58.04	26.32	0.46	2.8	1.03
Sunset Creek	SE 30th	1613.357	25-year	297	56.46	60.74	59.77	4.28	0.006805	5.32	65.4	27.19	0.5	3.03	1.29
Sunset Creek	SE 30th	1613.357	100-year	412	56.46	61.23	60.29	4.77	0.00793	6.25	78.89	28.73	0.55	3.45	1.71

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	1592.728	1.01-year	100.32	56.02	59.65	57.91	3.63	0.001149	1.69	62.89	33.09	0.19	2.23	0.16
Sunset Creek	SE 30th	1592.728	2-year	151	56.02	60.04	58.23	4.02	0.001518	2.15	75.99	33.8	0.23	2.6	0.25
Sunset Creek	SE 30th	1592.728	10-year	236	56.02	60.54	58.66	4.52	0.002077	2.81	92.89	34.71	0.28	3.07	0.4
Sunset Creek	SE 30th	1592.728	25-year	297	56.02	60.83	58.92	4.81	0.00242	3.22	103.26	35.25	0.3	3.35	0.51
Sunset Creek	SE 30th	1592.728	100-year	412	56.02	61.35	59.38	5.33	0.002877	3.85	121.91	36.21	0.34	3.85	0.69
Sunset Creek	SE 30th	1583.59	1.01-year	100.32	56.87	59.48	58.8	2.61	0.008049	3.48	32.65	32.1	0.47	1.59	0.8
Sunset Creek	SE 30th	1583.59	2-year	151	56.87	59.81	59.2	2.94	0.00914	4.19	43.62	33.2	0.52	1.91	1.09
Sunset Creek	SE 30th	1583.59	10-year	236	56.87	60.21	59.7	3.34	0.011291	5.25	56.96	34.5	0.6	2.28	1.61
Sunset Creek	SE 30th	1583.59	25-year	297	56.87	60.43	59.97	3.56	0.012715	5.91	64.84	35.25	0.64	2.5	1.98
Sunset Creek	SE 30th	1583.59	100-year	412	56.87	60.87	60.38	4	0.013713	6.8	80.49	36.69	0.68	2.91	2.49
Sunset Creek	SE 30th	1583.5		Lat Struct											
Sunset Creek	SE 30th	1576.451	1.01-year	100.32	56.81	59.39	58.71	2.58	0.01288	3.58	28.97	25.93	0.53	1.27	1.02
Sunset Creek	SE 30th	1576.451	2-year	151	56.81	59.69	59.18	2.88	0.015583	4.33	37.2	28.01	0.6	1.47	1.43
Sunset Creek	SE 30th	1576.451	10-year	236	56.81	60.02	59.67	3.21	0.020105	5.52	46.94	31.92	0.7	1.76	2.2
Sunset Creek	SE 30th	1576.451	25-year	297	56.81	60.17	59.92	3.36	0.024449	6.39	51.81	33.88	0.78	1.89	2.89
Sunset Creek	SE 30th	1576.451	100-year	412	56.81	60.36	60.36	3.55	0.034449	8.04	58.39	36.3	0.94	2.06	4.43
Sunset Creek	SE 30th	1535.154	1.01-year	85.27	56.74	58.88	58.13	2.14	0.005952	2.09	44.51	64.82	0.32	1.3	0.48
Sunset Creek	SE 30th	1535.154	2-year	128.35	56.74	59.18	58.35	2.44	0.006312	2.43	65.06	75.59	0.34	1.55	0.61
Sunset Creek	SE 30th	1535.154	10-year	200.6	56.74	59.54	58.67	2.8	0.006603	2.81	96.09	107.2	0.36	1.86	0.77
Sunset Creek	SE 30th	1535.154	25-year	252.45	56.74	59.75	58.95	3.01	0.006459	2.98	118.93	107.2	0.36	2.06	0.83
Sunset Creek	SE 30th	1535.154	100-year	350.2	56.74	60.09	59.26	3.35	0.006347	3.26	155.06	107.2	0.37	2.39	0.95
Sunset Creek	SE 30th	1520.645	1.01-year	85.27	56.07	58.86	57.6	2.79	0.001622	1.56	72.98	107.62	0.21	1.52	0.15
Sunset Creek	SE 30th	1520.645	2-year	128.35	56.07	59.16	57.84	3.09	0.001767	1.81	105.43	109.75	0.23	1.79	0.2
Sunset Creek	SE 30th	1520.645	10-year	200.6	56.07	59.52	58.19	3.45	0.00202	2.16	144.8	109.75	0.25	2.11	0.27
Sunset Creek	SE 30th	1520.645	25-year	252.45	56.07	59.73	58.4	3.66	0.002178	2.38	167.84	109.75	0.26	2.3	0.31
Sunset Creek	SE 30th	1520.645	100-year	350.2	56.07	60.06	58.97	3.99	0.002455	2.74	204.17	109.75	0.28	2.6	0.4
Sunset Creek	SE 30th	1493.465	1.01-year	85.27	56.01	58.7	57.64	2.69	0.004145	2.89	40.53	62.58	0.35	1.9	0.49
Sunset Creek	SE 30th	1493.465	2-year	128.35	56.01	58.95	58.02	2.94	0.005351	3.54	61.32	88.29	0.41	2.12	0.71
Sunset Creek	SE 30th	1493.465	10-year	200.6	56.01	59.27	58.92	3.26	0.006282	4.18	89.8	88.29	0.45	2.42	0.95
Sunset Creek	SE 30th	1493.465	25-year	252.45	56.01	59.46	59.1	3.45	0.006746	4.54	106.66	88.29	0.47	2.59	1.09
Sunset Creek	SE 30th	1493.465	100-year	350.2	56.01	59.76	59.35	3.75	0.007605	5.14	132.59	88.29	0.51	2.86	1.36
Sunset Creek	SE 30th	1474.062	1.01-year	85.27	56.81	58.67	58.2	1.86	0.003919	2.28	70.18	110.27	0.33	1.37	0.33
Sunset Creek	SE 30th	1474.062	2-year	128.35	56.81	58.94	58.39	2.13	0.003902	2.54	99.13	110.27	0.34	1.61	0.39
Sunset Creek	SE 30th	1474.062	10-year	200.6	56.81	59.27	58.59	2.46	0.004071	2.92	135.6	110.27	0.36	1.92	0.49
Sunset Creek	SE 30th	1474.062	25-year	252.45	56.81	59.46	58.74	2.65	0.004232	3.16	156.98	110.27	0.37	2.1	0.55
Sunset Creek	SE 30th	1474.062	100-year	350.2	56.81	59.76	58.94	2.95	0.004639	3.59	189.85	110.27	0.4	2.38	0.69
Sunset Creek	SE 30th	1400.25	1.01-year	85.27	56.09	57.96	57.61	1.87	0.014145	4.19	31.41	78.66	0.61	1.34	1.19
Sunset Creek	SE 30th	1400.25	2-year	128.35	56.09	58.15	58.15	2.06	0.016614	4.89	46.97	83.59	0.67	1.51	1.57
Sunset Creek	SE 30th	1400.25	10-year	200.6	56.09	58.38	58.38	2.29	0.019637	5.79	65.88	83.59	0.74	1.71	2.1
Sunset Creek	SE 30th	1400.25	25-year	252.45	56.09	58.52	58.52	2.43	0.02105	6.28	77.39	83.59	0.78	1.84	2.42
Sunset Creek	SE 30th	1400.25	100-year	350.2	56.09	58.85	58.73	2.76	0.018145	6.45	105.04	83.59	0.74	2.14	2.42
Sunset Creek	SE 30th	1312.582	1.01-year	85.27	54.16	56.24	55.93	2.08	0.0213	5.36	15.98	11.67	0.75	1.36	1.81
Sunset Creek	SE 30th	1312.582	2-year	128.35	54.16	56.73	56.72	2.57	0.013868	5.05	46.92	86.52	0.62	1.73	1.5
Sunset Creek	SE 30th	1312.582	10-year	200.6	54.16	57.34	56.99	3.18	0.006623	4.16	100.76	87.46	0.45	2.25	0.93
Sunset Creek	SE 30th	1312.582	25-year	252.45	54.16	57.8	57.13	3.64	0.004257	3.71	140.94	87.46	0.37	2.64	0.7
Sunset Creek	SE 30th	1312.582	100-year	350.2	54.16	58.59	57.35	4.43	0.002582	3.35	209.85	87.46	0.3	3.31	0.53
Sunset Creek	SE 30th	1208.49	1.01-year	85.27	51.7	54.69	53.8	2.99	0.011975	4.59	18.56	8.69	0.55	1.56	1.17
Sunset Creek	SE 30th	1208.49	2-year	128.35	51.7	55.76	54.36	4.06	0.007412	3.96	43.65	47.18	0.45	1.82	0.84
Sunset Creek	SE 30th	1208.49	10-year	200.6	51.7	56.96	55.65	5.26	0.002698	3.01	107.59	54.66	0.29	2.6	0.44
Sunset Creek	SE 30th	1208.49	25-year	252.45	51.7	57.5	55.97	5.8	0.002206	3.01	137.02	54.66	0.27	3.02	0.42
Sunset Creek	SE 30th	1208.49	100-year	350.2	51.7	58.34	56.34	6.64	0.001853	3.15	183.04	54.66	0.26	3.67	0.42
Sunset Creek	SE 30th	1177.949	1.01-year	100.55	51.42	54.73	53.05	3.31	0.001847	2.77	36.25	13.04	0.29	2.11	0.24
Sunset Creek	SE 30th	1177.949	2-year	151.35	51.42	55.49	53.47	4.07	0.001658	3.06	67.15	50.15	0.29	2.67	0.28
Sunset Creek	SE 30th	1177.949	10-year	236.6	51.42	56.27	54.07	4.85	0.001624	3.46	106.14	50.15	0.29	3.26	0.33
Sunset Creek	SE 30th	1177.949	25-year	297.45	51.42	56.72	54.46	5.3	0.001634	3.7	128.59	50.15	0.3	3.6	0.37
Sunset Creek	SE 30th	1177.949	100-year	413.2	51.42	57.46	55.54	6.04	0.001653	4.1	165.81	50.15	0.31	4.16	0.43
Sunset Creek	SE 30th	1012.233	1.01-year	100.55	49.75	53.92	52.37	4.17	0.012251	4.21	23.87	7.7	0.42	1.6	1.23
Sunset Creek	SE 30th	1012.233	2-year	151.35	49.75	54.61	53	4.86	0.014766	4.99	32.97	19.55	0.46	1.82	1.68
Sunset Creek	SE 30th	1012.233	10-year	236.6	49.75	55.32	53.89	5.57	0.015381	5.74	47.51	21.31	0.49	2.18	2.09
Sunset Creek	SE 30th	1012.233	25-year	297.45	49.75	55.73	54.97	5.98	0.01563	6.14	56.33	22.3	0.5	2.38	2.33
Sunset Creek	SE 30th	1012.233	100-year	413.2	49.75	56.4	55.54	6.65	0.015683	6.72	72.27	25.48	0.51	2.72	2.67
Sunset Creek	SE 30th	852.3866	1.01-year	100.55	50.09	52.62	51.63	2.53	0.006322	3.4	29.58	14.77	0.42	1.78	0.7
Sunset Creek	SE 30th	852.3866	2-year	151.35	50.09	53.16	52.04	3.07	0.006831	3.99	39.1	20.79	0.45	2.16	0.92
Sunset Creek	SE 30th	852.3866	10-year	236.6	50.09	54.18	52.6	4.09	0.005023	4.05	66.26	32.44	0.39	2.84	0.89
Sunset Creek	SE 30th	852.3866	25-year	297.45	50.09	54.64	53	4.55	0.0048	4.2	81.41	33	0.39	3.13	0.94
Sunset Creek	SE 30th	852.3866	100-year	413.2	50.09	55.41	53.69	5.32	0.004473	4.42	107.36	33.89	0.38	3.61	1.01
Sunset Creek	SE 30th	834.4796	1.01-year	100.55	50.42	52.35	52.05	1.93	0.01474	4.18	24.04	20.5	0.68	1.14	1.05
Sunset Creek	SE 30th	834.4796	2-year	151.35	50.42	53.03	52.37	2.61	0.007551	3.93	39.53	25.04	0.51	1.74	0.82
Sunset Creek	SE 30th	834.4796	10-year	236.6	50.42	54.13	52.8	3.71	0.003809	3.64	70.94	32.34	0.38	2.65	0.63
Sunset Creek	SE 30th	834.4796	25-year	297.45	50.42	54.59	53.07	4.17	0.003563	3.81	86.3	33.41	0.37	3.01	0.67
Sunset Creek	SE 30th	834.4796	100-year	413.2	50.42	55.37	53.54	4.95	0.003295	4.09	112.38	33.89	0.36	3.6	0.74

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	816.2844	1.01-year	100.55	50.18	52.24	51.75	2.06	0.008159	3.12	32.21	26.8	0.5	1.16	0.59
Sunset Creek	SE 30th	816.2844	2-year	151.35	50.18	53.01	52.01	2.83	0.00411	2.79	54.18	29.98	0.37	1.73	0.44
Sunset Creek	SE 30th	816.2844	10-year	236.6	50.18	54.14	52.38	3.96	0.002024	2.59	96.36	43.09	0.27	2.68	0.34
Sunset Creek	SE 30th	816.2844	25-year	297.45	50.18	54.61	52.61	4.43	0.001886	2.73	116.71	43.45	0.27	3.07	0.36
Sunset Creek	SE 30th	816.2844	100-year	413.2	50.18	55.4	53	5.22	0.001743	2.96	151.07	44.04	0.26	3.7	0.4
Sunset Creek	SE 30th	795.8286	1.01-year	100.55	50.27	52.19	51.34	1.92	0.003165	2.32	44.83	31.91	0.32	1.48	0.29
Sunset Creek	SE 30th	795.8286	2-year	151.35	50.27	52.99	51.59	2.72	0.001807	2.24	71.73	35.05	0.26	2.17	0.25
Sunset Creek	SE 30th	795.8286	10-year	236.6	50.27	54.13	51.96	3.86	0.001164	2.25	113.7	37.65	0.21	3.1	0.22
Sunset Creek	SE 30th	795.8286	25-year	297.45	50.27	54.6	52.18	4.33	0.001203	2.46	131.34	37.81	0.22	3.46	0.26
Sunset Creek	SE 30th	795.8286	100-year	413.2	50.27	55.38	52.55	5.11	0.001275	2.79	160.96	38.09	0.23	4.05	0.32
Sunset Creek	SE 30th	772.6812	1.01-year	100.55	49.8	52.11	51.34	2.31	0.003653	2.31	43.7	31.58	0.34	1.35	0.31
Sunset Creek	SE 30th	772.6812	2-year	151.35	49.8	52.95	51.57	3.15	0.001828	2.16	72.29	36.23	0.25	2.07	0.24
Sunset Creek	SE 30th	772.6812	10-year	236.6	49.8	54.11	51.89	4.31	0.00112	2.16	114.64	45.55	0.21	3.02	0.21
Sunset Creek	SE 30th	772.6812	25-year	297.45	49.8	54.58	52.11	4.78	0.001129	2.36	131.9	46.88	0.21	3.43	0.24
Sunset Creek	SE 30th	772.6812	100-year	413.2	49.8	55.36	52.47	5.56	0.001146	2.68	160.69	49.34	0.22	4.13	0.3
Sunset Creek	SE 30th	742.021	1.01-year	100.55	49.76	52.02	51.21	2.26	0.003189	2.11	47.66	33.85	0.31	1.33	0.26
Sunset Creek	SE 30th	742.021	2-year	151.35	49.76	52.91	51.43	3.15	0.001545	1.92	78.98	41.14	0.23	2.04	0.2
Sunset Creek	SE 30th	742.021	10-year	236.6	49.76	54.09	51.73	4.33	0.000915	1.94	121.68	51.43	0.19	3.1	0.18
Sunset Creek	SE 30th	742.021	25-year	297.45	49.76	54.55	51.93	4.79	0.000934	2.14	138.71	53.01	0.19	3.54	0.21
Sunset Creek	SE 30th	742.021	100-year	413.2	49.76	55.33	52.27	5.57	0.000969	2.47	167.11	53.01	0.2	4.26	0.26
Sunset Creek	SE 30th	704.0906		Bridge											
Sunset Creek	SE 30th	637.1669	1.01-year	100.55	49	51.9	50.27	2.9	0.000853	1.45	70.06	47.21	0.17	2.09	0.11
Sunset Creek	SE 30th	637.1669	2-year	151.35	49	52.5	50.53	3.5	0.000918	1.73	88.54	47.45	0.18	2.59	0.15
Sunset Creek	SE 30th	637.1669	10-year	236.6	49	53.1	50.86	4.1	0.001204	2.22	107.77	50.54	0.21	3.1	0.23
Sunset Creek	SE 30th	637.1669	25-year	297.45	49	53.43	51.05	4.43	0.00139	2.54	119.92	54.92	0.23	3.4	0.29
Sunset Creek	SE 30th	637.1669	100-year	413.2	49	53.95	51.41	4.95	0.001696	3.06	140.47	55.09	0.26	3.87	0.41
Sunset Creek	SE 30th	616.5581	1.01-year	100.55	48.88	51.91	49.89	3.03	0.000325	1.03	110.79	63.7	0.11	2.53	0.05
Sunset Creek	SE 30th	616.5581	2-year	151.35	48.88	52.5	50.12	3.62	0.000374	1.24	137.79	68.09	0.12	3.02	0.07
Sunset Creek	SE 30th	616.5581	10-year	236.6	48.88	53.11	50.44	4.23	0.000518	1.61	165.49	68.31	0.14	3.51	0.11
Sunset Creek	SE 30th	616.5581	25-year	297.45	48.88	53.45	50.61	4.57	0.000611	1.84	181.43	71.38	0.16	3.82	0.15
Sunset Creek	SE 30th	616.5581	100-year	413.2	48.88	53.98	50.91	5.1	0.000771	2.25	208.45	73.22	0.18	4.3	0.21
Sunset Creek	SE 30th	596.5916	1.01-year	100.55	48.52	51.89	49.66	3.37	0.000469	1.23	86.44	39.76	0.13	2.65	0.08
Sunset Creek	SE 30th	596.5916	2-year	151.35	48.52	52.48	49.91	3.96	0.000588	1.52	104.95	41.79	0.14	3.12	0.11
Sunset Creek	SE 30th	596.5916	10-year	236.6	48.52	53.07	50.27	4.55	0.000858	2.03	123.81	43	0.18	3.6	0.19
Sunset Creek	SE 30th	596.5916	25-year	297.45	48.52	53.39	50.49	4.87	0.001044	2.35	134.65	44.27	0.2	3.89	0.25
Sunset Creek	SE 30th	596.5916	100-year	413.2	48.52	53.9	50.89	5.38	0.00138	2.91	152.55	46.28	0.23	4.34	0.37
Sunset Creek	SE 30th	572.9708	1.01-year	100.55	47.8	51.78	50.11	3.98	0.007601	2.49	40.48	21.88	0.31	1.84	0.87
Sunset Creek	SE 30th	572.9708	2-year	151.35	47.8	52.35	50.59	4.55	0.007157	2.85	56.98	34.86	0.31	2.36	1.06
Sunset Creek	SE 30th	572.9708	10-year	236.6	47.8	52.9	51.28	5.1	0.008165	3.46	76.88	37.39	0.35	2.87	1.46
Sunset Creek	SE 30th	572.9708	25-year	297.45	47.8	53.2	51.64	5.4	0.008915	3.85	88.28	38.6	0.37	3.14	1.75
Sunset Creek	SE 30th	572.9708	100-year	413.2	47.8	53.67	52.3	5.87	0.01014	4.47	106.42	38.6	0.4	3.57	2.26
Sunset Creek	SE 30th	554.7107	1.01-year	100.55	47.62	51.53	49.85	3.91	0.008734	3.52	29.54	16.78	0.36	2.05	1.12
Sunset Creek	SE 30th	554.7107	2-year	151.35	47.62	52	50.4	4.38	0.011306	4.42	42.63	52.59	0.42	2.37	1.67
Sunset Creek	SE 30th	554.7107	10-year	236.6	47.62	52.6	51.17	4.98	0.010878	4.81	74.77	55.25	0.42	2.77	1.88
Sunset Creek	SE 30th	554.7107	25-year	297.45	47.62	52.94	52.36	5.32	0.010413	4.97	93.85	56.77	0.42	3	1.95
Sunset Creek	SE 30th	554.7107	100-year	413.2	47.62	53.48	52.75	5.86	0.009824	5.21	127.97	116.88	0.41	3.37	2.07
Sunset Creek	SE 30th	543.1325	1.01-year	100.55	47.65	51.51	49.72	3.86	0.003292	2.93	34.88	47.13	0.3	2.2	0.45
Sunset Creek	SE 30th	543.1325	2-year	151.35	47.65	52.02	50.19	4.37	0.003779	3.42	62.18	54.96	0.33	2.53	0.6
Sunset Creek	SE 30th	543.1325	10-year	236.6	47.65	52.58	50.87	4.93	0.004189	4	94.75	117.31	0.36	2.96	0.77
Sunset Creek	SE 30th	543.1325	25-year	297.45	47.65	52.91	51.29	5.26	0.004277	4.26	116.67	117.31	0.36	3.21	0.86
Sunset Creek	SE 30th	543.1325	100-year	413.2	47.65	53.43	52.3	5.78	0.004344	4.64	152.13	117.31	0.37	3.61	0.98
Sunset Creek	SE 30th	529.8341	1.01-year	100.55	47.8	51.46	49.72	3.66	0.003891	2.95	34.75	19.02	0.31	2.16	0.53
Sunset Creek	SE 30th	529.8341	2-year	151.35	47.8	51.96	50.2	4.16	0.004456	3.44	57.79	104.16	0.34	2.48	0.69
Sunset Creek	SE 30th	529.8341	10-year	236.6	47.8	52.53	50.88	4.73	0.00459	3.9	90.52	110.19	0.35	2.92	0.84
Sunset Creek	SE 30th	529.8341	25-year	297.45	47.8	52.85	51.3	5.05	0.004675	4.15	110.51	113.6	0.36	3.17	0.93
Sunset Creek	SE 30th	529.8341	100-year	413.2	47.8	53.38	52.33	5.58	0.004781	4.55	145.06	119.09	0.37	3.58	1.07
Sunset Creek	SE 30th	420.6496	1.01-year	100.55	47.11	51.29	48.76	4.18	0.001273	1.95	52.77	25.3	0.19	2.57	0.2
Sunset Creek	SE 30th	420.6496	2-year	151.35	47.11	51.73	49.16	4.62	0.001736	2.43	74.11	53.2	0.23	2.86	0.31
Sunset Creek	SE 30th	420.6496	10-year	236.6	47.11	52.27	49.73	5.16	0.002053	2.9	108.53	118.2	0.25	3.28	0.42
Sunset Creek	SE 30th	420.6496	25-year	297.45	47.11	52.58	50.1	5.47	0.002156	3.12	129.9	118.2	0.26	3.53	0.47
Sunset Creek	SE 30th	420.6496	100-year	413.2	47.11	53.09	50.74	5.98	0.002268	3.45	164.84	118.2	0.27	3.93	0.56
Sunset Creek	SE 30th	48.9477	1.01-year	100.55	47.18	50.65	49.5	3.47	0.002442	2.13	71.26	131.31	0.26	1.84	0.28
Sunset Creek	SE 30th	48.9477	2-year	151.35	47.18	50.98	49.88	3.8	0.002464	2.37	98.48	131.31	0.27	2.15	0.33
Sunset Creek	SE 30th	48.9477	10-year	236.6	47.18	51.5	50.55	4.32	0.002216	2.56	140.71	131.31	0.27	2.62	0.36
Sunset Creek	SE 30th	48.9477	25-year	297.45	47.18	51.8	50.7	4.62	0.002179	2.72	165.11	131.31	0.27	2.9	0.39
Sunset Creek	SE 30th	48.9477	100-year	413.2	47.18	52.3	50.92	5.12	0.00215	2.98	205.72	131.31	0.27	3.36	0.45

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Richards Creek	Historical	1507.208	1.01-year	15.05	57.05	58.62	57.65	1.57	0.002703	0.91	16.56	17.45	0.16	0.89	0.15
Richards Creek	Historical	1507.208	2-year	22.65	57.05	58.81	57.8	1.76	0.003796	1.13	20.06	19	0.19	0.98	0.23
Richards Creek	Historical	1507.208	10-year	35.4	57.05	59.03	58	1.98	0.005265	1.45	24.62	23.46	0.23	1.14	0.37
Richards Creek	Historical	1507.208	25-year	44.55	57.05	59.13	58.13	2.08	0.006525	1.69	27.09	26.94	0.26	1.21	0.49
Richards Creek	Historical	1507.208	100-year	61.8	57.05	59.27	58.31	2.22	0.00875	2.09	31.13	30.61	0.31	1.34	0.73
Richards Creek	Historical	1481.097	1.01-year	15.05	57.41	58.45	58.08	1.04	0.012687	1.84	10.58	30.74	0.37	0.74	0.58
Richards Creek	Historical	1481.097	2-year	22.65	57.41	58.65	58.32	1.24	0.009489	1.77	20.33	70.02	0.32	0.88	0.52
Richards Creek	Historical	1481.097	10-year	35.4	57.41	58.91	58.51	1.5	0.005139	1.48	44.41	115.25	0.24	1.09	0.35
Richards Creek	Historical	1481.097	25-year	44.55	57.41	59	58.61	1.59	0.004818	1.51	56.33	131.14	0.24	1.18	0.36
Richards Creek	Historical	1481.097	100-year	61.8	57.41	59.14	58.72	1.73	0.004481	1.57	76.03	145.39	0.24	1.32	0.37
Richards Creek	Historical	1291.987	1.01-year	15.05	55.48	56.38	56.05	0.9	0.009455	1.94	7.75	12.07	0.43	0.63	0.37
Richards Creek	Historical	1291.987	2-year	22.65	55.48	56.5	56.19	1.02	0.012864	2.44	9.29	12.84	0.5	0.71	0.57
Richards Creek	Historical	1291.987	10-year	35.4	55.48	56.41	56.38	0.93	0.046361	4.38	8.09	12.25	0.95	0.65	1.87
Richards Creek	Historical	1291.987	25-year	44.55	55.48	56.5	56.5	1.02	0.050988	4.83	9.21	12.8	1	0.7	2.24
Richards Creek	Historical	1291.987	100-year	61.8	55.48	56.68	56.68	1.2	0.049454	5.28	11.71	13.74	1.01	0.83	2.56
Richards Creek	Historical	999.2128	1.01-year	15.05	51.78	52.33	52.21	0.55	0.021643	2.41	6.26	14.62	0.65	0.42	0.57
Richards Creek	Historical	999.2128	2-year	22.65	51.78	52.53	52.32	0.75	0.014271	2.42	9.35	15.49	0.55	0.59	0.53
Richards Creek	Historical	999.2128	10-year	35.4	51.78	53.02	52.47	1.24	0.005472	2.03	17.43	17.57	0.36	0.97	0.33
Richards Creek	Historical	999.2128	25-year	44.55	51.78	54.1	52.56	2.32	0.000868	1.14	38.96	21.98	0.15	1.7	0.09
Richards Creek	Historical	999.2128	100-year	61.8	51.78	56.66	52.72	4.88	0.000065	0.49	191.13	214.45	0.04	3.44	0.01
Richards Creek	Historical	968.151	1.01-year	15.05	51.3	52.1	51.71	0.8	0.00443	1.44	10.46	15.61	0.31	0.66	0.18
Richards Creek	Historical	968.151	2-year	22.65	51.3	52.38	51.82	1.08	0.003527	1.53	14.82	16.66	0.29	0.87	0.19
Richards Creek	Historical	968.151	10-year	35.4	51.3	52.95	51.97	1.65	0.001863	1.41	25.07	18.89	0.22	1.28	0.15
Richards Creek	Historical	968.151	25-year	44.55	51.3	54.09	52.06	2.79	0.000439	0.91	49.03	22.93	0.11	2.02	0.06
Richards Creek	Historical	968.151	100-year	61.8	51.3	56.66	52.22	5.36	0.000067	0.53	116.81	217.23	0.05	3.8	0.02
Richards Creek	Historical	913.9713		Culvert											
Richards Creek	Historical	875.7664	1.01-year	15.05	49.6	50.72	49.88	1.12	0.000498	0.6	24.93	27.65	0.11	0.88	0.03
Richards Creek	Historical	875.7664	2-year	22.65	49.6	51.06	49.97	1.46	0.000432	0.65	34.86	30.91	0.11	1.1	0.03
Richards Creek	Historical	875.7664	10-year	35.4	49.6	51.58	50.09	1.98	0.000351	0.68	52.33	35.78	0.1	1.42	0.03
Richards Creek	Historical	875.7664	25-year	44.55	49.6	51.89	50.17	2.29	0.000327	0.7	63.72	38.62	0.1	1.6	0.03
Richards Creek	Historical	875.7664	100-year	61.8	49.6	52.4	50.29	2.8	0.000295	0.73	84.69	122.23	0.09	1.89	0.03
Richards Creek	Historical	843.4692	1.01-year	15.05	49.48	50.71	49.76	1.23	0.000354	0.53	28.16	29.03	0.1	0.95	0.02
Richards Creek	Historical	843.4692	2-year	22.65	49.48	51.05	49.85	1.57	0.000328	0.59	38.63	32.37	0.09	1.17	0.02
Richards Creek	Historical	843.4692	10-year	35.4	49.48	51.57	49.97	2.09	0.000279	0.62	56.91	37.17	0.09	1.49	0.03
Richards Creek	Historical	843.4692	25-year	44.55	49.48	51.88	50.05	2.4	0.000266	0.65	68.73	45.43	0.09	1.67	0.03
Richards Creek	Historical	843.4692	100-year	61.8	49.48	52.39	50.17	2.91	0.000246	0.68	90.4	144.04	0.08	1.96	0.03
Richards Creek	Historical	240.4131	1.01-year	15.05	45.9	50.71	46.6	4.81	0.000001	0.1	402.64	212.34	0.01	3.72	0
Richards Creek	Historical	240.4131	2-year	22.65	45.9	51.05	46.73	5.15	0.000001	0.13	477.21	225.63	0.01	4.02	0
Richards Creek	Historical	240.4131	10-year	35.4	45.9	51.57	46.92	5.67	0.000002	0.17	600.43	238.56	0.01	4.49	0
Richards Creek	Historical	240.4131	25-year	44.55	45.9	51.88	47.05	5.98	0.000002	0.19	673.56	238.56	0.01	4.76	0
Richards Creek	Historical	240.4131	100-year	61.8	45.9	52.39	47.25	6.49	0.000002	0.22	795.71	238.56	0.02	5.21	0
Richards Creek	Lower	85.48712	1.01-year	120.25	47.08	50.66	49.54	3.58	0.001315	2.1	131.45	256.31	0.25	1.94	0.16
Richards Creek	Lower	85.48712	2-year	181	47.08	50.99	50.28	3.91	0.001313	2.31	184.23	256.31	0.26	2.25	0.18
Richards Creek	Lower	85.48712	10-year	297	47.08	51.51	50.56	4.43	0.00131	2.62	265.35	256.31	0.27	2.72	0.22
Richards Creek	Lower	85.48712	25-year	376	47.08	51.82	50.7	4.74	0.001309	2.8	312.53	256.31	0.27	3	0.25
Richards Creek	Lower	85.48712	100-year	525	47.08	52.32	50.93	5.24	0.001308	3.07	391.18	256.31	0.28	3.46	0.28
Richards Creek	Lower	26.62222	1.01-year	120.25	47	50.58	49.45	3.58	0.0013	2.09	132.08	256.31	0.25	1.94	0.16
Richards Creek	Lower	26.62222	2-year	181	47	50.92	50.2	3.92	0.001301	2.3	184.88	256.31	0.26	2.25	0.18
Richards Creek	Lower	26.62222	10-year	297	47	51.44	50.48	4.44	0.0013	2.62	266.03	256.31	0.27	2.73	0.22
Richards Creek	Lower	26.62222	25-year	376	47	51.74	50.62	4.74	0.001301	2.79	313.23	256.31	0.27	3	0.24
Richards Creek	Lower	26.62222	100-year	525	47	52.24	50.85	5.24	0.001301	3.07	391.89	256.31	0.28	3.46	0.28

PHASE II ALTERNATIVE 2 OUTPUT TABLE

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	3272.859	1.01-year	52.48	82.49	85.22	83.99	2.73	0.006909	2.99	17.54	7.87	0.35	1.53	0.66
Sunset Creek	SE 30th	3272.859	2-year	79	82.49	85.87	84.38	3.38	0.007726	3.46	22.83	8.32	0.37	1.77	0.86
Sunset Creek	SE 30th	3272.859	10-year	126	82.49	86.72	84.96	4.23	0.009492	4.19	30.1	8.9	0.4	2.06	1.22
Sunset Creek	SE 30th	3272.859	25-year	157	82.49	87.13	85.3	4.64	0.010441	4.63	34.08	10.3	0.42	2.24	1.46
Sunset Creek	SE 30th	3272.859	100-year	212	82.49	87.79	85.83	5.3	0.011482	5.24	41.64	12.71	0.45	2.52	1.81
Sunset Creek	SE 30th	3251.92	1.01-year	52.48	82.52	84.68	84.21	2.16	0.024525	5.08	10.33	5.78	0.67	1.2	1.84
Sunset Creek	SE 30th	3251.92	2-year	79	82.52	85.22	84.69	2.7	0.027799	5.84	13.53	6.22	0.7	1.39	2.41
Sunset Creek	SE 30th	3251.92	10-year	126	82.52	86	85.54	3.48	0.031764	6.33	19.9	8.8	0.74	1.5	2.97
Sunset Creek	SE 30th	3251.92	25-year	157	82.52	86.34	85.88	3.82	0.033201	6.84	22.96	9.05	0.76	1.64	3.39
Sunset Creek	SE 30th	3251.92	100-year	212	82.52	86.88	86.38	4.36	0.035496	7.59	27.92	9.43	0.78	1.84	4.08
Sunset Creek	SE 30th	3230.282	1.01-year	52.48	81.37	84.02	83.73	2.65	0.030615	5.49	9.55	6.31	0.79	1.09	2.08
Sunset Creek	SE 30th	3230.282	2-year	79	81.37	84.46	84.23	3.09	0.033662	6.29	12.56	7.21	0.84	1.24	2.61
Sunset Creek	SE 30th	3230.282	10-year	126	81.37	85.18	84.92	3.81	0.034461	6.77	18.62	9.27	0.84	1.45	3.12
Sunset Creek	SE 30th	3230.282	25-year	157	81.37	85.54	85.24	4.17	0.03394	7.15	21.97	9.59	0.83	1.61	3.42
Sunset Creek	SE 30th	3230.282	100-year	212	81.37	86.11	85.72	4.74	0.033218	7.67	27.63	10.1	0.82	1.86	3.85
Sunset Creek	SE 30th	3207.655	1.01-year	52.48	81.58	83.02	83.02	1.44	0.045494	6.27	8.36	6.93	1.01	0.98	2.8
Sunset Creek	SE 30th	3207.655	2-year	79	81.58	83.43	83.43	1.85	0.044215	7.02	11.25	7.41	1.01	1.19	3.29
Sunset Creek	SE 30th	3207.655	10-year	126	81.58	84.06	84.06	2.48	0.044338	7.75	16.25	8.79	1	1.42	3.92
Sunset Creek	SE 30th	3207.655	25-year	157	81.58	84.37	84.37	2.79	0.044896	8.25	19.02	9.07	1	1.57	4.39
Sunset Creek	SE 30th	3207.655	100-year	212	81.58	84.86	84.86	3.28	0.045967	8.98	23.6	9.51	1	1.78	5.12
Sunset Creek	SE 30th	3193.525	1.01-year	52.48	81.39	82.96	82.47	1.57	0.012631	3.2	16.4	13.89	0.52	0.99	0.78
Sunset Creek	SE 30th	3193.525	2-year	79	81.39	83.44	82.75	2.05	0.010801	3.36	23.53	15.91	0.49	1.2	0.81
Sunset Creek	SE 30th	3193.525	10-year	126	81.39	84.14	83.16	2.75	0.008933	3.52	35.78	18.79	0.45	1.5	0.84
Sunset Creek	SE 30th	3193.525	25-year	157	81.39	84.54	83.39	3.15	0.00785	3.62	43.42	19.42	0.43	1.74	0.85
Sunset Creek	SE 30th	3193.525	100-year	212	81.39	85.16	83.75	3.77	0.00686	3.82	55.51	19.91	0.4	2.11	0.9
Sunset Creek	SE 30th	3181.277	1.01-year	52.48	80.83	82.23	82.23	1.4	0.049653	6.06	8.66	7.7	1.01	0.97	3.01
Sunset Creek	SE 30th	3181.277	2-year	79	80.83	82.63	82.61	1.8	0.047241	6.68	11.83	8.35	0.99	1.19	3.51
Sunset Creek	SE 30th	3181.277	10-year	126	80.83	83.26	83.16	2.43	0.04141	7.2	17.49	9.4	0.93	1.5	3.89
Sunset Creek	SE 30th	3181.277	25-year	157	80.83	83.58	83.46	2.75	0.039203	7.67	20.55	10.44	0.92	1.73	4.22
Sunset Creek	SE 30th	3181.277	100-year	212	80.83	84.06	83.99	3.23	0.035379	8.35	26.15	12.35	0.91	2.12	4.68
Sunset Creek	SE 30th	3171.478	1.01-year	52.48	79.8	82.09	81.5	2.29	0.017938	4.34	12.08	6.96	0.58	1.29	1.44
Sunset Creek	SE 30th	3171.478	2-year	79	79.8	82.53	81.92	2.73	0.020229	5.19	15.34	7.97	0.63	1.55	1.96
Sunset Creek	SE 30th	3171.478	10-year	126	79.8	83.09	82.55	3.29	0.022901	6.46	20.2	9.36	0.7	1.96	2.8
Sunset Creek	SE 30th	3171.478	25-year	157	79.8	83.37	82.91	3.57	0.024983	7.2	22.91	10.06	0.74	2.16	3.37
Sunset Creek	SE 30th	3171.478	100-year	212	79.8	83.77	83.5	3.97	0.0285	8.38	27.21	11.07	0.81	2.46	4.38
Sunset Creek	SE 30th	3160.526	1.01-year	52.48	79.96	81.89	81.42	1.93	0.018375	4.34	12.09	7.93	0.62	1.24	1.42
Sunset Creek	SE 30th	3160.526	2-year	79	79.96	82.32	81.81	2.36	0.020239	5.05	15.65	8.81	0.66	1.47	1.86
Sunset Creek	SE 30th	3160.526	10-year	126	79.96	82.89	82.38	2.93	0.022223	6.07	21.16	10.52	0.7	1.82	2.53
Sunset Creek	SE 30th	3160.526	25-year	157	79.96	83.18	82.72	3.22	0.022836	6.66	24.36	11.4	0.73	2.05	2.92
Sunset Creek	SE 30th	3160.526	100-year	212	79.96	83.62	83.23	3.66	0.023797	7.55	29.71	12.74	0.76	2.4	3.56
Sunset Creek	SE 30th	3145.921	1.01-year	52.48	78.83	81.92	80.46	3.09	0.003732	2.52	21.19	10.58	0.29	1.92	0.45
Sunset Creek	SE 30th	3145.921	2-year	79	78.83	82.37	80.86	3.54	0.004594	3.15	26.22	11.91	0.33	2.29	0.66
Sunset Creek	SE 30th	3145.921	10-year	126	78.83	82.97	81.42	4.14	0.005759	4.01	33.92	13.69	0.38	2.78	1
Sunset Creek	SE 30th	3145.921	25-year	157	78.83	83.29	81.74	4.46	0.006411	4.49	38.41	14.63	0.41	3.04	1.22
Sunset Creek	SE 30th	3145.921	100-year	212	78.83	83.77	82.27	4.94	0.007307	5.21	45.89	16.07	0.45	3.44	1.57
Sunset Creek	SE 30th	3119.845	1.01-year	52.48	79.67	81.65	81.05	1.98	0.011764	3.56	14.77	10.26	0.51	1.32	0.97
Sunset Creek	SE 30th	3119.845	2-year	79	79.67	82.05	81.4	2.38	0.011998	4.21	19.08	11.5	0.54	1.67	1.25
Sunset Creek	SE 30th	3119.845	10-year	126	79.67	82.57	81.89	2.9	0.013116	5.17	25.47	13.13	0.59	2.13	1.74
Sunset Creek	SE 30th	3119.845	25-year	157	79.67	82.82	82.17	3.15	0.014262	5.77	28.89	13.92	0.62	2.35	2.1
Sunset Creek	SE 30th	3119.845	100-year	212	79.67	83.2	82.63	3.53	0.016027	6.69	34.41	15.12	0.68	2.69	2.69
Sunset Creek	SE 30th	3103.342	1.01-year	52.48	79.66	81.46	80.89	1.8	0.011936	3.47	15.11	10.95	0.52	1.24	0.92
Sunset Creek	SE 30th	3103.342	2-year	79	79.66	81.86	81.22	2.2	0.01343	4.03	19.62	12.1	0.56	1.44	1.21
Sunset Creek	SE 30th	3103.342	10-year	126	79.66	82.36	81.7	2.7	0.01577	4.81	26.17	13.61	0.61	1.7	1.67
Sunset Creek	SE 30th	3103.342	25-year	157	79.66	82.61	81.98	2.95	0.016334	5.31	29.67	14.35	0.63	1.92	1.95
Sunset Creek	SE 30th	3103.342	100-year	212	79.66	82.99	82.39	3.33	0.017504	6.1	35.2	15.45	0.67	2.24	2.45
Sunset Creek	SE 30th	3082.734	1.01-year	52.48	79.61	81.15	80.76	1.54	0.015717	3.74	14.02	11.68	0.6	1.11	1.09
Sunset Creek	SE 30th	3082.734	2-year	79	79.61	81.52	81.06	1.91	0.015628	4.26	18.63	13.16	0.61	1.37	1.33
Sunset Creek	SE 30th	3082.734	10-year	126	79.61	82	81.5	2.39	0.015851	5.1	25.43	15.76	0.64	1.78	1.76
Sunset Creek	SE 30th	3082.734	25-year	157	79.61	82.23	81.76	2.62	0.01654	5.61	29.26	17.06	0.67	1.99	2.06
Sunset Creek	SE 30th	3082.734	100-year	212	79.61	82.61	82.16	3	0.016909	6.32	36.13	19.16	0.7	2.34	2.47
Sunset Creek	SE 30th	3066.484	1.01-year	52.48	79.15	80.44	80.44	1.29	0.045593	5.66	9.27	9.44	1.01	0.91	2.59
Sunset Creek	SE 30th	3066.484	2-year	79	79.15	80.77	80.77	1.62	0.041061	6.3	12.68	11.37	0.98	1.17	2.99
Sunset Creek	SE 30th	3066.484	10-year	126	79.15	81.27	81.27	2.12	0.032155	6.97	19.39	15.18	0.92	1.63	3.27
Sunset Creek	SE 30th	3066.484	25-year	157	79.15	81.55	81.55	2.4	0.028891	7.28	23.84	16.54	0.89	1.88	3.4
Sunset Creek	SE 30th	3066.484	100-year	212	79.15	81.92	81.92	2.77	0.027733	7.96	30.23	17.83	0.9	2.23	3.85
Sunset Creek	SE 30th	3034.622	1.01-year	52.48	77.36	78.8	78.83	1.44	0.053489	6	8.75	8.57	1.05	0.94	3.13
Sunset Creek	SE 30th	3034.622	2-year	79	77.36	79.11	79.19	1.75	0.057465	6.84	11.54	9.56	1.1	1.1	3.94
Sunset Creek	SE 30th	3034.622	10-year	126	77.36	79.48	79.7	2.12	0.068201	8.2	15.36	10.77	1.21	1.29	5.48
Sunset Creek	SE 30th	3034.622	25-year	157	77.36	79.7	79.98	2.34	0.071417	8.82	17.81	11.47	1.25	1.39	6.22
Sunset Creek	SE 30th	3034.622	100-year	212	77.36	80.11	80.4	2.75	0.068713	9.35	22.66	12.75	1.24	1.59	6.81

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	3020.31	1.01-year	52.48	76.74	78.69	78.18	1.95	0.011941	3.74	14.04	11.02	0.58	1.14	0.85
Sunset Creek	SE 30th	3020.31	2-year	79	76.74	79.07	78.53	2.33	0.012354	4.22	18.74	13.76	0.63	1.24	0.96
Sunset Creek	SE 30th	3020.31	10-year	126	76.74	79.57	79.08	2.83	0.012503	4.77	26.69	17.98	0.67	1.45	1.13
Sunset Creek	SE 30th	3020.31	25-year	157	76.74	79.84	79.34	3.1	0.012582	5.03	31.75	19.91	0.68	1.59	1.25
Sunset Creek	SE 30th	3020.31	100-year	212	76.74	80.22	79.74	3.48	0.012788	5.51	39.63	21.2	0.67	1.94	1.55
Sunset Creek	SE 30th	2982.026	1.01-year	52.48	76.27	77.64	77.64	1.37	0.041864	5.49	9.57	10.28	1	0.86	2.24
Sunset Creek	SE 30th	2982.026	2-year	79	76.27	77.97	77.97	1.7	0.041566	5.98	13.22	12.11	1.01	1	2.6
Sunset Creek	SE 30th	2982.026	10-year	126	76.27	78.42	78.42	2.15	0.042101	6.55	19.23	14.7	1.01	1.2	3.15
Sunset Creek	SE 30th	2982.026	25-year	157	76.27	78.66	78.66	2.39	0.042096	6.84	22.94	16.1	1.01	1.3	3.42
Sunset Creek	SE 30th	2982.026	100-year	212	76.27	79.03	79.03	2.76	0.041059	7.23	29.3	18.1	1	1.48	3.78
Sunset Creek	SE 30th	2969.117	1.01-year	52.48	75.88	76.97	77.07	1.09	0.065542	5.54	9.48	14.93	1.22	0.62	2.54
Sunset Creek	SE 30th	2969.117	2-year	79	75.88	77.13	77.29	1.25	0.07752	6.56	12.04	16.63	1.36	0.71	3.42
Sunset Creek	SE 30th	2969.117	10-year	126	75.88	77.99	77.62	2.11	0.016637	4.66	27.04	18.12	0.67	1.39	1.44
Sunset Creek	SE 30th	2969.117	25-year	157	75.88	78.3	77.81	2.42	0.014764	4.81	32.64	18.59	0.64	1.61	1.49
Sunset Creek	SE 30th	2969.117	100-year	212	75.88	78.72	78.12	2.84	0.014239	5.23	40.57	19.24	0.63	1.9	1.69
Sunset Creek	SE 30th	2939.869	1.01-year	52.48	73.61	76.82	75.69	3.21	0.0053	2.32	22.64	14.71	0.33	1.38	0.46
Sunset Creek	SE 30th	2939.869	2-year	79	73.61	77.25	76.05	3.64	0.006353	2.69	29.37	16.87	0.36	1.56	0.62
Sunset Creek	SE 30th	2939.869	10-year	126	73.61	77.81	76.54	4.2	0.007148	3.22	39.19	18.18	0.39	1.91	0.85
Sunset Creek	SE 30th	2939.869	25-year	157	73.61	78.11	76.8	4.5	0.007632	3.51	44.79	18.85	0.4	2.09	1
Sunset Creek	SE 30th	2939.869	100-year	212	73.61	78.51	77.2	4.9	0.008977	4.04	52.43	19.74	0.44	2.32	1.3
Sunset Creek	SE 30th	2904.859	1.01-year	52.48	74.07	76.39	75.43	2.32	0.035368	2.86	18.34	15.88	0.47	1.03	2.28
Sunset Creek	SE 30th	2904.859	2-year	79	74.07	76.76	75.8	2.69	0.035055	3.22	24.51	17.55	0.48	1.25	2.74
Sunset Creek	SE 30th	2904.859	10-year	126	74.07	77.28	76.48	3.21	0.034618	3.67	34.34	19.94	0.49	1.54	3.34
Sunset Creek	SE 30th	2904.859	25-year	157	74.07	77.58	76.7	3.51	0.033762	3.86	41.26	28.12	0.49	1.7	3.59
Sunset Creek	SE 30th	2904.859	100-year	212	74.07	77.99	77.03	3.92	0.029905	4.01	54.84	34.28	0.48	1.98	3.69
Sunset Creek	SE 30th	2887.542	1.01-year	52.48	73.52	76	75.02	2.48	0.016879	2.48	21.15	16.68	0.39	1.13	1.19
Sunset Creek	SE 30th	2887.542	2-year	79	73.52	76.35	75.58	2.83	0.018402	2.91	27.15	17.78	0.41	1.36	1.56
Sunset Creek	SE 30th	2887.542	10-year	126	73.52	76.85	75.94	3.33	0.020043	3.46	36.45	19.36	0.44	1.66	2.08
Sunset Creek	SE 30th	2887.542	25-year	157	73.52	77.14	76.13	3.62	0.020645	3.73	42.11	20.26	0.46	1.83	2.36
Sunset Creek	SE 30th	2887.542	100-year	212	73.52	77.55	76.47	4.03	0.020458	4.12	54.02	31.33	0.46	2.14	2.74
Sunset Creek	SE 30th	2869.669	1.01-year	52.48	73.86	74.99	74.99	1.13	0.1141	5.38	9.76	11.01	1.01	0.84	6
Sunset Creek	SE 30th	2869.669	2-year	79	73.86	75.45	75.31	1.59	0.077457	5.1	15.48	13.75	0.85	1.07	5.16
Sunset Creek	SE 30th	2869.669	10-year	126	73.86	76.06	75.72	2.2	0.052374	5.13	24.65	16.55	0.73	1.46	4.78
Sunset Creek	SE 30th	2869.669	25-year	157	73.86	76.37	75.95	2.51	0.045904	5.28	30.08	18.64	0.7	1.69	4.84
Sunset Creek	SE 30th	2869.669	100-year	212	73.86	76.83	76.3	2.97	0.037413	5.55	40.53	26.66	0.65	2.13	4.96
Sunset Creek	SE 30th	2850.365	1.01-year	52.48	72.12	74.78	73.51	2.66	0.008734	2.49	21.71	12.12	0.3	1.82	0.99
Sunset Creek	SE 30th	2850.365	2-year	79	72.12	75.2	73.85	3.08	0.01057	3.08	27.12	14.28	0.34	2.16	1.43
Sunset Creek	SE 30th	2850.365	10-year	126	72.12	75.73	74.37	3.61	0.013553	3.95	34.65	18.53	0.39	2.6	2.2
Sunset Creek	SE 30th	2850.365	25-year	157	72.12	76	74.67	3.88	0.015301	4.43	38.77	20.55	0.42	2.83	2.7
Sunset Creek	SE 30th	2850.365	100-year	212	72.12	76.4	75.15	4.28	0.018224	5.21	45	23.52	0.47	3.16	3.6
Sunset Creek	SE 30th	2823.726	1.01-year	52.48	72.56	74.28	73.76	1.72	0.030371	3.5	15.06	12.76	0.54	1.22	2.31
Sunset Creek	SE 30th	2823.726	2-year	79	72.56	74.63	74.08	2.07	0.03169	4.05	20.53	17.35	0.56	1.48	2.92
Sunset Creek	SE 30th	2823.726	10-year	126	72.56	75.07	74.62	2.51	0.032689	4.79	28.7	19.84	0.59	1.86	3.79
Sunset Creek	SE 30th	2823.726	25-year	157	72.56	75.31	74.85	2.75	0.03308	5.19	33.61	21.42	0.61	2.08	4.29
Sunset Creek	SE 30th	2823.726	100-year	212	72.56	75.67	75.2	3.11	0.033877	5.79	41.7	23.79	0.63	2.4	5.08
Sunset Creek	SE 30th	2794.948	1.01-year	52.48	71.19	73.47	72.93	2.28	0.026753	3.41	16.36	16.09	0.51	1.29	2.16
Sunset Creek	SE 30th	2794.948	2-year	79	71.19	73.91	73.29	2.72	0.022637	3.63	24.42	20.59	0.48	1.62	2.28
Sunset Creek	SE 30th	2794.948	10-year	126	71.19	74.34	73.8	3.15	0.023419	4.28	34.12	23.97	0.51	2.01	2.94
Sunset Creek	SE 30th	2794.948	25-year	157	71.19	74.52	74.01	3.33	0.026317	4.78	38.53	25.36	0.54	2.17	3.57
Sunset Creek	SE 30th	2794.948	100-year	212	71.19	74.86	74.32	3.67	0.027583	5.34	47.48	27.94	0.57	2.48	4.27
Sunset Creek	SE 30th	2760.247	1.01-year	52.48	70.04	71.78	71.78	1.74	0.048883	6.25	8.4	7.05	1.01	1.02	3.1
Sunset Creek	SE 30th	2760.247	2-year	79	70.04	72.19	72.19	2.15	0.048803	6.92	11.41	7.83	1.01	1.22	3.71
Sunset Creek	SE 30th	2760.247	10-year	126	70.04	72.94	72.94	2.9	0.031018	6.76	20.98	19.47	0.83	1.68	3.25
Sunset Creek	SE 30th	2760.247	25-year	157	70.04	73.26	73.26	3.22	0.025632	6.75	27.92	23.44	0.77	1.93	3.1
Sunset Creek	SE 30th	2760.247	100-year	212	70.04	73.59	73.59	3.55	0.025171	7.29	35.9	25.15	0.78	2.2	3.46
Sunset Creek	SE 30th	2717.8	1.01-year	52.48	68.16	69.95	69.54	1.79	0.048405	4.18	12.55	11.02	0.69	0.99	2.99
Sunset Creek	SE 30th	2717.8	2-year	79	68.16	70.31	69.97	2.15	0.046019	4.76	16.61	11.62	0.7	1.22	3.5
Sunset Creek	SE 30th	2717.8	10-year	126	68.16	70.79	70.42	2.63	0.046934	5.62	22.4	12.43	0.74	1.5	4.4
Sunset Creek	SE 30th	2717.8	25-year	157	68.16	71.06	70.68	2.9	0.047497	6.08	25.81	12.89	0.76	1.65	4.9
Sunset Creek	SE 30th	2717.8	100-year	212	68.16	71.5	71.09	3.34	0.047432	6.72	31.57	13.62	0.78	1.88	5.58
Sunset Creek	SE 30th	2702.718	1.01-year	52.48	67.5	69.37	68.88	1.87	0.034923	3.89	13.5	11.29	0.63	1.04	2.27
Sunset Creek	SE 30th	2702.718	2-year	79	67.5	69.59	69.32	2.09	0.045781	4.9	16.13	11.7	0.74	1.19	3.39
Sunset Creek	SE 30th	2702.718	10-year	126	67.5	70.08	69.75	2.58	0.045004	5.71	22.06	12.56	0.76	1.48	4.16
Sunset Creek	SE 30th	2702.718	25-year	157	67.5	70.37	70.01	2.87	0.044172	6.11	25.7	13.06	0.77	1.64	4.53
Sunset Creek	SE 30th	2702.718	100-year	212	67.5	70.85	70.41	3.35	0.04122	6.58	32.2	13.91	0.76	1.9	4.89
Sunset Creek	SE 30th	2676.488	1.01-year	52.48	66.34	67.98	67.73	1.64	0.06808	4.84	10.85	10.69	0.85	0.89	3.76
Sunset Creek	SE 30th	2676.488	2-year	79	66.34	68.56	68.16	2.22	0.036744	4.58	17.26	11.64	0.66	1.26	2.88
Sunset Creek	SE 30th	2676.488	10-year	126	66.34	69.11	68.62	2.77	0.034664	5.26	23.96	12.56	0.67	1.58	3.42
Sunset Creek	SE 30th	2676.488	25-year	157	66.34	69.49	68.86	3.15	0.030777	5.43	28.9	13.19	0.65	1.79	3.43
Sunset Creek	SE 30th	2676.488	100-year	212	66.34	70.14	69.27	3.8	0.025381	5.6	37.83	14.27	0.61	2.12	3.36

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	2651.525	1.01-year	52.48	65.23	67.11	66.59	1.88	0.02436	4.01	13.07	8.91	0.58	1.25	1.91
Sunset Creek	SE 30th	2651.525	2-year	79	65.23	67.77	66.97	2.54	0.030738	4.04	19.54	13.29	0.59	1.27	2.45
Sunset Creek	SE 30th	2651.525	10-year	126	65.23	68.64	67.51	3.41	0.01769	3.95	31.88	15.1	0.48	1.79	1.97
Sunset Creek	SE 30th	2651.525	25-year	157	65.23	69.14	67.93	3.91	0.014316	3.96	39.67	16.14	0.44	2.06	1.84
Sunset Creek	SE 30th	2651.525	100-year	212	65.23	69.9	68.32	4.67	0.011391	4.03	52.57	17.72	0.41	2.45	1.74
Sunset Creek	SE 30th	2643.063	1.01-year	52.48	64.86	66.99	66.26	2.13	0.012101	3.81	13.79	7.97	0.51	1.35	1.02
Sunset Creek	SE 30th	2643.063	2-year	79	64.86	67.61	66.66	2.75	0.013404	4	19.76	11.77	0.54	1.35	1.13
Sunset Creek	SE 30th	2643.063	10-year	126	64.86	68.51	67.43	3.65	0.009535	4.08	30.88	12.8	0.46	1.84	1.1
Sunset Creek	SE 30th	2643.063	25-year	157	64.86	69.01	67.69	4.15	0.00869	4.2	37.38	13.36	0.44	2.09	1.13
Sunset Creek	SE 30th	2643.063	100-year	212	64.86	69.76	68.12	4.9	0.008109	4.44	47.7	14.21	0.43	2.43	1.23
Sunset Creek	SE 30th	2640.568	1.01-year	52.48	64.75	67.07	65.54	2.32	0.000602	1.74	30.18	13	0.2	1.71	0.06
Sunset Creek	SE 30th	2640.568	2-year	79	64.75	67.7	65.79	2.95	0.000676	2.06	38.3	13	0.21	2.03	0.09
Sunset Creek	SE 30th	2640.568	10-year	126	64.75	68.59	66.17	3.84	0.000802	2.52	49.91	13	0.23	2.41	0.12
Sunset Creek	SE 30th	2640.568	25-year	157	64.75	69.08	66.4	4.33	0.000886	2.79	56.33	13	0.24	2.6	0.14
Sunset Creek	SE 30th	2640.568	100-year	212	64.75	69.83	66.76	5.08	0.000977	3.21	66.01	13.99	0.25	2.99	0.18
Sunset Creek	SE 30th	2625.968		Bridge											
Sunset Creek	SE 30th	2611.37	1.01-year	52.48	63.5	67.09	64.29	3.59	0.000168	1.12	46.68	13	0.1	2.31	0.02
Sunset Creek	SE 30th	2611.37	2-year	79	63.5	67.72	64.54	4.22	0.000242	1.44	54.84	13	0.12	2.56	0.04
Sunset Creek	SE 30th	2611.37	10-year	126	63.5	68.62	64.92	5.12	0.00036	1.89	66.53	13	0.15	2.86	0.06
Sunset Creek	SE 30th	2611.37	25-year	157	63.5	69.11	65.15	5.61	0.000434	2.15	72.99	13	0.16	3.01	0.08
Sunset Creek	SE 30th	2611.37	100-year	212	63.5	69.83	65.51	6.33	0.00054	2.57	82.34	14.02	0.18	3.35	0.11
Sunset Creek	SE 30th	2610.895		Bridge											
Sunset Creek	SE 30th	2610.42	1.01-year	52.48	63.5	67.09	64.29	3.59	0.000117	1.12	46.68	13	0.1	2.31	0.02
Sunset Creek	SE 30th	2610.42	2-year	79	63.5	67.72	64.54	4.22	0.000168	1.44	54.84	13	0.12	2.56	0.03
Sunset Creek	SE 30th	2610.42	10-year	126	63.5	68.62	64.92	5.12	0.00025	1.89	66.52	13	0.15	2.86	0.04
Sunset Creek	SE 30th	2610.42	25-year	157	63.5	69.11	65.15	5.61	0.000301	2.15	72.98	13	0.16	3.01	0.06
Sunset Creek	SE 30th	2610.42	100-year	212	63.5	69.83	65.51	6.33	0.000375	2.58	82.32	14.05	0.18	3.35	0.08
Sunset Creek	SE 30th	2610.395		Bridge											
Sunset Creek	SE 30th	2610.37	1.01-year	52.48	63.5	67.09	64.29	3.59	0.000117	1.12	46.68	13	0.1	2.31	0.02
Sunset Creek	SE 30th	2610.37	2-year	79	63.5	67.72	64.54	4.22	0.000168	1.44	54.84	13	0.12	2.56	0.03
Sunset Creek	SE 30th	2610.37	10-year	126	63.5	68.62	64.92	5.12	0.00025	1.89	66.52	13	0.15	2.86	0.04
Sunset Creek	SE 30th	2610.37	25-year	157	63.5	69.11	65.15	5.61	0.000301	2.15	72.98	13	0.16	3.01	0.06
Sunset Creek	SE 30th	2610.37	100-year	212	63.5	69.83	65.51	6.33	0.000375	2.58	82.32	14.05	0.18	3.35	0.08
Sunset Creek	SE 30th	2596.365		Bridge											
Sunset Creek	SE 30th	2582.37	1.01-year	52.48	64	67.08	64.79	3.08	0.000182	1.31	40.03	13	0.13	2.09	0.02
Sunset Creek	SE 30th	2582.37	2-year	79	64	67.7	65.05	3.7	0.000243	1.64	48.14	13	0.15	2.36	0.04
Sunset Creek	SE 30th	2582.37	10-year	126	64	68.6	65.42	4.6	0.000336	2.11	59.75	13	0.17	2.69	0.06
Sunset Creek	SE 30th	2582.37	25-year	157	64	69.09	65.65	5.09	0.000394	2.37	66.15	13	0.19	2.85	0.07
Sunset Creek	SE 30th	2582.37	100-year	212	64	69.78	66.01	5.78	0.00048	2.82	75.19	16.09	0.21	3.19	0.1
Sunset Creek	SE 30th	2582.335		Bridge											
Sunset Creek	SE 30th	2582.32	1.01-year	52.48	64	67.08	64.79	3.08	0.000182	1.31	40.03	13	0.13	2.09	0.02
Sunset Creek	SE 30th	2582.32	2-year	79	64	67.7	65.05	3.7	0.000243	1.64	48.14	13	0.15	2.36	0.04
Sunset Creek	SE 30th	2582.32	10-year	126	64	68.6	65.42	4.6	0.000336	2.11	59.75	13	0.17	2.69	0.06
Sunset Creek	SE 30th	2582.32	25-year	157	64	69.09	65.65	5.09	0.000394	2.37	66.15	13	0.19	2.85	0.07
Sunset Creek	SE 30th	2582.32	100-year	212	64	69.78	66.01	5.78	0.000481	2.82	75.16	16.08	0.21	3.18	0.1
Sunset Creek	SE 30th	2581.843		Bridge											
Sunset Creek	SE 30th	2581.368	1.01-year	52.48	64	67.08	64.79	3.08	0.000262	1.31	40.03	13	0.13	2.09	0.03
Sunset Creek	SE 30th	2581.368	2-year	79	64	67.7	65.05	3.7	0.00035	1.64	48.14	13	0.15	2.36	0.05
Sunset Creek	SE 30th	2581.368	10-year	126	64	68.6	65.43	4.6	0.000484	2.11	59.74	13	0.17	2.69	0.08
Sunset Creek	SE 30th	2581.368	25-year	157	64	69.09	65.65	5.09	0.000567	2.37	66.15	13	0.19	2.85	0.1
Sunset Creek	SE 30th	2581.368	100-year	212	64	69.78	66.01	5.78	0.000693	2.82	75.14	16.22	0.21	3.18	0.14
Sunset Creek	SE 30th	2578.872	1.01-year	52.48	64	67.08	64.79	3.08	0.000368	1.17	44.71	16.02	0.12	2.25	0.05
Sunset Creek	SE 30th	2578.872	2-year	79	64	67.71	65.03	3.71	0.000489	1.44	54.92	16.63	0.14	2.58	0.08
Sunset Creek	SE 30th	2578.872	10-year	126	64	68.6	65.4	4.6	0.000624	1.8	70.11	17.51	0.16	3.11	0.12
Sunset Creek	SE 30th	2578.872	25-year	157	64	69.1	65.61	5.1	0.000694	2	78.63	18	0.16	3.41	0.15
Sunset Creek	SE 30th	2578.872	100-year	212	64	69.8	65.96	5.8	0.000837	2.34	90.78	18.68	0.18	3.81	0.2
Sunset Creek	SE 30th	2576.368	1.01-year	52.48	64.5	67.04	65.55	2.54	0.003514	1.9	27.69	13.24	0.23	1.78	0.39
Sunset Creek	SE 30th	2576.368	2-year	79	64.5	67.66	65.84	3.16	0.003851	2.18	36.16	14.23	0.24	2.11	0.51
Sunset Creek	SE 30th	2576.368	10-year	126	64.5	68.54	66.27	4.04	0.004244	2.55	49.41	15.66	0.25	2.54	0.67
Sunset Creek	SE 30th	2576.368	25-year	157	64.5	69.04	66.53	4.54	0.004418	2.74	57.3	16.6	0.26	2.78	0.77
Sunset Creek	SE 30th	2576.368	100-year	212	64.5	69.73	66.93	5.23	0.004381	3.08	70.16	20.69	0.27	3.33	0.91
Sunset Creek	SE 30th	2541.368	1.01-year	52.48	64.3	66.81	65.69	2.51	0.006401	2.71	19.38	10.11	0.34	1.53	0.61
Sunset Creek	SE 30th	2541.368	2-year	79	64.3	67.4	66.04	3.1	0.006972	3.09	25.53	10.95	0.36	1.81	0.79
Sunset Creek	SE 30th	2541.368	10-year	126	64.3	68.24	66.56	3.94	0.007581	3.57	35.29	12.16	0.37	2.18	1.03
Sunset Creek	SE 30th	2541.368	25-year	157	64.3	68.71	66.85	4.41	0.007885	3.81	41.16	12.83	0.38	2.37	1.17
Sunset Creek	SE 30th	2541.368	100-year	212	64.3	69.38	67.33	5.08	0.008044	4.24	50.54	16.7	0.39	2.76	1.39

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	2539.81	1.01-year	52.48	64.28	66.8	65.68	2.52	0.005041	2.72	19.29	9.97	0.34	1.53	0.48
Sunset Creek	SE 30th	2539.81	2-year	79	64.28	67.38	66.02	3.1	0.005495	3.12	25.32	10.78	0.36	1.8	0.62
Sunset Creek	SE 30th	2539.81	10-year	126	64.28	68.23	66.54	3.95	0.005983	3.61	34.88	11.94	0.37	2.17	0.81
Sunset Creek	SE 30th	2539.81	25-year	157	64.28	68.7	66.84	4.42	0.006229	3.86	40.62	12.58	0.38	2.36	0.92
Sunset Creek	SE 30th	2539.81	100-year	212	64.28	69.36	67.31	5.08	0.006415	4.31	49.56	15.31	0.39	2.74	1.1
Sunset Creek	SE 30th	2527.427	1.01-year	52.48	64.16	66.75	65.55	2.59	0.004357	2.55	20.55	10.63	0.32	1.56	0.43
Sunset Creek	SE 30th	2527.427	2-year	79	64.16	67.33	65.9	3.17	0.004761	2.93	26.99	11.6	0.34	1.84	0.55
Sunset Creek	SE 30th	2527.427	10-year	126	64.16	68.18	66.41	4.02	0.005129	3.37	37.36	13.01	0.35	2.22	0.71
Sunset Creek	SE 30th	2527.427	25-year	157	64.16	68.65	66.7	4.49	0.005249	3.6	43.65	14.07	0.36	2.43	0.8
Sunset Creek	SE 30th	2527.427	100-year	212	64.16	69.32	67.16	5.16	0.00496	3.97	55.18	20.31	0.36	2.94	0.91
Sunset Creek	SE 30th	2513.681	1.01-year	52.48	64.02	66.63	65.66	2.61	0.006964	3.08	17.03	9.26	0.4	1.43	0.62
Sunset Creek	SE 30th	2513.681	2-year	79	64.02	67.19	66.02	3.17	0.00757	3.52	22.43	10.06	0.42	1.69	0.8
Sunset Creek	SE 30th	2513.681	10-year	126	64.02	68	66.56	3.98	0.008132	4.05	31.12	11.24	0.43	2.03	1.03
Sunset Creek	SE 30th	2513.681	25-year	157	64.02	68.46	66.87	4.44	0.008439	4.31	36.39	11.98	0.44	2.2	1.16
Sunset Creek	SE 30th	2513.681	100-year	212	64.02	69.12	67.36	5.1	0.008866	4.71	46.09	29.37	0.45	2.47	1.36
Sunset Creek	SE 30th	2492.185	1.01-year	52.48	63.81	66.45	65.46	2.64	0.008364	3.22	16.28	10.06	0.45	1.3	0.68
Sunset Creek	SE 30th	2492.185	2-year	79	63.81	67.02	65.9	3.21	0.008106	3.56	22.21	10.92	0.44	1.59	0.81
Sunset Creek	SE 30th	2492.185	10-year	126	63.81	67.84	66.52	4.03	0.007933	3.98	31.7	12.17	0.43	1.98	0.98
Sunset Creek	SE 30th	2492.185	25-year	157	63.81	68.29	66.81	4.48	0.007931	4.2	37.42	12.87	0.43	2.18	1.08
Sunset Creek	SE 30th	2492.185	100-year	212	63.81	68.95	67.26	5.14	0.007895	4.59	46.81	18.11	0.44	2.53	1.25
Sunset Creek	SE 30th	2481.368	1.01-year	52.48	63.7	66.31	65.37	2.61	0.012788	3.45	15.23	9.63	0.48	1.25	1
Sunset Creek	SE 30th	2481.368	2-year	79	63.7	66.88	65.81	3.18	0.012635	3.78	20.9	10.44	0.47	1.54	1.22
Sunset Creek	SE 30th	2481.368	10-year	126	63.7	67.7	66.48	4	0.012743	4.21	29.91	11.61	0.46	1.92	1.53
Sunset Creek	SE 30th	2481.368	25-year	157	63.7	68.15	66.79	4.45	0.012942	4.45	35.31	12.25	0.46	2.12	1.71
Sunset Creek	SE 30th	2481.368	100-year	212	63.7	68.8	67.24	5.1	0.013137	4.86	44.21	16.62	0.47	2.45	2.01
Sunset Creek	SE 30th	2464.334	1.01-year	52.48	63.54	66.02	65.24	2.48	0.016416	3.8	13.8	8.77	0.53	1.21	1.24
Sunset Creek	SE 30th	2464.334	2-year	79	63.54	66.58	65.78	3.04	0.016439	4.19	18.87	9.5	0.52	1.48	1.52
Sunset Creek	SE 30th	2464.334	10-year	126	63.54	67.37	66.32	3.83	0.016923	4.69	26.84	10.55	0.52	1.83	1.93
Sunset Creek	SE 30th	2464.334	25-year	157	63.54	67.81	66.62	4.27	0.017396	4.98	31.56	11.12	0.52	2.01	2.18
Sunset Creek	SE 30th	2464.334	100-year	212	63.54	68.42	67.11	4.88	0.018294	5.48	39.02	14.59	0.53	2.29	2.61
Sunset Creek	SE 30th	2429.853	1.01-year	52.48	63.22	65.71	64.62	2.49	0.007757	2.95	17.79	10.5	0.4	1.36	0.66
Sunset Creek	SE 30th	2429.853	2-year	79	63.22	66.26	65.04	3.04	0.008311	3.33	23.75	11.27	0.4	1.65	0.85
Sunset Creek	SE 30th	2429.853	10-year	126	63.22	67.03	65.65	3.81	0.009229	3.82	32.95	12.47	0.41	2.01	1.16
Sunset Creek	SE 30th	2429.853	25-year	157	63.22	67.46	65.93	4.24	0.009782	4.09	38.36	13.14	0.42	2.2	1.34
Sunset Creek	SE 30th	2429.853	100-year	212	63.22	68.07	66.37	4.85	0.01001	4.52	47.9	18.01	0.43	2.55	1.59
Sunset Creek	SE 30th	2407.706	1.01-year	52.48	63.01	65.37	64.6	2.36	0.015283	3.84	13.68	8.62	0.54	1.23	1.17
Sunset Creek	SE 30th	2407.706	2-year	79	63.01	65.87	65.13	2.86	0.016981	4.37	18.1	9.28	0.55	1.47	1.55
Sunset Creek	SE 30th	2407.706	10-year	126	63.01	66.56	65.68	3.55	0.019474	5.08	24.82	10.2	0.57	1.77	2.15
Sunset Creek	SE 30th	2407.706	25-year	157	63.01	66.92	65.99	3.91	0.02111	5.48	28.64	10.69	0.59	1.92	2.53
Sunset Creek	SE 30th	2407.706	100-year	212	63.01	67.44	66.48	4.43	0.024318	6.16	34.41	11.39	0.62	2.13	3.24
Sunset Creek	SE 30th	2379.636	1.01-year	52.48	62.75	65.18	64.11	2.43	0.006687	2.65	19.8	13.33	0.38	1.3	0.54
Sunset Creek	SE 30th	2379.636	2-year	79	62.75	65.69	64.48	2.94	0.006831	2.94	26.88	14.6	0.38	1.59	0.68
Sunset Creek	SE 30th	2379.636	10-year	126	62.75	66.4	65.09	3.65	0.00717	3.32	37.91	16.38	0.38	1.98	0.89
Sunset Creek	SE 30th	2379.636	25-year	157	62.75	66.78	65.33	4.03	0.00743	3.54	44.3	17.47	0.39	2.18	1.01
Sunset Creek	SE 30th	2379.636	100-year	212	62.75	67.35	65.72	4.6	0.007393	3.9	54.88	19.78	0.39	2.57	1.18
Sunset Creek	SE 30th	2361.19	1.01-year	52.48	62.58	64.92	64.13	2.34	0.012606	3.56	14.73	9.67	0.51	1.25	0.98
Sunset Creek	SE 30th	2361.19	2-year	79	62.58	65.38	64.63	2.8	0.013799	4.08	19.36	10.52	0.53	1.49	1.28
Sunset Creek	SE 30th	2361.19	10-year	126	62.58	66.02	65.17	3.44	0.014921	4.76	26.61	12.81	0.55	1.83	1.71
Sunset Creek	SE 30th	2361.19	25-year	157	62.58	66.36	65.44	3.78	0.015248	5.12	31.35	14.98	0.56	2.04	1.94
Sunset Creek	SE 30th	2361.19	100-year	212	62.58	66.91	65.9	4.33	0.015091	5.54	40.47	18.45	0.56	2.37	2.23
Sunset Creek	SE 30th	2341.739	1.01-year	52.48	62.4	64.62	63.99	2.22	0.014546	3.89	13.5	10.11	0.59	1.13	1.03
Sunset Creek	SE 30th	2341.739	2-year	79	62.4	65.07	64.5	2.67	0.014885	4.33	18.23	11	0.59	1.38	1.28
Sunset Creek	SE 30th	2341.739	10-year	126	62.4	65.69	64.99	3.29	0.015709	4.93	25.53	12.26	0.6	1.7	1.67
Sunset Creek	SE 30th	2341.739	25-year	157	62.4	66.02	65.26	3.62	0.016651	5.31	29.59	12.9	0.62	1.86	1.93
Sunset Creek	SE 30th	2341.739	100-year	212	62.4	66.56	65.7	4.16	0.016244	5.72	38.33	21.12	0.61	2.18	2.21
Sunset Creek	SE 30th	2313.296	1.01-year	52.48	62.13	64.24	63.58	2.11	0.013079	3.76	13.95	10.54	0.58	1.13	0.92
Sunset Creek	SE 30th	2313.296	2-year	79	62.13	64.67	63.98	2.54	0.013495	4.21	18.75	11.38	0.58	1.38	1.17
Sunset Creek	SE 30th	2313.296	10-year	126	62.13	65.27	64.58	3.14	0.01487	4.88	25.81	12.51	0.6	1.7	1.58
Sunset Creek	SE 30th	2313.296	25-year	157	62.13	65.55	64.85	3.42	0.015936	5.32	29.85	16.98	0.62	1.87	1.86
Sunset Creek	SE 30th	2313.296	100-year	212	62.13	66.07	65.27	3.94	0.021872	5.42	41.98	28.25	0.67	1.77	2.41
Sunset Creek	SE 30th	2297.254	1.01-year	52.48	61.98	64.14	63.24	2.16	0.009569	2.52	20.84	17.77	0.41	1.11	0.66
Sunset Creek	SE 30th	2297.254	2-year	79	61.98	64.62	63.57	2.64	0.008908	2.65	29.78	19.99	0.38	1.4	0.78
Sunset Creek	SE 30th	2297.254	10-year	126	61.98	65.25	64.12	3.27	0.008775	2.9	43.45	23.13	0.37	1.79	0.98
Sunset Creek	SE 30th	2297.254	25-year	157	61.98	65.57	64.33	3.59	0.008509	3.08	51.55	29.48	0.37	2.03	1.08
Sunset Creek	SE 30th	2297.254	100-year	212	61.98	66.07	64.64	4.09	0.007536	3.32	66.72	31.92	0.36	2.5	1.17
Sunset Creek	SE 30th	2285.55	1.01-year	52.48	61.88	64.02	63.15	2.14	0.010206	2.56	20.52	17.87	0.42	1.09	0.69
Sunset Creek	SE 30th	2285.55	2-year	79	61.88	64.51	63.47	2.63	0.009562	2.64	29.91	20.82	0.39	1.36	0.81
Sunset Creek	SE 30th	2285.55	10-year	126	61.88	65.15	64.04	3.27	0.009385	2.83	44.5	24.7	0.37	1.7	1
Sunset Creek	SE 30th	2285.55	25-year	157	61.88	65.48	64.24	3.6	0.009387	2.97	52.86	26.8	0.37	1.9	1.11
Sunset Creek	SE 30th	2285.55	100-year	212	61.88	65.99	64.56	4.11	0.007799	3.14	70.28	34.96	0.35	2.38	1.16

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	2261.889	1.01-year	52.48	61.65	63.78	62.91	2.13	0.009712	2.61	20.12	16.04	0.41	1.18	0.72
Sunset Creek	SE 30th	2261.889	2-year	79	61.65	64.27	63.24	2.62	0.009308	2.78	28.45	18	0.39	1.48	0.86
Sunset Creek	SE 30th	2261.889	10-year	126	61.65	64.91	63.77	3.26	0.008921	3.1	41.23	23.73	0.38	1.92	1.07
Sunset Creek	SE 30th	2261.889	25-year	157	61.65	65.23	63.99	3.58	0.008338	3.3	49.41	26.57	0.38	2.22	1.16
Sunset Creek	SE 30th	2261.889	100-year	212	61.65	65.77	64.33	4.12	0.007247	3.53	64.88	30.01	0.36	2.73	1.23
Sunset Creek	SE 30th	2238.42	1.01-year	52.48	61.44	63.61	62.6	2.17	0.006768	2.29	22.9	17.19	0.35	1.26	0.53
Sunset Creek	SE 30th	2238.42	2-year	79	61.44	64.11	62.92	2.67	0.006762	2.48	31.87	19.16	0.34	1.56	0.66
Sunset Creek	SE 30th	2238.42	10-year	126	61.44	64.75	63.36	3.31	0.006286	2.8	45.92	24.5	0.33	2.07	0.81
Sunset Creek	SE 30th	2238.42	25-year	157	61.44	65.09	63.66	3.65	0.005972	3	54.43	26.01	0.33	2.38	0.89
Sunset Creek	SE 30th	2238.42	100-year	212	61.44	65.65	63.99	4.21	0.005424	3.26	69.57	28.51	0.33	2.9	0.98
Sunset Creek	SE 30th	2205.456	1.01-year	52.48	61.13	63.36	62.39	2.23	0.008068	2.44	21.51	15.91	0.37	1.27	0.64
Sunset Creek	SE 30th	2205.456	2-year	79	61.13	63.84	62.73	2.71	0.00827	2.66	29.74	17.86	0.36	1.55	0.8
Sunset Creek	SE 30th	2205.456	10-year	126	61.13	64.49	63.24	3.36	0.008668	2.99	42.25	23.94	0.36	1.94	1.05
Sunset Creek	SE 30th	2205.456	25-year	157	61.13	64.85	63.46	3.72	0.007841	3.16	51.23	26.42	0.36	2.27	1.11
Sunset Creek	SE 30th	2205.456	100-year	212	61.13	65.44	63.81	4.31	0.006588	3.35	67.77	29.64	0.34	2.82	1.16
Sunset Creek	SE 30th	2189.813	1.01-year	52.48	60.98	63.24	62.25	2.26	0.007643	2.39	21.99	16.03	0.36	1.29	0.61
Sunset Creek	SE 30th	2189.813	2-year	79	60.98	63.72	62.57	2.74	0.007968	2.62	30.19	17.96	0.36	1.57	0.78
Sunset Creek	SE 30th	2189.813	10-year	126	60.98	64.36	63.09	3.38	0.008769	2.97	42.44	20.51	0.36	1.92	1.05
Sunset Creek	SE 30th	2189.813	25-year	157	60.98	64.73	63.31	3.75	0.007976	3.12	51.26	25.73	0.35	2.24	1.11
Sunset Creek	SE 30th	2189.813	100-year	212	60.98	65.34	63.66	4.36	0.00656	3.29	68.09	30.21	0.33	2.81	1.15
Sunset Creek	SE 30th	2175.255	1.01-year	52.48	60.85	63.13	62.12	2.28	0.007336	2.35	22.37	16.12	0.35	1.3	0.6
Sunset Creek	SE 30th	2175.255	2-year	79	60.85	63.61	62.44	2.76	0.007775	2.59	30.49	18.03	0.35	1.58	0.77
Sunset Creek	SE 30th	2175.255	10-year	126	60.85	64.23	62.96	3.38	0.00874	2.96	42.5	20.52	0.36	1.92	1.05
Sunset Creek	SE 30th	2175.255	25-year	157	60.85	64.6	63.18	3.75	0.008876	3.11	50.46	22.02	0.36	2.12	1.18
Sunset Creek	SE 30th	2175.255	100-year	212	60.85	65.24	63.53	4.39	0.007955	3.25	65.92	27.53	0.35	2.55	1.26
Sunset Creek	SE 30th	2121.292	1.01-year	52.48	60.34	62.85	61.71	2.51	0.004023	2.25	23.31	15.4	0.32	1.41	0.35
Sunset Creek	SE 30th	2121.292	2-year	79	60.34	63.29	62.06	2.95	0.004524	2.59	30.63	20.1	0.34	1.66	0.47
Sunset Creek	SE 30th	2121.292	10-year	126	60.34	63.94	62.57	3.6	0.003743	2.89	47.61	28.1	0.33	2.26	0.53
Sunset Creek	SE 30th	2121.292	25-year	157	60.34	64.35	62.8	4.01	0.003192	2.96	59.25	28.74	0.31	2.64	0.53
Sunset Creek	SE 30th	2121.292	100-year	212	60.34	65.04	63.17	4.7	0.002515	3.04	79.36	29.8	0.28	3.27	0.51
Sunset Creek	SE 30th	2107.746	1.01-year	52.48	60.22	62.81	61.6	2.59	0.002806	2.1	24.96	16.36	0.3	1.42	0.25
Sunset Creek	SE 30th	2107.746	2-year	79	60.22	63.25	61.94	3.03	0.00287	2.42	33.62	25.29	0.31	1.77	0.32
Sunset Creek	SE 30th	2107.746	10-year	126	60.22	63.91	62.45	3.69	0.002441	2.72	50.78	26.53	0.3	2.39	0.36
Sunset Creek	SE 30th	2107.746	25-year	157	60.22	64.33	62.69	4.11	0.002163	2.83	61.85	27.2	0.29	2.77	0.37
Sunset Creek	SE 30th	2107.746	100-year	212	60.22	65.02	63.02	4.8	0.001796	2.96	80.97	27.99	0.27	3.41	0.38
Sunset Creek	SE 30th	2098.229	1.01-year	100.32	60.13	62.65	62.12	2.52	0.010475	3.15	32.57	42.26	0.54	0.99	0.65
Sunset Creek	SE 30th	2098.229	2-year	151	60.13	63.04	62.51	2.91	0.007654	3.32	49.35	42.91	0.49	1.36	0.65
Sunset Creek	SE 30th	2098.229	10-year	236	60.13	63.64	62.88	3.51	0.005318	3.49	75.38	43.89	0.43	1.92	0.64
Sunset Creek	SE 30th	2098.229	25-year	297	60.13	64.04	63.06	3.91	0.004469	3.6	92.74	44.54	0.41	2.29	0.64
Sunset Creek	SE 30th	2098.229	100-year	412	60.13	64.71	63.38	4.58	0.003592	3.79	123.02	45.64	0.38	2.92	0.66
Sunset Creek	SE 30th	2070.489	1.01-year	100.32	60.45	62.56	61.73	2.11	0.003482	2.02	49.67	39.18	0.32	1.23	0.27
Sunset Creek	SE 30th	2070.489	2-year	151	60.45	62.98	61.98	2.53	0.003054	2.26	68.63	47.19	0.31	1.62	0.31
Sunset Creek	SE 30th	2070.489	10-year	236	60.45	63.6	62.31	3.15	0.002468	2.51	98.67	48.8	0.29	2.23	0.34
Sunset Creek	SE 30th	2070.489	25-year	297	60.45	64.01	62.49	3.56	0.00222	2.65	118.56	49.83	0.28	2.62	0.36
Sunset Creek	SE 30th	2070.489	100-year	412	60.45	64.69	62.82	4.24	0.001935	2.88	153.29	51.47	0.28	3.29	0.4
Sunset Creek	SE 30th	2050.566	1.01-year	100.32	59.65	62.37	61.97	2.72	0.009256	2.98	33.92	34.24	0.51	0.99	0.57
Sunset Creek	SE 30th	2050.566	2-year	151	59.65	62.82	62.19	3.17	0.006281	3.1	51.85	45.37	0.44	1.4	0.55
Sunset Creek	SE 30th	2050.566	10-year	236	59.65	63.49	62.51	3.84	0.004056	3.18	82.72	47.24	0.38	2.01	0.51
Sunset Creek	SE 30th	2050.566	25-year	297	59.65	63.9	62.75	4.25	0.003383	3.26	102.68	48.41	0.36	2.4	0.51
Sunset Creek	SE 30th	2050.566	100-year	412	59.65	64.6	63.07	4.95	0.002728	3.43	137.18	50.17	0.33	3.04	0.52
Sunset Creek	SE 30th	2036.451	1.01-year	100.32	60.13	62.26	61.72	2.13	0.008428	2.83	38.52	47.32	0.48	1.04	0.55
Sunset Creek	SE 30th	2036.451	2-year	151	60.13	62.77	62.03	2.64	0.004602	2.7	63.41	49	0.37	1.54	0.44
Sunset Creek	SE 30th	2036.451	10-year	236	60.13	63.47	62.39	3.34	0.003026	2.78	98.07	51.26	0.32	2.19	0.41
Sunset Creek	SE 30th	2036.451	25-year	297	60.13	63.89	62.57	3.76	0.002585	2.87	120.11	52.64	0.31	2.6	0.42
Sunset Creek	SE 30th	2036.451	100-year	412	60.13	64.6	62.85	4.47	0.002145	3.05	157.45	52.87	0.29	3.27	0.44
Sunset Creek	SE 30th	2016.641	1.01-year	100.32	59.66	62.2	61.35	2.54	0.003075	2.06	50.21	42.43	0.31	1.32	0.25
Sunset Creek	SE 30th	2016.641	2-year	151	59.66	62.74	61.64	3.08	0.002219	2.18	73.92	45.1	0.28	1.83	0.25
Sunset Creek	SE 30th	2016.641	10-year	236	59.66	63.43	61.94	3.77	0.00181	2.42	106.01	46.8	0.26	2.5	0.28
Sunset Creek	SE 30th	2016.641	25-year	297	59.66	63.86	62.14	4.2	0.001683	2.58	126.14	47.83	0.26	2.9	0.3
Sunset Creek	SE 30th	2016.641	100-year	412	59.66	64.57	62.47	4.91	0.001548	2.84	160.54	49.55	0.26	3.57	0.35
Sunset Creek	SE 30th	1988.07	1.01-year	100.32	59.15	62.15	61.01	3	0.001716	1.9	60.17	42	0.24	1.79	0.19
Sunset Creek	SE 30th	1988.07	2-year	151	59.15	62.69	61.27	3.54	0.001511	2.11	83.51	43.62	0.24	2.3	0.22
Sunset Creek	SE 30th	1988.07	10-year	236	59.15	63.39	61.63	4.24	0.001441	2.43	114.86	45.7	0.24	2.95	0.27
Sunset Creek	SE 30th	1988.07	25-year	297	59.15	63.82	61.84	4.67	0.001424	2.63	134.61	46.96	0.24	3.35	0.3
Sunset Creek	SE 30th	1988.07	100-year	412	59.15	64.53	62.24	5.38	0.001405	2.94	168.55	49.05	0.25	4.01	0.35
Sunset Creek	SE 30th	1968.444	1.01-year	100.32	59.73	62.1	61.04	2.37	0.001844	2.08	57.87	41.14	0.26	1.88	0.22
Sunset Creek	SE 30th	1968.444	2-year	151	59.73	62.65	61.33	2.92	0.001616	2.3	81.33	44.08	0.26	2.41	0.24
Sunset Creek	SE 30th	1968.444	10-year	236	59.73	63.35	61.71	3.62	0.001517	2.63	112.72	45.23	0.26	3.1	0.29
Sunset Creek	SE 30th	1968.444	25-year	297	59.73	63.78	61.92	4.05	0.001501	2.84	132.2	46.26	0.26	3.51	0.33
Sunset Creek	SE 30th	1968.444	100-year	412	59.73	64.48	62.27	4.75	0.001487	3.19	165.42	47.96	0.27	4.2	0.39

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	1954.61	1.01-year	100.32	59.63	61.99	61.33	2.36	0.008212	3.06	43.17	38.25	0.38	1.89	0.97
Sunset Creek	SE 30th	1954.61	2-year	151	59.63	62.57	61.66	2.94	0.005902	3.07	67.43	43.67	0.33	2.43	0.9
Sunset Creek	SE 30th	1954.61	10-year	236	59.63	63.29	62.03	3.66	0.00473	3.23	99.74	45.74	0.31	3.1	0.92
Sunset Creek	SE 30th	1954.61	25-year	297	59.63	63.73	62.3	4.1	0.004372	3.37	119.83	46.98	0.31	3.51	0.96
Sunset Creek	SE 30th	1954.61	100-year	412	59.63	64.44	62.62	4.81	0.003986	3.61	154.17	49.03	0.3	4.17	1.04
Sunset Creek	SE 30th	1928.749	1.01-year	100.32	59.16	61.96	60.54	2.8	0.001812	1.53	68.09	38.44	0.19	2.04	0.23
Sunset Creek	SE 30th	1928.749	2-year	151	59.16	62.54	60.77	3.38	0.001734	1.77	91.52	42.78	0.19	2.61	0.28
Sunset Creek	SE 30th	1928.749	10-year	236	59.16	63.26	61.1	4.1	0.001786	2.11	122.71	43.96	0.2	3.32	0.37
Sunset Creek	SE 30th	1928.749	25-year	297	59.16	63.69	61.31	4.53	0.001837	2.32	141.81	44.64	0.21	3.74	0.43
Sunset Creek	SE 30th	1928.749	100-year	412	59.16	64.4	61.66	5.24	0.001915	2.65	173.95	45.74	0.22	4.44	0.53
Sunset Creek	SE 30th	1881.347	1.01-year	100.32	58.45	61.71	60.37	3.26	0.005655	3.04	36.16	22.84	0.34	2.28	0.81
Sunset Creek	SE 30th	1881.347	2-year	151	58.45	62.25	60.8	3.8	0.006073	3.59	50.66	36.83	0.36	2.77	1.05
Sunset Creek	SE 30th	1881.347	10-year	236	58.45	62.96	61.48	4.51	0.005834	4.04	78.11	39.28	0.37	3.4	1.24
Sunset Creek	SE 30th	1881.347	25-year	297	58.45	63.39	61.9	4.94	0.005589	4.25	95.35	40.41	0.36	3.79	1.32
Sunset Creek	SE 30th	1881.347	100-year	412	58.45	64.1	62.64	5.65	0.005316	4.6	124.4	40.94	0.36	4.43	1.47
Sunset Creek	SE 30th	1868.66	1.01-year	100.32	59.05	61.67	60.65	2.62	0.004449	2.64	45.34	33.4	0.33	1.96	0.54
Sunset Creek	SE 30th	1868.66	2-year	151	59.05	62.24	61.01	3.19	0.003885	2.91	64.72	35.17	0.32	2.5	0.61
Sunset Creek	SE 30th	1868.66	10-year	236	59.05	62.95	61.52	3.9	0.003739	3.35	90.37	36.56	0.32	3.17	0.74
Sunset Creek	SE 30th	1868.66	25-year	297	59.05	63.38	61.76	4.33	0.003734	3.63	105.99	36.56	0.33	3.58	0.84
Sunset Creek	SE 30th	1868.66	100-year	412	59.05	64.07	62.15	5.02	0.003805	4.1	131.53	36.56	0.34	4.25	1.01
Sunset Creek	SE 30th	1856.084	1.01-year	100.32	58.51	61.54	60.64	3.03	0.009194	3.18	36.92	28.3	0.39	1.96	1.13
Sunset Creek	SE 30th	1856.084	2-year	151	58.51	62.12	61.06	3.61	0.007785	3.44	53.97	30.95	0.37	2.51	1.22
Sunset Creek	SE 30th	1856.084	10-year	236	58.51	62.83	61.6	4.32	0.007328	3.91	77.03	34.26	0.38	3.18	1.45
Sunset Creek	SE 30th	1856.084	25-year	297	58.51	63.25	61.86	4.74	0.007228	4.21	92.07	36.27	0.38	3.58	1.62
Sunset Creek	SE 30th	1856.084	100-year	412	58.51	63.96	62.31	5.45	0.00691	4.61	117.72	36.27	0.38	4.25	1.83
Sunset Creek	SE 30th	1817.494	1.01-year	100.32	58.15	61.26	59.86	3.11	0.004924	3.33	30.99	17.77	0.36	2.1	0.65
Sunset Creek	SE 30th	1817.494	2-year	151	58.15	61.77	60.34	3.62	0.005847	4.07	41.58	23.46	0.41	2.5	0.91
Sunset Creek	SE 30th	1817.494	10-year	236	58.15	62.37	61.03	4.22	0.00705	5.03	56.84	25.61	0.46	2.98	1.31
Sunset Creek	SE 30th	1817.494	25-year	297	58.15	62.73	61.59	4.58	0.007687	5.58	66.11	25.61	0.49	3.27	1.57
Sunset Creek	SE 30th	1817.494	100-year	412	58.15	63.33	62.25	5.18	0.008613	6.47	81.33	25.61	0.53	3.75	2.01
Sunset Creek	SE 30th	1805.019	1.01-year	100.32	58.22	61.22	59.92	3	0.004481	3.25	37.73	28.54	0.36	2.11	0.59
Sunset Creek	SE 30th	1805.019	2-year	151	58.22	61.74	60.37	3.52	0.004649	3.74	53.63	32.01	0.37	2.54	0.74
Sunset Creek	SE 30th	1805.019	10-year	236	58.22	62.39	61.23	4.17	0.004871	4.34	76.07	53.24	0.39	3.06	0.93
Sunset Creek	SE 30th	1805.019	25-year	297	58.22	62.78	61.56	4.56	0.00479	4.6	92.15	60.85	0.4	3.38	1.01
Sunset Creek	SE 30th	1805.019	100-year	412	58.22	63.46	62.1	5.24	0.004327	4.84	122.76	67.33	0.39	3.94	1.06
Sunset Creek	SE 30th	1791.536	1.01-year	100.32	58.58	61.12	60.26	2.54	0.005998	3.49	32.84	26.2	0.43	1.87	0.7
Sunset Creek	SE 30th	1791.536	2-year	151	58.58	61.65	60.74	3.07	0.005534	3.91	47.64	28.57	0.43	2.35	0.81
Sunset Creek	SE 30th	1791.536	10-year	236	58.58	62.25	61.28	3.67	0.005915	4.65	64.98	28.57	0.46	2.91	1.07
Sunset Creek	SE 30th	1791.536	25-year	297	58.58	62.61	61.59	4.03	0.006259	5.14	75.08	28.57	0.48	3.23	1.26
Sunset Creek	SE 30th	1791.536	100-year	412	58.58	63.18	62.03	4.6	0.006856	5.94	91.41	28.57	0.52	3.76	1.61
Sunset Creek	SE 30th	1777.213	1.01-year	100.32	58.04	61.1	59.79	3.06	0.00334	2.79	43.51	29.94	0.32	2.13	0.44
Sunset Creek	SE 30th	1777.213	2-year	151	58.04	61.64	60.25	3.6	0.003268	3.15	60.86	60.16	0.32	2.6	0.53
Sunset Creek	SE 30th	1777.213	10-year	236	58.04	62.27	60.89	4.23	0.003557	3.74	83.05	66.33	0.35	3.14	0.7
Sunset Creek	SE 30th	1777.213	25-year	297	58.04	62.64	61.24	4.6	0.003738	4.09	96.39	66.54	0.36	3.47	0.81
Sunset Creek	SE 30th	1777.213	100-year	412	58.04	63.24	61.67	5.2	0.004003	4.65	118.39	66.89	0.38	3.99	1
Sunset Creek	SE 30th	1749.718	1.01-year	100.32	57.73	60.91	59.77	3.18	0.005586	3.47	33.31	20.49	0.39	2.1	0.73
Sunset Creek	SE 30th	1749.718	2-year	151	57.73	61.39	60.31	3.66	0.006433	4.19	44.81	47.1	0.43	2.51	1.01
Sunset Creek	SE 30th	1749.718	10-year	236	57.73	61.91	60.9	4.18	0.008186	5.27	60.57	63.78	0.5	2.96	1.51
Sunset Creek	SE 30th	1749.718	25-year	297	57.73	62.21	61.31	4.48	0.009052	5.87	70.54	64.03	0.54	3.22	1.82
Sunset Creek	SE 30th	1749.718	100-year	412	57.73	62.72	61.95	4.99	0.010215	6.79	87.2	64.43	0.58	3.66	2.34
Sunset Creek	SE 30th	1689.563	1.01-year	100.32	57.21	60.02	59.59	2.81	0.020876	5.42	18.92	17.83	0.7	1.56	2.03
Sunset Creek	SE 30th	1689.563	2-year	151	57.21	60.43	60.37	3.22	0.020473	6.14	29.13	26.36	0.72	1.9	2.43
Sunset Creek	SE 30th	1689.563	10-year	236	57.21	61.02	60.84	3.81	0.016972	6.53	45.24	28.17	0.68	2.4	2.55
Sunset Creek	SE 30th	1689.563	25-year	297	57.21	61.38	61.07	4.17	0.015528	6.76	55.52	29.26	0.67	2.71	2.62
Sunset Creek	SE 30th	1689.563	100-year	412	57.21	61.97	61.51	4.76	0.013881	7.16	73.28	43.57	0.65	3.2	2.78
Sunset Creek	SE 30th	1668.393	1.01-year	100.32	56.93	59.91	59.04	2.98	0.008146	4.05	28.94	25.06	0.47	1.94	0.99
Sunset Creek	SE 30th	1668.393	2-year	151	56.93	60.35	59.81	3.42	0.008396	4.62	40.03	26.29	0.5	2.31	1.21
Sunset Creek	SE 30th	1668.393	10-year	236	56.93	60.91	60.31	3.98	0.008645	5.32	55.37	27.91	0.52	2.79	1.51
Sunset Creek	SE 30th	1668.393	25-year	297	56.93	61.26	60.56	4.33	0.008706	5.71	65.25	28.9	0.53	3.09	1.68
Sunset Creek	SE 30th	1668.393	100-year	412	56.93	61.84	61.01	4.91	0.008713	6.31	82.48	30.55	0.54	3.58	1.95
Sunset Creek	SE 30th	1626.318	1.01-year	100.32	56.89	59.64	58.71	2.75	0.006398	3.64	31.21	23.61	0.43	1.9	0.76
Sunset Creek	SE 30th	1626.318	2-year	151	56.89	60.03	59.27	3.14	0.007479	4.38	40.51	24.76	0.48	2.23	1.04
Sunset Creek	SE 30th	1626.318	10-year	236	56.89	60.51	59.87	3.62	0.009048	5.39	52.72	26.21	0.54	2.65	1.49
Sunset Creek	SE 30th	1626.318	25-year	297	56.89	60.8	60.15	3.91	0.009898	5.99	60.41	27.07	0.58	2.9	1.79
Sunset Creek	SE 30th	1626.318	100-year	412	56.89	61.3	60.62	4.41	0.010777	6.86	74.37	28.58	0.62	3.33	2.24
Sunset Creek	SE 30th	1613.357	1.01-year	100.32	56.46	59.63	58.27	3.17	0.003357	2.9	37.14	23.32	0.33	2.08	0.44
Sunset Creek	SE 30th	1613.357	2-year	151	56.46	60	58.69	3.54	0.004389	3.65	46.19	24.85	0.39	2.4	0.66
Sunset Creek	SE 30th	1613.357	10-year	236	56.46	60.47	59.4	4.01	0.0059	4.69	58.04	26.32	0.46	2.8	1.03
Sunset Creek	SE 30th	1613.357	25-year	297	56.46	60.74	59.77	4.28	0.006805	5.32	65.4	27.19	0.5	3.03	1.29
Sunset Creek	SE 30th	1613.357	100-year	412	56.46	61.23	60.29	4.77	0.00793	6.25	78.89	28.73	0.55	3.45	1.71

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	1592.728	1.01-year	100.32	56.02	59.65	57.91	3.63	0.001149	1.69	62.89	33.09	0.19	2.23	0.16
Sunset Creek	SE 30th	1592.728	2-year	151	56.02	60.04	58.23	4.02	0.001518	2.15	75.99	33.8	0.23	2.6	0.25
Sunset Creek	SE 30th	1592.728	10-year	236	56.02	60.54	58.66	4.52	0.002077	2.81	92.89	34.71	0.28	3.07	0.4
Sunset Creek	SE 30th	1592.728	25-year	297	56.02	60.83	58.92	4.81	0.00242	3.22	103.26	35.25	0.3	3.35	0.51
Sunset Creek	SE 30th	1592.728	100-year	412	56.02	61.35	59.38	5.33	0.002877	3.85	121.91	36.21	0.34	3.85	0.69
Sunset Creek	SE 30th	1583.59	1.01-year	100.32	56.87	59.48	58.8	2.61	0.008049	3.48	32.65	32.1	0.47	1.59	0.8
Sunset Creek	SE 30th	1583.59	2-year	151	56.87	59.81	59.2	2.94	0.00914	4.19	43.62	33.2	0.52	1.91	1.09
Sunset Creek	SE 30th	1583.59	10-year	236	56.87	60.21	59.7	3.34	0.011291	5.25	56.96	34.5	0.6	2.28	1.61
Sunset Creek	SE 30th	1583.59	25-year	297	56.87	60.43	59.97	3.56	0.012715	5.91	64.84	35.25	0.64	2.5	1.98
Sunset Creek	SE 30th	1583.59	100-year	412	56.87	60.87	60.38	4	0.013713	6.8	80.49	36.69	0.68	2.91	2.49
Sunset Creek	SE 30th	1583.5		Lat Struct											
Sunset Creek	SE 30th	1576.451	1.01-year	100.32	56.81	59.39	58.71	2.58	0.01288	3.58	28.97	25.93	0.53	1.27	1.02
Sunset Creek	SE 30th	1576.451	2-year	151	56.81	59.69	59.18	2.88	0.015583	4.33	37.2	28.01	0.6	1.47	1.43
Sunset Creek	SE 30th	1576.451	10-year	236	56.81	60.02	59.67	3.21	0.020105	5.52	46.94	31.92	0.7	1.76	2.2
Sunset Creek	SE 30th	1576.451	25-year	297	56.81	60.17	59.92	3.36	0.024449	6.39	51.81	33.88	0.78	1.89	2.89
Sunset Creek	SE 30th	1576.451	100-year	412	56.81	60.36	60.36	3.55	0.034449	8.04	58.39	36.3	0.94	2.06	4.43
Sunset Creek	SE 30th	1535.154	1.01-year	85.27	56.74	58.88	58.13	2.14	0.005952	2.09	44.51	64.82	0.32	1.3	0.48
Sunset Creek	SE 30th	1535.154	2-year	128.35	56.74	59.18	58.35	2.44	0.006312	2.43	65.06	75.59	0.34	1.55	0.61
Sunset Creek	SE 30th	1535.154	10-year	200.6	56.74	59.54	58.67	2.8	0.006603	2.81	96.09	107.2	0.36	1.86	0.77
Sunset Creek	SE 30th	1535.154	25-year	252.45	56.74	59.75	58.95	3.01	0.006459	2.98	118.93	107.2	0.36	2.06	0.83
Sunset Creek	SE 30th	1535.154	100-year	350.2	56.74	60.09	59.26	3.35	0.006347	3.26	155.06	107.2	0.37	2.39	0.95
Sunset Creek	SE 30th	1520.645	1.01-year	85.27	56.07	58.86	57.6	2.79	0.001622	1.56	72.98	107.62	0.21	1.52	0.15
Sunset Creek	SE 30th	1520.645	2-year	128.35	56.07	59.16	57.84	3.09	0.001767	1.81	105.43	109.75	0.23	1.79	0.2
Sunset Creek	SE 30th	1520.645	10-year	200.6	56.07	59.52	58.19	3.45	0.00202	2.16	144.8	109.75	0.25	2.11	0.27
Sunset Creek	SE 30th	1520.645	25-year	252.45	56.07	59.73	58.4	3.66	0.002178	2.38	167.84	109.75	0.26	2.3	0.31
Sunset Creek	SE 30th	1520.645	100-year	350.2	56.07	60.06	58.97	3.99	0.002455	2.74	204.17	109.75	0.28	2.6	0.4
Sunset Creek	SE 30th	1493.465	1.01-year	85.27	56.01	58.7	57.64	2.69	0.004145	2.89	40.53	62.58	0.35	1.9	0.49
Sunset Creek	SE 30th	1493.465	2-year	128.35	56.01	58.95	58.02	2.94	0.005351	3.54	61.32	88.29	0.41	2.12	0.71
Sunset Creek	SE 30th	1493.465	10-year	200.6	56.01	59.27	58.92	3.26	0.006281	4.18	89.8	88.29	0.45	2.42	0.95
Sunset Creek	SE 30th	1493.465	25-year	252.45	56.01	59.46	59.1	3.45	0.006746	4.54	106.66	88.29	0.47	2.59	1.09
Sunset Creek	SE 30th	1493.465	100-year	350.2	56.01	59.76	59.35	3.75	0.007605	5.14	132.59	88.29	0.51	2.86	1.36
Sunset Creek	SE 30th	1474.062	1.01-year	85.27	56.81	58.67	58.2	1.86	0.003919	2.28	70.18	110.27	0.33	1.37	0.33
Sunset Creek	SE 30th	1474.062	2-year	128.35	56.81	58.94	58.39	2.13	0.003902	2.54	99.13	110.27	0.34	1.61	0.39
Sunset Creek	SE 30th	1474.062	10-year	200.6	56.81	59.27	58.59	2.46	0.004071	2.92	135.6	110.27	0.36	1.92	0.49
Sunset Creek	SE 30th	1474.062	25-year	252.45	56.81	59.46	58.74	2.65	0.004232	3.16	156.98	110.27	0.37	2.1	0.55
Sunset Creek	SE 30th	1474.062	100-year	350.2	56.81	59.76	58.94	2.95	0.004639	3.59	189.85	110.27	0.4	2.38	0.69
Sunset Creek	SE 30th	1400.25	1.01-year	85.27	56.09	57.96	57.61	1.87	0.014145	4.19	31.41	78.66	0.61	1.34	1.19
Sunset Creek	SE 30th	1400.25	2-year	128.35	56.09	58.15	58.15	2.06	0.016614	4.89	46.97	83.59	0.67	1.51	1.57
Sunset Creek	SE 30th	1400.25	10-year	200.6	56.09	58.38	58.38	2.29	0.019637	5.79	65.88	83.59	0.74	1.71	2.1
Sunset Creek	SE 30th	1400.25	25-year	252.45	56.09	58.52	58.52	2.43	0.02105	6.28	77.39	83.59	0.78	1.84	2.42
Sunset Creek	SE 30th	1400.25	100-year	350.2	56.09	58.85	58.73	2.76	0.018143	6.45	105.04	83.59	0.74	2.14	2.42
Sunset Creek	SE 30th	1312.582	1.01-year	85.27	54.16	56.24	55.93	2.08	0.0213	5.36	15.98	11.67	0.75	1.36	1.81
Sunset Creek	SE 30th	1312.582	2-year	128.35	54.16	56.73	56.72	2.57	0.013865	5.05	46.93	86.52	0.62	1.73	1.5
Sunset Creek	SE 30th	1312.582	10-year	200.6	54.16	57.34	56.99	3.18	0.006623	4.16	100.75	87.46	0.45	2.25	0.93
Sunset Creek	SE 30th	1312.582	25-year	252.45	54.16	57.8	57.13	3.64	0.004257	3.71	140.95	87.46	0.37	2.64	0.7
Sunset Creek	SE 30th	1312.582	100-year	350.2	54.16	58.59	57.35	4.43	0.002582	3.35	209.85	87.46	0.3	3.31	0.53
Sunset Creek	SE 30th	1208.49	1.01-year	85.27	51.7	54.69	53.8	2.99	0.011975	4.59	18.56	8.69	0.55	1.56	1.17
Sunset Creek	SE 30th	1208.49	2-year	128.35	51.7	55.76	54.36	4.06	0.007418	3.96	43.63	47.17	0.45	1.82	0.84
Sunset Creek	SE 30th	1208.49	10-year	200.6	51.7	56.96	55.65	5.26	0.002698	3.01	107.59	54.66	0.29	2.6	0.44
Sunset Creek	SE 30th	1208.49	25-year	252.45	51.7	57.5	55.97	5.8	0.002206	3.01	137.02	54.66	0.27	3.02	0.42
Sunset Creek	SE 30th	1208.49	100-year	350.2	51.7	58.34	56.34	6.64	0.001853	3.15	183.05	54.66	0.26	3.67	0.42
Sunset Creek	SE 30th	1177.949	1.01-year	100.55	51.42	54.73	53.05	3.31	0.001847	2.77	36.25	13.04	0.29	2.11	0.24
Sunset Creek	SE 30th	1177.949	2-year	151.35	51.42	55.49	53.47	4.07	0.001659	3.06	67.13	50.14	0.29	2.67	0.28
Sunset Creek	SE 30th	1177.949	10-year	236.6	51.42	56.27	54.07	4.85	0.001625	3.46	106.13	50.15	0.29	3.26	0.33
Sunset Creek	SE 30th	1177.949	25-year	297.45	51.42	56.72	54.46	5.3	0.001634	3.7	128.59	50.15	0.3	3.6	0.37
Sunset Creek	SE 30th	1177.949	100-year	413.2	51.42	57.46	55.54	6.04	0.001653	4.1	165.82	50.15	0.31	4.16	0.43
Sunset Creek	SE 30th	1012.233	1.01-year	100.55	49.75	53.92	52.37	4.17	0.012251	4.21	23.87	7.7	0.42	1.6	1.23
Sunset Creek	SE 30th	1012.233	2-year	151.35	49.75	54.61	53	4.86	0.014792	4.99	32.94	19.55	0.46	1.82	1.68
Sunset Creek	SE 30th	1012.233	10-year	236.6	49.75	55.32	53.89	5.57	0.015391	5.74	47.5	21.31	0.49	2.18	2.09
Sunset Creek	SE 30th	1012.233	25-year	297.45	49.75	55.73	54.97	5.98	0.015626	6.14	56.34	22.3	0.5	2.38	2.32
Sunset Creek	SE 30th	1012.233	100-year	413.2	49.75	56.4	55.54	6.65	0.015675	6.72	72.28	25.48	0.51	2.72	2.66
Sunset Creek	SE 30th	852.3866	1.01-year	100.55	50.09	52.62	51.63	2.53	0.006318	3.4	29.59	14.77	0.42	1.78	0.7
Sunset Creek	SE 30th	852.3866	2-year	151.35	50.09	53.16	52.04	3.07	0.00678	3.98	39.22	20.86	0.45	2.16	0.91
Sunset Creek	SE 30th	852.3866	10-year	236.6	50.09	54.19	52.6	4.1	0.004971	4.03	66.57	32.49	0.39	2.84	0.88
Sunset Creek	SE 30th	852.3866	25-year	297.45	50.09	54.65	53	4.56	0.004727	4.18	81.9	33.02	0.39	3.14	0.93
Sunset Creek	SE 30th	852.3866	100-year	413.2	50.09	55.42	53.69	5.33	0.004455	4.42	107.51	33.91	0.38	3.61	1
Sunset Creek	SE 30th	834.4796	1.01-year	100.55	50.42	52.35	52.05	1.93	0.01469	4.18	24.06	20.51	0.68	1.14	1.04
Sunset Creek	SE 30th	834.4796	2-year	151.35	50.42	53.04	52.37	2.62	0.007447	3.91	39.73	25.09	0.51	1.75	0.81
Sunset Creek	SE 30th	834.4796	10-year	236.6	50.42	54.14	52.8	3.72	0.003764	3.62	71.26	32.4	0.38	2.65	0.62
Sunset Creek	SE 30th	834.4796	25-year	297.45	50.42	54.61	53.07	4.19	0.003505	3.79	86.83	33.42	0.37	3.02	0.66
Sunset Creek	SE 30th	834.4796	100-year	413.2	50.42	55.37	53.54	4.95	0.003281	4.09	112.53	33.91	0.36	3.6	0.74

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	816.2844	1.01-year	100.55	50.18	52.24	51.75	2.06	0.008119	3.12	32.26	26.81	0.5	1.17	0.59
Sunset Creek	SE 30th	816.2844	2-year	151.35	50.18	53.02	52.01	2.84	0.004056	2.78	54.43	30.02	0.36	1.73	0.44
Sunset Creek	SE 30th	816.2844	10-year	236.6	50.18	54.15	52.38	3.97	0.002	2.58	96.79	43.1	0.27	2.69	0.34
Sunset Creek	SE 30th	816.2844	25-year	297.45	50.18	54.63	52.61	4.45	0.001856	2.72	117.38	43.46	0.26	3.08	0.36
Sunset Creek	SE 30th	816.2844	100-year	413.2	50.18	55.4	53	5.22	0.001737	2.95	151.26	44.04	0.26	3.71	0.4
Sunset Creek	SE 30th	795.8286	1.01-year	100.55	50.27	52.19	51.34	1.92	0.00315	2.32	44.91	31.92	0.32	1.49	0.29
Sunset Creek	SE 30th	795.8286	2-year	151.35	50.27	53	51.59	2.73	0.001784	2.23	72.03	35.08	0.26	2.18	0.24
Sunset Creek	SE 30th	795.8286	10-year	236.6	50.27	54.14	51.96	3.87	0.001152	2.25	114.08	37.65	0.21	3.11	0.22
Sunset Creek	SE 30th	795.8286	25-year	297.45	50.27	54.62	52.18	4.35	0.001187	2.44	131.93	37.82	0.22	3.47	0.26
Sunset Creek	SE 30th	795.8286	100-year	413.2	50.27	55.38	52.55	5.11	0.001271	2.78	161.13	38.09	0.23	4.05	0.32
Sunset Creek	SE 30th	772.6812	1.01-year	100.55	49.8	52.11	51.34	2.31	0.00363	2.31	43.79	31.6	0.34	1.35	0.31
Sunset Creek	SE 30th	772.6812	2-year	151.35	49.8	52.96	51.57	3.16	0.001804	2.16	72.62	36.28	0.25	2.08	0.23
Sunset Creek	SE 30th	772.6812	10-year	236.6	49.8	54.12	51.89	4.32	0.001109	2.15	115.02	45.55	0.21	3.03	0.21
Sunset Creek	SE 30th	772.6812	25-year	297.45	49.8	54.59	52.11	4.79	0.001113	2.35	132.48	46.93	0.21	3.44	0.24
Sunset Creek	SE 30th	772.6812	100-year	413.2	49.8	55.36	52.47	5.56	0.001142	2.68	160.86	49.35	0.22	4.13	0.29
Sunset Creek	SE 30th	742.021	1.01-year	100.55	49.76	52.02	51.21	2.26	0.003164	2.1	47.78	33.86	0.31	1.33	0.26
Sunset Creek	SE 30th	742.021	2-year	151.35	49.76	52.92	51.43	3.16	0.001523	1.91	79.33	41.34	0.23	2.05	0.19
Sunset Creek	SE 30th	742.021	10-year	236.6	49.76	54.1	51.73	4.34	0.000905	1.94	122.07	51.49	0.19	3.11	0.18
Sunset Creek	SE 30th	742.021	25-year	297.45	49.76	54.57	51.93	4.81	0.000921	2.14	139.3	53.01	0.19	3.55	0.2
Sunset Creek	SE 30th	742.021	100-year	413.2	49.76	55.34	52.27	5.58	0.000966	2.47	167.27	53.01	0.2	4.27	0.26
Sunset Creek	SE 30th	704.0906		Bridge											
Sunset Creek	SE 30th	637.1669	1.01-year	100.55	49	51.91	50.27	2.91	0.000848	1.45	70.2	47.21	0.17	2.09	0.11
Sunset Creek	SE 30th	637.1669	2-year	151.35	49	52.51	50.53	3.51	0.000908	1.72	88.85	47.46	0.18	2.59	0.15
Sunset Creek	SE 30th	637.1669	10-year	236.6	49	53.12	50.86	4.12	0.001179	2.21	108.51	50.82	0.21	3.12	0.23
Sunset Creek	SE 30th	637.1669	25-year	297.45	49	53.46	51.05	4.46	0.001351	2.52	121.12	55.09	0.23	3.42	0.29
Sunset Creek	SE 30th	637.1669	100-year	413.2	49	54.01	51.41	5.01	0.001627	3.02	142.47	55.09	0.26	3.92	0.4
Sunset Creek	SE 30th	616.5581	1.01-year	100.55	48.88	51.91	49.89	3.03	0.000323	1.03	110.99	63.74	0.11	2.53	0.05
Sunset Creek	SE 30th	616.5581	2-year	151.35	48.88	52.51	50.12	3.63	0.00037	1.24	138.24	68.09	0.12	3.03	0.07
Sunset Creek	SE 30th	616.5581	10-year	236.6	48.88	53.13	50.44	4.25	0.000508	1.6	166.47	68.5	0.14	3.53	0.11
Sunset Creek	SE 30th	616.5581	25-year	297.45	48.88	53.48	50.61	4.6	0.000595	1.83	182.93	71.65	0.16	3.84	0.14
Sunset Creek	SE 30th	616.5581	100-year	413.2	48.88	54.04	50.91	5.16	0.000742	2.22	211.02	73.22	0.18	4.35	0.2
Sunset Creek	SE 30th	596.5916	1.01-year	100.55	48.52	51.89	49.66	3.37	0.000467	1.22	86.58	39.79	0.13	2.65	0.08
Sunset Creek	SE 30th	596.5916	2-year	151.35	48.52	52.49	49.91	3.97	0.000583	1.52	105.26	41.8	0.14	3.12	0.11
Sunset Creek	SE 30th	596.5916	10-year	236.6	48.52	53.09	50.27	4.57	0.000843	2.01	124.53	43.09	0.18	3.62	0.19
Sunset Creek	SE 30th	596.5916	25-year	297.45	48.52	53.42	50.49	4.9	0.001019	2.33	135.73	44.4	0.2	3.92	0.25
Sunset Creek	SE 30th	596.5916	100-year	413.2	48.52	53.95	50.89	5.43	0.001329	2.88	154.47	46.49	0.23	4.39	0.36
Sunset Creek	SE 30th	572.9708	1.01-year	100.55	47.8	51.79	50.11	3.99	0.007538	2.48	40.59	22.01	0.31	1.85	0.87
Sunset Creek	SE 30th	572.9708	2-year	151.35	47.8	52.36	50.59	4.56	0.007033	2.83	57.4	34.91	0.31	2.37	1.04
Sunset Creek	SE 30th	572.9708	10-year	236.6	47.8	52.92	51.28	5.12	0.007889	3.42	77.89	37.52	0.34	2.89	1.42
Sunset Creek	SE 30th	572.9708	25-year	297.45	47.8	53.24	51.64	5.44	0.008498	3.78	89.82	38.6	0.36	3.18	1.69
Sunset Creek	SE 30th	572.9708	100-year	413.2	47.8	53.73	52.3	5.93	0.009453	4.37	109.03	38.6	0.39	3.64	2.15
Sunset Creek	SE 30th	554.7107	1.01-year	100.55	47.62	51.53	49.85	3.91	0.008664	3.51	29.65	16.97	0.36	2.05	1.11
Sunset Creek	SE 30th	554.7107	2-year	151.35	47.62	52.02	50.4	4.4	0.010876	4.35	43.97	52.7	0.41	2.38	1.62
Sunset Creek	SE 30th	554.7107	10-year	236.6	47.62	52.65	51.17	5.03	0.009955	4.65	78.01	55.51	0.4	2.81	1.75
Sunset Creek	SE 30th	554.7107	25-year	297.45	47.62	53.01	52.36	5.39	0.009395	4.77	98.04	57.1	0.4	3.05	1.79
Sunset Creek	SE 30th	554.7107	100-year	413.2	47.62	53.57	52.75	5.95	0.008626	4.95	134.54	116.88	0.39	3.44	1.85
Sunset Creek	SE 30th	543.1325	1.01-year	100.55	47.65	51.52	49.72	3.87	0.003274	2.92	35.23	50.97	0.3	2.2	0.45
Sunset Creek	SE 30th	543.1325	2-year	151.35	47.65	52.04	50.19	4.39	0.003644	3.37	63.54	55.1	0.32	2.55	0.58
Sunset Creek	SE 30th	543.1325	10-year	236.6	47.65	52.64	50.87	4.99	0.003872	3.88	98.61	117.31	0.34	3	0.73
Sunset Creek	SE 30th	543.1325	25-year	297.45	47.65	52.98	51.29	5.33	0.003881	4.1	121.75	117.31	0.35	3.26	0.79
Sunset Creek	SE 30th	543.1325	100-year	413.2	47.65	53.53	52.3	5.88	0.003888	4.45	158.79	117.31	0.36	3.68	0.89
Sunset Creek	SE 30th	529.8341	1.01-year	100.55	47.8	51.47	49.72	3.67	0.003859	2.94	34.89	19.26	0.31	2.17	0.52
Sunset Creek	SE 30th	529.8341	2-year	151.35	47.8	51.99	50.2	4.19	0.004265	3.39	59.3	104.45	0.33	2.5	0.67
Sunset Creek	SE 30th	529.8341	10-year	236.6	47.8	52.59	50.88	4.79	0.004205	3.77	94.29	110.85	0.34	2.97	0.78
Sunset Creek	SE 30th	529.8341	25-year	297.45	47.8	52.94	51.3	5.14	0.004211	3.99	115.69	114.45	0.34	3.24	0.85
Sunset Creek	SE 30th	529.8341	100-year	413.2	47.8	53.48	52.33	5.68	0.004245	4.35	152.44	120.21	0.35	3.66	0.97
Sunset Creek	SE 30th	420.6496	1.01-year	100.55	47.11	51.29	48.76	4.18	0.001295	1.95	52.9	25.45	0.19	2.57	0.21
Sunset Creek	SE 30th	420.6496	2-year	151.35	47.11	51.75	49.16	4.64	0.001814	2.47	75.05	54.14	0.23	2.87	0.32
Sunset Creek	SE 30th	420.6496	10-year	236.6	47.11	52.3	49.73	5.19	0.002274	3.04	110.85	118.2	0.26	3.31	0.47
Sunset Creek	SE 30th	420.6496	25-year	297.45	47.11	52.62	50.1	5.51	0.002461	3.33	132.78	118.2	0.28	3.56	0.55
Sunset Creek	SE 30th	420.6496	100-year	413.2	47.11	53.14	50.75	6.03	0.002707	3.75	168.33	118.2	0.3	3.97	0.67
Sunset Creek	SE 30th	48.9477	1.01-year	100.55	47.18	50.65	49.5	3.47	0.002442	2.13	71.26	131.31	0.26	1.84	0.28
Sunset Creek	SE 30th	48.9477	2-year	151.35	47.18	50.98	49.88	3.8	0.002464	2.37	98.48	131.31	0.27	2.15	0.33
Sunset Creek	SE 30th	48.9477	10-year	236.6	47.18	51.5	50.55	4.32	0.002216	2.56	140.71	131.31	0.27	2.62	0.36
Sunset Creek	SE 30th	48.9477	25-year	297.45	47.18	51.8	50.7	4.62	0.002179	2.72	165.11	131.31	0.27	2.9	0.39
Sunset Creek	SE 30th	48.9477	100-year	413.2	47.18	52.3	50.92	5.12	0.00215	2.98	205.72	131.31	0.27	3.36	0.45

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Richards Creek	Historical	1507.208	1.01-year	15.05	57.05	58.62	57.65	1.57	0.002703	0.91	16.56	17.45	0.16	0.89	0.15
Richards Creek	Historical	1507.208	2-year	22.65	57.05	58.81	57.8	1.76	0.003796	1.13	20.06	19	0.19	0.98	0.23
Richards Creek	Historical	1507.208	10-year	35.4	57.05	59.03	58	1.98	0.005265	1.45	24.62	23.46	0.23	1.14	0.37
Richards Creek	Historical	1507.208	25-year	44.55	57.05	59.13	58.13	2.08	0.006525	1.69	27.09	26.94	0.26	1.21	0.49
Richards Creek	Historical	1507.208	100-year	61.8	57.05	59.27	58.31	2.22	0.00875	2.09	31.13	30.61	0.31	1.34	0.73
Richards Creek	Historical	1481.097	1.01-year	15.05	57.41	58.45	58.08	1.04	0.012687	1.84	10.58	30.74	0.37	0.74	0.58
Richards Creek	Historical	1481.097	2-year	22.65	57.41	58.65	58.32	1.24	0.009489	1.77	20.33	70.02	0.32	0.88	0.52
Richards Creek	Historical	1481.097	10-year	35.4	57.41	58.91	58.51	1.5	0.005139	1.48	44.41	115.25	0.24	1.09	0.35
Richards Creek	Historical	1481.097	25-year	44.55	57.41	59	58.61	1.59	0.004818	1.51	56.33	131.14	0.24	1.18	0.36
Richards Creek	Historical	1481.097	100-year	61.8	57.41	59.14	58.72	1.73	0.004481	1.57	76.03	145.39	0.24	1.32	0.37
Richards Creek	Historical	1291.987	1.01-year	15.05	55.48	56.38	56.05	0.9	0.009455	1.94	7.75	12.07	0.43	0.63	0.37
Richards Creek	Historical	1291.987	2-year	22.65	55.48	56.5	56.19	1.02	0.012864	2.44	9.29	12.84	0.5	0.71	0.57
Richards Creek	Historical	1291.987	10-year	35.4	55.48	56.41	56.38	0.93	0.046361	4.38	8.09	12.25	0.95	0.65	1.87
Richards Creek	Historical	1291.987	25-year	44.55	55.48	56.5	56.5	1.02	0.050988	4.83	9.21	12.8	1	0.7	2.24
Richards Creek	Historical	1291.987	100-year	61.8	55.48	56.68	56.68	1.2	0.049454	5.28	11.71	13.74	1.01	0.83	2.56
Richards Creek	Historical	999.2128	1.01-year	15.05	51.78	52.33	52.21	0.55	0.021643	2.41	6.26	14.62	0.65	0.42	0.57
Richards Creek	Historical	999.2128	2-year	22.65	51.78	52.53	52.32	0.75	0.014271	2.42	9.35	15.49	0.55	0.59	0.53
Richards Creek	Historical	999.2128	10-year	35.4	51.78	53.02	52.47	1.24	0.005472	2.03	17.43	17.57	0.36	0.97	0.33
Richards Creek	Historical	999.2128	25-year	44.55	51.78	54.1	52.56	2.32	0.000868	1.14	38.96	21.98	0.15	1.7	0.09
Richards Creek	Historical	999.2128	100-year	61.8	51.78	56.66	52.72	4.88	0.000065	0.49	191.13	214.45	0.04	3.44	0.01
Richards Creek	Historical	968.151	1.01-year	15.05	51.3	52.1	51.71	0.8	0.00443	1.44	10.46	15.61	0.31	0.66	0.18
Richards Creek	Historical	968.151	2-year	22.65	51.3	52.38	51.82	1.08	0.003527	1.53	14.82	16.66	0.29	0.87	0.19
Richards Creek	Historical	968.151	10-year	35.4	51.3	52.95	51.97	1.65	0.001863	1.41	25.07	18.89	0.22	1.28	0.15
Richards Creek	Historical	968.151	25-year	44.55	51.3	54.09	52.06	2.79	0.000439	0.91	49.03	22.93	0.11	2.02	0.06
Richards Creek	Historical	968.151	100-year	61.8	51.3	56.66	52.22	5.36	0.000067	0.53	116.81	217.23	0.05	3.8	0.02
Richards Creek	Historical	913.9713		Culvert											
Richards Creek	Historical	875.7664	1.01-year	15.05	49.6	50.72	49.88	1.12	0.000498	0.6	24.93	27.65	0.11	0.88	0.03
Richards Creek	Historical	875.7664	2-year	22.65	49.6	51.06	49.97	1.46	0.000432	0.65	34.86	30.91	0.11	1.1	0.03
Richards Creek	Historical	875.7664	10-year	35.4	49.6	51.58	50.09	1.98	0.000351	0.68	52.33	35.78	0.1	1.42	0.03
Richards Creek	Historical	875.7664	25-year	44.55	49.6	51.89	50.17	2.29	0.000327	0.7	63.72	38.62	0.1	1.6	0.03
Richards Creek	Historical	875.7664	100-year	61.8	49.6	52.4	50.29	2.8	0.000295	0.73	84.69	122.23	0.09	1.89	0.03
Richards Creek	Historical	843.4692	1.01-year	15.05	49.48	50.71	49.76	1.23	0.000354	0.53	28.16	29.03	0.1	0.95	0.02
Richards Creek	Historical	843.4692	2-year	22.65	49.48	51.05	49.85	1.57	0.000328	0.59	38.63	32.37	0.09	1.17	0.02
Richards Creek	Historical	843.4692	10-year	35.4	49.48	51.57	49.97	2.09	0.000279	0.62	56.91	37.17	0.09	1.49	0.03
Richards Creek	Historical	843.4692	25-year	44.55	49.48	51.88	50.05	2.4	0.000266	0.65	68.73	45.43	0.09	1.67	0.03
Richards Creek	Historical	843.4692	100-year	61.8	49.48	52.39	50.17	2.91	0.000246	0.68	90.4	144.04	0.08	1.96	0.03
Richards Creek	Historical	240.4131	1.01-year	15.05	45.9	50.71	46.6	4.81	0.000001	0.1	402.64	212.34	0.01	3.72	0
Richards Creek	Historical	240.4131	2-year	22.65	45.9	51.05	46.73	5.15	0.000001	0.13	477.21	225.63	0.01	4.02	0
Richards Creek	Historical	240.4131	10-year	35.4	45.9	51.57	46.92	5.67	0.000002	0.17	600.43	238.56	0.01	4.49	0
Richards Creek	Historical	240.4131	25-year	44.55	45.9	51.88	47.05	5.98	0.000002	0.19	673.56	238.56	0.01	4.76	0
Richards Creek	Historical	240.4131	100-year	61.8	45.9	52.39	47.25	6.49	0.000002	0.22	795.71	238.56	0.02	5.21	0
Richards Creek	Lower	85.48712	1.01-year	120.25	47.08	50.66	49.54	3.58	0.001315	2.1	131.45	256.31	0.25	1.94	0.16
Richards Creek	Lower	85.48712	2-year	181	47.08	50.99	50.28	3.91	0.001313	2.31	184.23	256.31	0.26	2.25	0.18
Richards Creek	Lower	85.48712	10-year	297	47.08	51.51	50.56	4.43	0.00131	2.62	265.35	256.31	0.27	2.72	0.22
Richards Creek	Lower	85.48712	25-year	376	47.08	51.82	50.7	4.74	0.001309	2.8	312.53	256.31	0.27	3	0.25
Richards Creek	Lower	85.48712	100-year	525	47.08	52.32	50.93	5.24	0.001308	3.07	391.18	256.31	0.28	3.46	0.28
Richards Creek	Lower	26.62222	1.01-year	120.25	47	50.58	49.45	3.58	0.0013	2.09	132.08	256.31	0.25	1.94	0.16
Richards Creek	Lower	26.62222	2-year	181	47	50.92	50.2	3.92	0.001301	2.3	184.88	256.31	0.26	2.25	0.18
Richards Creek	Lower	26.62222	10-year	297	47	51.44	50.48	4.44	0.0013	2.62	266.03	256.31	0.27	2.73	0.22
Richards Creek	Lower	26.62222	25-year	376	47	51.74	50.62	4.74	0.001301	2.79	313.23	256.31	0.27	3	0.24
Richards Creek	Lower	26.62222	100-year	525	47	52.24	50.85	5.24	0.001301	3.07	391.89	256.31	0.28	3.46	0.28

PHASE III ALTERNATIVE 3 OUTPUT TABLE

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	3272.859	1.01-year	52.48	82.49	85.22	83.99	2.73	0.006909	2.99	17.54	7.87	0.35	1.53	0.66
Sunset Creek	SE 30th	3272.859	2-year	79	82.49	85.87	84.38	3.38	0.007726	3.46	22.83	8.32	0.37	1.77	0.86
Sunset Creek	SE 30th	3272.859	10-year	126	82.49	86.72	84.96	4.23	0.009492	4.19	30.1	8.9	0.4	2.06	1.22
Sunset Creek	SE 30th	3272.859	25-year	157	82.49	87.13	85.3	4.64	0.010441	4.63	34.08	10.3	0.42	2.24	1.46
Sunset Creek	SE 30th	3272.859	100-year	212	82.49	87.79	85.83	5.3	0.011482	5.24	41.64	12.71	0.45	2.52	1.81
Sunset Creek	SE 30th	3251.92	1.01-year	52.48	82.52	84.68	84.21	2.16	0.024525	5.08	10.33	5.78	0.67	1.2	1.84
Sunset Creek	SE 30th	3251.92	2-year	79	82.52	85.22	84.69	2.7	0.027799	5.84	13.53	6.22	0.7	1.39	2.41
Sunset Creek	SE 30th	3251.92	10-year	126	82.52	86	85.54	3.48	0.031764	6.33	19.9	8.8	0.74	1.5	2.97
Sunset Creek	SE 30th	3251.92	25-year	157	82.52	86.34	85.88	3.82	0.033201	6.84	22.96	9.05	0.76	1.64	3.39
Sunset Creek	SE 30th	3251.92	100-year	212	82.52	86.88	86.38	4.36	0.035496	7.59	27.92	9.43	0.78	1.84	4.08
Sunset Creek	SE 30th	3230.282	1.01-year	52.48	81.37	84.02	83.73	2.65	0.030615	5.49	9.55	6.31	0.79	1.09	2.08
Sunset Creek	SE 30th	3230.282	2-year	79	81.37	84.46	84.23	3.09	0.033662	6.29	12.56	7.21	0.84	1.24	2.61
Sunset Creek	SE 30th	3230.282	10-year	126	81.37	85.18	84.92	3.81	0.034461	6.77	18.62	9.27	0.84	1.45	3.12
Sunset Creek	SE 30th	3230.282	25-year	157	81.37	85.54	85.24	4.17	0.03394	7.15	21.97	9.59	0.83	1.61	3.42
Sunset Creek	SE 30th	3230.282	100-year	212	81.37	86.11	85.72	4.74	0.033218	7.67	27.63	10.1	0.82	1.86	3.85
Sunset Creek	SE 30th	3207.655	1.01-year	52.48	81.58	83.02	83.02	1.44	0.045494	6.27	8.36	6.93	1.01	0.98	2.8
Sunset Creek	SE 30th	3207.655	2-year	79	81.58	83.43	83.43	1.85	0.044215	7.02	11.25	7.41	1.01	1.19	3.29
Sunset Creek	SE 30th	3207.655	10-year	126	81.58	84.06	84.06	2.48	0.044338	7.75	16.25	8.79	1	1.42	3.92
Sunset Creek	SE 30th	3207.655	25-year	157	81.58	84.37	84.37	2.79	0.044896	8.25	19.02	9.07	1	1.57	4.39
Sunset Creek	SE 30th	3207.655	100-year	212	81.58	84.86	84.86	3.28	0.045967	8.98	23.6	9.51	1	1.78	5.12
Sunset Creek	SE 30th	3193.525	1.01-year	52.48	81.39	82.96	82.47	1.57	0.012631	3.2	16.4	13.89	0.52	0.99	0.78
Sunset Creek	SE 30th	3193.525	2-year	79	81.39	83.44	82.75	2.05	0.010801	3.36	23.53	15.91	0.49	1.2	0.81
Sunset Creek	SE 30th	3193.525	10-year	126	81.39	84.14	83.16	2.75	0.008933	3.52	35.78	18.79	0.45	1.5	0.84
Sunset Creek	SE 30th	3193.525	25-year	157	81.39	84.54	83.39	3.15	0.00785	3.62	43.42	19.42	0.43	1.74	0.85
Sunset Creek	SE 30th	3193.525	100-year	212	81.39	85.16	83.75	3.77	0.00686	3.82	55.51	19.91	0.4	2.11	0.9
Sunset Creek	SE 30th	3181.277	1.01-year	52.48	80.83	82.23	82.23	1.4	0.049653	6.06	8.66	7.7	1.01	0.97	3.01
Sunset Creek	SE 30th	3181.277	2-year	79	80.83	82.63	82.61	1.8	0.047241	6.68	11.83	8.35	0.99	1.19	3.51
Sunset Creek	SE 30th	3181.277	10-year	126	80.83	83.26	83.16	2.43	0.04141	7.2	17.49	9.4	0.93	1.5	3.89
Sunset Creek	SE 30th	3181.277	25-year	157	80.83	83.58	83.46	2.75	0.039203	7.67	20.55	10.44	0.92	1.73	4.22
Sunset Creek	SE 30th	3181.277	100-year	212	80.83	84.06	83.99	3.23	0.035379	8.35	26.15	12.35	0.91	2.12	4.68
Sunset Creek	SE 30th	3171.478	1.01-year	52.48	79.8	82.09	81.5	2.29	0.017938	4.34	12.08	6.96	0.58	1.29	1.44
Sunset Creek	SE 30th	3171.478	2-year	79	79.8	82.53	81.92	2.73	0.020229	5.19	15.34	7.97	0.63	1.55	1.96
Sunset Creek	SE 30th	3171.478	10-year	126	79.8	83.09	82.55	3.29	0.022901	6.46	20.2	9.36	0.7	1.96	2.8
Sunset Creek	SE 30th	3171.478	25-year	157	79.8	83.37	82.91	3.57	0.024983	7.2	22.91	10.06	0.74	2.16	3.37
Sunset Creek	SE 30th	3171.478	100-year	212	79.8	83.77	83.5	3.97	0.0285	8.38	27.21	11.07	0.81	2.46	4.38
Sunset Creek	SE 30th	3160.526	1.01-year	52.48	79.96	81.89	81.42	1.93	0.018375	4.34	12.09	7.93	0.62	1.24	1.42
Sunset Creek	SE 30th	3160.526	2-year	79	79.96	82.32	81.81	2.36	0.020239	5.05	15.65	8.81	0.66	1.47	1.86
Sunset Creek	SE 30th	3160.526	10-year	126	79.96	82.89	82.38	2.93	0.022223	6.07	21.16	10.52	0.7	1.82	2.53
Sunset Creek	SE 30th	3160.526	25-year	157	79.96	83.18	82.72	3.22	0.022836	6.66	24.36	11.4	0.73	2.05	2.92
Sunset Creek	SE 30th	3160.526	100-year	212	79.96	83.62	83.23	3.66	0.023797	7.55	29.71	12.74	0.76	2.4	3.56
Sunset Creek	SE 30th	3145.921	1.01-year	52.48	78.83	81.92	80.46	3.09	0.003732	2.52	21.19	10.58	0.29	1.92	0.45
Sunset Creek	SE 30th	3145.921	2-year	79	78.83	82.37	80.86	3.54	0.004594	3.15	26.22	11.91	0.33	2.29	0.66
Sunset Creek	SE 30th	3145.921	10-year	126	78.83	82.97	81.42	4.14	0.005759	4.01	33.92	13.69	0.38	2.78	1
Sunset Creek	SE 30th	3145.921	25-year	157	78.83	83.29	81.74	4.46	0.006411	4.49	38.41	14.63	0.41	3.04	1.22
Sunset Creek	SE 30th	3145.921	100-year	212	78.83	83.77	82.27	4.94	0.007307	5.21	45.89	16.07	0.45	3.44	1.57
Sunset Creek	SE 30th	3119.845	1.01-year	52.48	79.67	81.65	81.05	1.98	0.011764	3.56	14.77	10.26	0.51	1.32	0.97
Sunset Creek	SE 30th	3119.845	2-year	79	79.67	82.05	81.4	2.38	0.011998	4.21	19.08	11.5	0.54	1.67	1.25
Sunset Creek	SE 30th	3119.845	10-year	126	79.67	82.57	81.89	2.9	0.013116	5.17	25.47	13.13	0.59	2.13	1.74
Sunset Creek	SE 30th	3119.845	25-year	157	79.67	82.82	82.17	3.15	0.014262	5.77	28.89	13.92	0.62	2.35	2.1
Sunset Creek	SE 30th	3119.845	100-year	212	79.67	83.2	82.63	3.53	0.016027	6.69	34.41	15.12	0.68	2.69	2.69
Sunset Creek	SE 30th	3103.342	1.01-year	52.48	79.66	81.46	80.89	1.8	0.011936	3.47	15.11	10.95	0.52	1.24	0.92
Sunset Creek	SE 30th	3103.342	2-year	79	79.66	81.86	81.22	2.2	0.01343	4.03	19.62	12.1	0.56	1.44	1.21
Sunset Creek	SE 30th	3103.342	10-year	126	79.66	82.36	81.7	2.7	0.01577	4.81	26.17	13.61	0.61	1.7	1.67
Sunset Creek	SE 30th	3103.342	25-year	157	79.66	82.61	81.98	2.95	0.016334	5.31	29.67	14.35	0.63	1.92	1.95
Sunset Creek	SE 30th	3103.342	100-year	212	79.66	82.99	82.39	3.33	0.017504	6.1	35.2	15.45	0.67	2.24	2.45
Sunset Creek	SE 30th	3082.734	1.01-year	52.48	79.61	81.15	80.76	1.54	0.015717	3.74	14.02	11.68	0.6	1.11	1.09
Sunset Creek	SE 30th	3082.734	2-year	79	79.61	81.52	81.06	1.91	0.015628	4.26	18.63	13.16	0.61	1.37	1.33
Sunset Creek	SE 30th	3082.734	10-year	126	79.61	82	81.5	2.39	0.015851	5.1	25.43	15.76	0.64	1.78	1.76
Sunset Creek	SE 30th	3082.734	25-year	157	79.61	82.23	81.76	2.62	0.01654	5.61	29.26	17.06	0.67	1.99	2.06
Sunset Creek	SE 30th	3082.734	100-year	212	79.61	82.61	82.16	3	0.016909	6.32	36.13	19.16	0.7	2.34	2.47
Sunset Creek	SE 30th	3066.484	1.01-year	52.48	79.15	80.44	80.44	1.29	0.045593	5.66	9.27	9.44	1.01	0.91	2.59
Sunset Creek	SE 30th	3066.484	2-year	79	79.15	80.77	80.77	1.62	0.041061	6.3	12.68	11.37	0.98	1.17	2.99
Sunset Creek	SE 30th	3066.484	10-year	126	79.15	81.27	81.27	2.12	0.032155	6.97	19.39	15.18	0.92	1.63	3.27
Sunset Creek	SE 30th	3066.484	25-year	157	79.15	81.55	81.55	2.4	0.028891	7.28	23.84	16.54	0.89	1.88	3.4
Sunset Creek	SE 30th	3066.484	100-year	212	79.15	81.92	81.92	2.77	0.027733	7.96	30.23	17.83	0.9	2.23	3.85
Sunset Creek	SE 30th	3034.622	1.01-year	52.48	77.36	78.8	78.83	1.44	0.053489	6	8.75	8.57	1.05	0.94	3.13
Sunset Creek	SE 30th	3034.622	2-year	79	77.36	79.11	79.19	1.75	0.057465	6.84	11.54	9.56	1.1	1.1	3.94
Sunset Creek	SE 30th	3034.622	10-year	126	77.36	79.48	79.7	2.12	0.068201	8.2	15.36	10.77	1.21	1.29	5.48
Sunset Creek	SE 30th	3034.622	25-year	157	77.36	79.7	79.98	2.34	0.071417	8.82	17.81	11.47	1.25	1.39	6.22
Sunset Creek	SE 30th	3034.622	100-year	212	77.36	80.11	80.4	2.75	0.068713	9.35	22.66	12.75	1.24	1.59	6.81

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	3020.31	1.01-year	52.48	76.74	78.69	78.18	1.95	0.011941	3.74	14.04	11.02	0.58	1.14	0.85
Sunset Creek	SE 30th	3020.31	2-year	79	76.74	79.07	78.53	2.33	0.012354	4.22	18.74	13.76	0.63	1.24	0.96
Sunset Creek	SE 30th	3020.31	10-year	126	76.74	79.57	79.08	2.83	0.012503	4.77	26.69	17.98	0.67	1.45	1.13
Sunset Creek	SE 30th	3020.31	25-year	157	76.74	79.84	79.34	3.1	0.012582	5.03	31.75	19.91	0.68	1.59	1.25
Sunset Creek	SE 30th	3020.31	100-year	212	76.74	80.22	79.74	3.48	0.012788	5.51	39.63	21.2	0.67	1.94	1.55
Sunset Creek	SE 30th	2982.026	1.01-year	52.48	76.27	77.64	77.64	1.37	0.041864	5.49	9.57	10.28	1	0.86	2.24
Sunset Creek	SE 30th	2982.026	2-year	79	76.27	77.97	77.97	1.7	0.041566	5.98	13.22	12.11	1.01	1	2.6
Sunset Creek	SE 30th	2982.026	10-year	126	76.27	78.42	78.42	2.15	0.042101	6.55	19.23	14.7	1.01	1.2	3.15
Sunset Creek	SE 30th	2982.026	25-year	157	76.27	78.66	78.66	2.39	0.042096	6.84	22.94	16.1	1.01	1.3	3.42
Sunset Creek	SE 30th	2982.026	100-year	212	76.27	79.03	79.03	2.76	0.041059	7.23	29.3	18.1	1	1.48	3.78
Sunset Creek	SE 30th	2969.117	1.01-year	52.48	75.88	76.97	77.07	1.09	0.065542	5.54	9.48	14.93	1.22	0.62	2.54
Sunset Creek	SE 30th	2969.117	2-year	79	75.88	77.13	77.29	1.25	0.07752	6.56	12.04	16.63	1.36	0.71	3.42
Sunset Creek	SE 30th	2969.117	10-year	126	75.88	77.99	77.62	2.11	0.016637	4.66	27.04	18.12	0.67	1.39	1.44
Sunset Creek	SE 30th	2969.117	25-year	157	75.88	78.3	77.81	2.42	0.014764	4.81	32.64	18.59	0.64	1.61	1.49
Sunset Creek	SE 30th	2969.117	100-year	212	75.88	78.72	78.12	2.84	0.014239	5.23	40.57	19.24	0.63	1.9	1.69
Sunset Creek	SE 30th	2939.869	1.01-year	52.48	73.61	76.82	75.69	3.21	0.0053	2.32	22.64	14.71	0.33	1.38	0.46
Sunset Creek	SE 30th	2939.869	2-year	79	73.61	77.25	76.05	3.64	0.006353	2.69	29.37	16.87	0.36	1.56	0.62
Sunset Creek	SE 30th	2939.869	10-year	126	73.61	77.81	76.54	4.2	0.007148	3.22	39.19	18.18	0.39	1.91	0.85
Sunset Creek	SE 30th	2939.869	25-year	157	73.61	78.11	76.8	4.5	0.007632	3.51	44.79	18.85	0.4	2.09	1
Sunset Creek	SE 30th	2939.869	100-year	212	73.61	78.51	77.2	4.9	0.008977	4.04	52.43	19.74	0.44	2.32	1.3
Sunset Creek	SE 30th	2904.859	1.01-year	52.48	74.07	76.39	75.43	2.32	0.035368	2.86	18.34	15.88	0.47	1.03	2.28
Sunset Creek	SE 30th	2904.859	2-year	79	74.07	76.76	75.8	2.69	0.035055	3.22	24.51	17.55	0.48	1.25	2.74
Sunset Creek	SE 30th	2904.859	10-year	126	74.07	77.28	76.48	3.21	0.034618	3.67	34.34	19.94	0.49	1.54	3.34
Sunset Creek	SE 30th	2904.859	25-year	157	74.07	77.58	76.7	3.51	0.033762	3.86	41.26	28.12	0.49	1.7	3.59
Sunset Creek	SE 30th	2904.859	100-year	212	74.07	77.99	77.03	3.92	0.029905	4.01	54.84	34.28	0.48	1.98	3.69
Sunset Creek	SE 30th	2887.542	1.01-year	52.48	73.52	76	75.02	2.48	0.016879	2.48	21.15	16.68	0.39	1.13	1.19
Sunset Creek	SE 30th	2887.542	2-year	79	73.52	76.35	75.58	2.83	0.018402	2.91	27.15	17.78	0.41	1.36	1.56
Sunset Creek	SE 30th	2887.542	10-year	126	73.52	76.85	75.94	3.33	0.020043	3.46	36.45	19.36	0.44	1.66	2.08
Sunset Creek	SE 30th	2887.542	25-year	157	73.52	77.14	76.13	3.62	0.020645	3.73	42.11	20.26	0.46	1.83	2.36
Sunset Creek	SE 30th	2887.542	100-year	212	73.52	77.55	76.47	4.03	0.020458	4.12	54.02	31.33	0.46	2.14	2.74
Sunset Creek	SE 30th	2869.669	1.01-year	52.48	73.86	74.99	74.99	1.13	0.1141	5.38	9.76	11.01	1.01	0.84	6
Sunset Creek	SE 30th	2869.669	2-year	79	73.86	75.45	75.31	1.59	0.077457	5.1	15.48	13.75	0.85	1.07	5.16
Sunset Creek	SE 30th	2869.669	10-year	126	73.86	76.06	75.72	2.2	0.052374	5.13	24.65	16.55	0.73	1.46	4.78
Sunset Creek	SE 30th	2869.669	25-year	157	73.86	76.37	75.95	2.51	0.045904	5.28	30.08	18.64	0.7	1.69	4.84
Sunset Creek	SE 30th	2869.669	100-year	212	73.86	76.83	76.3	2.97	0.037413	5.55	40.53	26.66	0.65	2.13	4.96
Sunset Creek	SE 30th	2850.365	1.01-year	52.48	72.12	74.78	73.51	2.66	0.008734	2.49	21.71	12.12	0.3	1.82	0.99
Sunset Creek	SE 30th	2850.365	2-year	79	72.12	75.2	73.85	3.08	0.01057	3.08	27.12	14.28	0.34	2.16	1.43
Sunset Creek	SE 30th	2850.365	10-year	126	72.12	75.73	74.37	3.61	0.013553	3.95	34.65	18.53	0.39	2.6	2.2
Sunset Creek	SE 30th	2850.365	25-year	157	72.12	76	74.67	3.88	0.015301	4.43	38.77	20.55	0.42	2.83	2.7
Sunset Creek	SE 30th	2850.365	100-year	212	72.12	76.4	75.15	4.28	0.018224	5.21	45	23.52	0.47	3.16	3.6
Sunset Creek	SE 30th	2823.726	1.01-year	52.48	72.56	74.28	73.76	1.72	0.030371	3.5	15.06	12.76	0.54	1.22	2.31
Sunset Creek	SE 30th	2823.726	2-year	79	72.56	74.63	74.08	2.07	0.03169	4.05	20.53	17.35	0.56	1.48	2.92
Sunset Creek	SE 30th	2823.726	10-year	126	72.56	75.07	74.62	2.51	0.032689	4.79	28.7	19.84	0.59	1.86	3.79
Sunset Creek	SE 30th	2823.726	25-year	157	72.56	75.31	74.85	2.75	0.03308	5.19	33.61	21.42	0.61	2.08	4.29
Sunset Creek	SE 30th	2823.726	100-year	212	72.56	75.67	75.2	3.11	0.033877	5.79	41.7	23.79	0.63	2.4	5.08
Sunset Creek	SE 30th	2794.948	1.01-year	52.48	71.19	73.47	72.93	2.28	0.026753	3.41	16.36	16.09	0.51	1.29	2.16
Sunset Creek	SE 30th	2794.948	2-year	79	71.19	73.91	73.29	2.72	0.022637	3.63	24.42	20.59	0.48	1.62	2.28
Sunset Creek	SE 30th	2794.948	10-year	126	71.19	74.34	73.8	3.15	0.023419	4.28	34.12	23.97	0.51	2.01	2.94
Sunset Creek	SE 30th	2794.948	25-year	157	71.19	74.52	74.01	3.33	0.026317	4.78	38.53	25.36	0.54	2.17	3.57
Sunset Creek	SE 30th	2794.948	100-year	212	71.19	74.86	74.32	3.67	0.027583	5.34	47.48	27.94	0.57	2.48	4.27
Sunset Creek	SE 30th	2760.247	1.01-year	52.48	70.04	71.78	71.78	1.74	0.048883	6.25	8.4	7.05	1.01	1.02	3.1
Sunset Creek	SE 30th	2760.247	2-year	79	70.04	72.19	72.19	2.15	0.048803	6.92	11.41	7.83	1.01	1.22	3.71
Sunset Creek	SE 30th	2760.247	10-year	126	70.04	72.94	72.94	2.9	0.031018	6.76	20.98	19.47	0.83	1.68	3.25
Sunset Creek	SE 30th	2760.247	25-year	157	70.04	73.26	73.26	3.22	0.025632	6.75	27.92	23.44	0.77	1.93	3.1
Sunset Creek	SE 30th	2760.247	100-year	212	70.04	73.59	73.59	3.55	0.025171	7.29	35.9	25.15	0.78	2.2	3.46
Sunset Creek	SE 30th	2717.8	1.01-year	52.48	68.16	69.95	69.54	1.79	0.048405	4.18	12.55	11.02	0.69	0.99	2.99
Sunset Creek	SE 30th	2717.8	2-year	79	68.16	70.31	69.97	2.15	0.046019	4.76	16.61	11.62	0.7	1.22	3.5
Sunset Creek	SE 30th	2717.8	10-year	126	68.16	70.79	70.42	2.63	0.046934	5.62	22.4	12.43	0.74	1.5	4.4
Sunset Creek	SE 30th	2717.8	25-year	157	68.16	71.06	70.68	2.9	0.047497	6.08	25.81	12.89	0.76	1.65	4.9
Sunset Creek	SE 30th	2717.8	100-year	212	68.16	71.5	71.09	3.34	0.047432	6.72	31.57	13.62	0.78	1.88	5.58
Sunset Creek	SE 30th	2702.718	1.01-year	52.48	67.5	69.37	68.88	1.87	0.034923	3.89	13.5	11.29	0.63	1.04	2.27
Sunset Creek	SE 30th	2702.718	2-year	79	67.5	69.59	69.32	2.09	0.045781	4.9	16.13	11.7	0.74	1.19	3.39
Sunset Creek	SE 30th	2702.718	10-year	126	67.5	70.08	69.75	2.58	0.045004	5.71	22.06	12.56	0.76	1.48	4.16
Sunset Creek	SE 30th	2702.718	25-year	157	67.5	70.37	70.01	2.87	0.044172	6.11	25.7	13.06	0.77	1.64	4.53
Sunset Creek	SE 30th	2702.718	100-year	212	67.5	70.85	70.41	3.35	0.04122	6.58	32.2	13.91	0.76	1.9	4.89
Sunset Creek	SE 30th	2676.488	1.01-year	52.48	66.34	67.98	67.73	1.64	0.06808	4.84	10.85	10.69	0.85	0.89	3.76
Sunset Creek	SE 30th	2676.488	2-year	79	66.34	68.56	68.16	2.22	0.036744	4.58	17.26	11.64	0.66	1.26	2.88
Sunset Creek	SE 30th	2676.488	10-year	126	66.34	69.11	68.62	2.77	0.034664	5.26	23.96	12.56	0.67	1.58	3.42
Sunset Creek	SE 30th	2676.488	25-year	157	66.34	69.49	68.86	3.15	0.030777	5.43	28.9	13.19	0.65	1.79	3.43
Sunset Creek	SE 30th	2676.488	100-year	212	66.34	70.14	69.27	3.8	0.025381	5.6	37.83	14.27	0.61	2.12	3.36

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	2651.525	1.01-year	52.48	65.23	67.11	66.59	1.88	0.02436	4.01	13.07	8.91	0.58	1.25	1.91
Sunset Creek	SE 30th	2651.525	2-year	79	65.23	67.77	66.97	2.54	0.030738	4.04	19.54	13.29	0.59	1.27	2.45
Sunset Creek	SE 30th	2651.525	10-year	126	65.23	68.64	67.51	3.41	0.01769	3.95	31.88	15.1	0.48	1.79	1.97
Sunset Creek	SE 30th	2651.525	25-year	157	65.23	69.14	67.93	3.91	0.014316	3.96	39.67	16.14	0.44	2.06	1.84
Sunset Creek	SE 30th	2651.525	100-year	212	65.23	69.9	68.32	4.67	0.011391	4.03	52.57	17.72	0.41	2.45	1.74
Sunset Creek	SE 30th	2643.063	1.01-year	52.48	64.86	66.99	66.26	2.13	0.012101	3.81	13.79	7.97	0.51	1.35	1.02
Sunset Creek	SE 30th	2643.063	2-year	79	64.86	67.61	66.66	2.75	0.013404	4	19.76	11.77	0.54	1.35	1.13
Sunset Creek	SE 30th	2643.063	10-year	126	64.86	68.51	67.43	3.65	0.009535	4.08	30.88	12.8	0.46	1.84	1.1
Sunset Creek	SE 30th	2643.063	25-year	157	64.86	69.01	67.69	4.15	0.00869	4.2	37.38	13.36	0.44	2.09	1.13
Sunset Creek	SE 30th	2643.063	100-year	212	64.86	69.76	68.12	4.9	0.008109	4.44	47.7	14.21	0.43	2.43	1.23
Sunset Creek	SE 30th	2640.568	1.01-year	52.48	64.75	67.07	65.54	2.32	0.000602	1.74	30.18	13	0.2	1.71	0.06
Sunset Creek	SE 30th	2640.568	2-year	79	64.75	67.7	65.79	2.95	0.000676	2.06	38.3	13	0.21	2.03	0.09
Sunset Creek	SE 30th	2640.568	10-year	126	64.75	68.59	66.17	3.84	0.000802	2.52	49.91	13	0.23	2.41	0.12
Sunset Creek	SE 30th	2640.568	25-year	157	64.75	69.08	66.4	4.33	0.000886	2.79	56.33	13	0.24	2.6	0.14
Sunset Creek	SE 30th	2640.568	100-year	212	64.75	69.83	66.76	5.08	0.000977	3.21	66.01	13.99	0.25	2.99	0.18
Sunset Creek	SE 30th	2625.968		Bridge											
Sunset Creek	SE 30th	2611.37	1.01-year	52.48	63.5	67.09	64.29	3.59	0.000168	1.12	46.68	13	0.1	2.31	0.02
Sunset Creek	SE 30th	2611.37	2-year	79	63.5	67.72	64.54	4.22	0.000242	1.44	54.84	13	0.12	2.56	0.04
Sunset Creek	SE 30th	2611.37	10-year	126	63.5	68.62	64.92	5.12	0.00036	1.89	66.53	13	0.15	2.86	0.06
Sunset Creek	SE 30th	2611.37	25-year	157	63.5	69.11	65.15	5.61	0.000434	2.15	72.99	13	0.16	3.01	0.08
Sunset Creek	SE 30th	2611.37	100-year	212	63.5	69.83	65.51	6.33	0.00054	2.57	82.34	14.02	0.18	3.35	0.11
Sunset Creek	SE 30th	2610.895		Bridge											
Sunset Creek	SE 30th	2610.42	1.01-year	52.48	63.5	67.09	64.29	3.59	0.000117	1.12	46.68	13	0.1	2.31	0.02
Sunset Creek	SE 30th	2610.42	2-year	79	63.5	67.72	64.54	4.22	0.000168	1.44	54.84	13	0.12	2.56	0.03
Sunset Creek	SE 30th	2610.42	10-year	126	63.5	68.62	64.92	5.12	0.00025	1.89	66.52	13	0.15	2.86	0.04
Sunset Creek	SE 30th	2610.42	25-year	157	63.5	69.11	65.15	5.61	0.000301	2.15	72.98	13	0.16	3.01	0.06
Sunset Creek	SE 30th	2610.42	100-year	212	63.5	69.83	65.51	6.33	0.000375	2.58	82.32	14.05	0.18	3.35	0.08
Sunset Creek	SE 30th	2610.395		Bridge											
Sunset Creek	SE 30th	2610.37	1.01-year	52.48	63.5	67.09	64.29	3.59	0.000117	1.12	46.68	13	0.1	2.31	0.02
Sunset Creek	SE 30th	2610.37	2-year	79	63.5	67.72	64.54	4.22	0.000168	1.44	54.84	13	0.12	2.56	0.03
Sunset Creek	SE 30th	2610.37	10-year	126	63.5	68.62	64.92	5.12	0.00025	1.89	66.52	13	0.15	2.86	0.04
Sunset Creek	SE 30th	2610.37	25-year	157	63.5	69.11	65.15	5.61	0.000301	2.15	72.98	13	0.16	3.01	0.06
Sunset Creek	SE 30th	2610.37	100-year	212	63.5	69.83	65.51	6.33	0.000375	2.58	82.32	14.05	0.18	3.35	0.08
Sunset Creek	SE 30th	2596.365		Bridge											
Sunset Creek	SE 30th	2582.37	1.01-year	52.48	64	67.08	64.79	3.08	0.000182	1.31	40.03	13	0.13	2.09	0.02
Sunset Creek	SE 30th	2582.37	2-year	79	64	67.7	65.05	3.7	0.000243	1.64	48.14	13	0.15	2.36	0.04
Sunset Creek	SE 30th	2582.37	10-year	126	64	68.6	65.42	4.6	0.000336	2.11	59.75	13	0.17	2.69	0.06
Sunset Creek	SE 30th	2582.37	25-year	157	64	69.09	65.65	5.09	0.000394	2.37	66.15	13	0.19	2.85	0.07
Sunset Creek	SE 30th	2582.37	100-year	212	64	69.78	66.01	5.78	0.00048	2.82	75.19	16.09	0.21	3.19	0.1
Sunset Creek	SE 30th	2582.335		Bridge											
Sunset Creek	SE 30th	2582.32	1.01-year	52.48	64	67.08	64.79	3.08	0.000182	1.31	40.03	13	0.13	2.09	0.02
Sunset Creek	SE 30th	2582.32	2-year	79	64	67.7	65.05	3.7	0.000243	1.64	48.14	13	0.15	2.36	0.04
Sunset Creek	SE 30th	2582.32	10-year	126	64	68.6	65.42	4.6	0.000336	2.11	59.75	13	0.17	2.69	0.06
Sunset Creek	SE 30th	2582.32	25-year	157	64	69.09	65.65	5.09	0.000394	2.37	66.15	13	0.19	2.85	0.07
Sunset Creek	SE 30th	2582.32	100-year	212	64	69.78	66.01	5.78	0.000481	2.82	75.16	16.08	0.21	3.18	0.1
Sunset Creek	SE 30th	2581.843		Bridge											
Sunset Creek	SE 30th	2581.368	1.01-year	52.48	64	67.08	64.79	3.08	0.000262	1.31	40.03	13	0.13	2.09	0.03
Sunset Creek	SE 30th	2581.368	2-year	79	64	67.7	65.05	3.7	0.00035	1.64	48.14	13	0.15	2.36	0.05
Sunset Creek	SE 30th	2581.368	10-year	126	64	68.6	65.43	4.6	0.000484	2.11	59.74	13	0.17	2.69	0.08
Sunset Creek	SE 30th	2581.368	25-year	157	64	69.09	65.65	5.09	0.000567	2.37	66.15	13	0.19	2.85	0.1
Sunset Creek	SE 30th	2581.368	100-year	212	64	69.78	66.01	5.78	0.000693	2.82	75.14	16.22	0.21	3.18	0.14
Sunset Creek	SE 30th	2578.872	1.01-year	52.48	64	67.08	64.79	3.08	0.000368	1.17	44.71	16.02	0.12	2.25	0.05
Sunset Creek	SE 30th	2578.872	2-year	79	64	67.71	65.03	3.71	0.000489	1.44	54.92	16.63	0.14	2.58	0.08
Sunset Creek	SE 30th	2578.872	10-year	126	64	68.6	65.4	4.6	0.000624	1.8	70.11	17.51	0.16	3.11	0.12
Sunset Creek	SE 30th	2578.872	25-year	157	64	69.1	65.61	5.1	0.000694	2	78.63	18	0.16	3.41	0.15
Sunset Creek	SE 30th	2578.872	100-year	212	64	69.8	65.96	5.8	0.000837	2.34	90.78	18.68	0.18	3.81	0.2
Sunset Creek	SE 30th	2576.368	1.01-year	52.48	64.5	67.04	65.55	2.54	0.003514	1.9	27.69	13.24	0.23	1.78	0.39
Sunset Creek	SE 30th	2576.368	2-year	79	64.5	67.66	65.84	3.16	0.003851	2.18	36.16	14.23	0.24	2.11	0.51
Sunset Creek	SE 30th	2576.368	10-year	126	64.5	68.54	66.27	4.04	0.004244	2.55	49.41	15.66	0.25	2.54	0.67
Sunset Creek	SE 30th	2576.368	25-year	157	64.5	69.04	66.53	4.54	0.004418	2.74	57.3	16.6	0.26	2.78	0.77
Sunset Creek	SE 30th	2576.368	100-year	212	64.5	69.73	66.93	5.23	0.004381	3.08	70.16	20.69	0.27	3.33	0.91
Sunset Creek	SE 30th	2541.368	1.01-year	52.48	64.3	66.81	65.69	2.51	0.006401	2.71	19.38	10.11	0.34	1.53	0.61
Sunset Creek	SE 30th	2541.368	2-year	79	64.3	67.4	66.04	3.1	0.006972	3.09	25.53	10.95	0.36	1.81	0.79
Sunset Creek	SE 30th	2541.368	10-year	126	64.3	68.24	66.56	3.94	0.007581	3.57	35.29	12.16	0.37	2.18	1.03
Sunset Creek	SE 30th	2541.368	25-year	157	64.3	68.71	66.85	4.41	0.007885	3.81	41.16	12.83	0.38	2.37	1.17
Sunset Creek	SE 30th	2541.368	100-year	212	64.3	69.38	67.33	5.08	0.008044	4.24	50.54	16.7	0.39	2.76	1.39
Sunset Creek	SE 30th	2539.81	1.01-year	52.48	64.28	66.8	65.68	2.52	0.005041	2.72	19.29	9.97	0.34	1.53	0.48
Sunset Creek	SE 30th	2539.81	2-year	79	64.28	67.38	66.02	3.1	0.005495	3.12	25.32	10.78	0.36	1.8	0.62
Sunset Creek	SE 30th	2539.81	10-year	126	64.28	68.23	66.54	3.95	0.005983	3.61	34.88	11.94	0.37	2.17	0.81
Sunset Creek	SE 30th	2539.81	25-year	157	64.28	68.7	66.84	4.42	0.006229	3.86	40.62	12.58	0.38	2.36	0.92
Sunset Creek	SE 30th	2539.81	100-year	212	64.28	69.36	67.31	5.08	0.006415	4.31	49.56	15.31	0.39	2.74	1.1

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	2527.427	1.01-year	52.48	64.16	66.75	65.55	2.59	0.004357	2.55	20.55	10.63	0.32	1.56	0.43
Sunset Creek	SE 30th	2527.427	2-year	79	64.16	67.33	65.9	3.17	0.004761	2.93	26.99	11.6	0.34	1.84	0.55
Sunset Creek	SE 30th	2527.427	10-year	126	64.16	68.18	66.41	4.02	0.005129	3.37	37.36	13.01	0.35	2.22	0.71
Sunset Creek	SE 30th	2527.427	25-year	157	64.16	68.65	66.7	4.49	0.005249	3.6	43.65	14.07	0.36	2.43	0.8
Sunset Creek	SE 30th	2527.427	100-year	212	64.16	69.32	67.16	5.16	0.00496	3.97	55.18	20.31	0.36	2.94	0.91
Sunset Creek	SE 30th	2513.681	1.01-year	52.48	64.02	66.63	65.66	2.61	0.006964	3.08	17.03	9.26	0.4	1.43	0.62
Sunset Creek	SE 30th	2513.681	2-year	79	64.02	67.19	66.02	3.17	0.00757	3.52	22.43	10.06	0.42	1.69	0.8
Sunset Creek	SE 30th	2513.681	10-year	126	64.02	68	66.56	3.98	0.008132	4.05	31.12	11.24	0.43	2.03	1.03
Sunset Creek	SE 30th	2513.681	25-year	157	64.02	68.46	66.87	4.44	0.008439	4.31	36.39	11.98	0.44	2.2	1.16
Sunset Creek	SE 30th	2513.681	100-year	212	64.02	69.12	67.36	5.1	0.008866	4.71	46.09	29.37	0.45	2.47	1.36
Sunset Creek	SE 30th	2492.185	1.01-year	52.48	63.81	66.45	65.46	2.64	0.008364	3.22	16.28	10.06	0.45	1.3	0.68
Sunset Creek	SE 30th	2492.185	2-year	79	63.81	67.02	65.9	3.21	0.008106	3.56	22.21	10.92	0.44	1.59	0.81
Sunset Creek	SE 30th	2492.185	10-year	126	63.81	67.84	66.52	4.03	0.007933	3.98	31.7	12.17	0.43	1.98	0.98
Sunset Creek	SE 30th	2492.185	25-year	157	63.81	68.29	66.81	4.48	0.007931	4.2	37.42	12.87	0.43	2.18	1.08
Sunset Creek	SE 30th	2492.185	100-year	212	63.81	68.95	67.26	5.14	0.007895	4.59	46.81	18.11	0.44	2.53	1.25
Sunset Creek	SE 30th	2481.368	1.01-year	52.48	63.7	66.31	65.37	2.61	0.012788	3.45	15.23	9.63	0.48	1.25	1
Sunset Creek	SE 30th	2481.368	2-year	79	63.7	66.88	65.81	3.18	0.012635	3.78	20.9	10.44	0.47	1.54	1.22
Sunset Creek	SE 30th	2481.368	10-year	126	63.7	67.7	66.48	4	0.012743	4.21	29.91	11.61	0.46	1.92	1.53
Sunset Creek	SE 30th	2481.368	25-year	157	63.7	68.15	66.79	4.45	0.012942	4.45	35.31	12.25	0.46	2.12	1.71
Sunset Creek	SE 30th	2481.368	100-year	212	63.7	68.8	67.24	5.1	0.013137	4.86	44.21	16.62	0.47	2.45	2.01
Sunset Creek	SE 30th	2464.334	1.01-year	52.48	63.54	66.02	65.24	2.48	0.016416	3.8	13.8	8.77	0.53	1.21	1.24
Sunset Creek	SE 30th	2464.334	2-year	79	63.54	66.58	65.78	3.04	0.016439	4.19	18.87	9.5	0.52	1.48	1.52
Sunset Creek	SE 30th	2464.334	10-year	126	63.54	67.37	66.32	3.83	0.016923	4.69	26.84	10.55	0.52	1.83	1.93
Sunset Creek	SE 30th	2464.334	25-year	157	63.54	67.81	66.62	4.27	0.017396	4.98	31.56	11.12	0.52	2.01	2.18
Sunset Creek	SE 30th	2464.334	100-year	212	63.54	68.42	67.11	4.88	0.018294	5.48	39.02	14.59	0.53	2.29	2.61
Sunset Creek	SE 30th	2429.853	1.01-year	52.48	63.22	65.71	64.62	2.49	0.007757	2.95	17.79	10.5	0.4	1.36	0.66
Sunset Creek	SE 30th	2429.853	2-year	79	63.22	66.26	65.04	3.04	0.008311	3.33	23.75	11.27	0.4	1.65	0.85
Sunset Creek	SE 30th	2429.853	10-year	126	63.22	67.03	65.65	3.81	0.009229	3.82	32.95	12.47	0.41	2.01	1.16
Sunset Creek	SE 30th	2429.853	25-year	157	63.22	67.46	65.93	4.24	0.009782	4.09	38.36	13.14	0.42	2.2	1.34
Sunset Creek	SE 30th	2429.853	100-year	212	63.22	68.07	66.37	4.85	0.01001	4.52	47.9	18.01	0.43	2.55	1.59
Sunset Creek	SE 30th	2407.706	1.01-year	52.48	63.01	65.37	64.6	2.36	0.015283	3.84	13.68	8.62	0.54	1.23	1.17
Sunset Creek	SE 30th	2407.706	2-year	79	63.01	65.87	65.13	2.86	0.016981	4.37	18.1	9.28	0.55	1.47	1.55
Sunset Creek	SE 30th	2407.706	10-year	126	63.01	66.56	65.68	3.55	0.019474	5.08	24.82	10.2	0.57	1.77	2.15
Sunset Creek	SE 30th	2407.706	25-year	157	63.01	66.92	65.99	3.91	0.02111	5.48	28.64	10.69	0.59	1.92	2.53
Sunset Creek	SE 30th	2407.706	100-year	212	63.01	67.44	66.48	4.43	0.024318	6.16	34.41	11.39	0.62	2.13	3.24
Sunset Creek	SE 30th	2379.636	1.01-year	52.48	62.75	65.18	64.11	2.43	0.006687	2.65	19.8	13.33	0.38	1.3	0.54
Sunset Creek	SE 30th	2379.636	2-year	79	62.75	65.69	64.48	2.94	0.006831	2.94	26.88	14.6	0.38	1.59	0.68
Sunset Creek	SE 30th	2379.636	10-year	126	62.75	66.4	65.09	3.65	0.00717	3.32	37.91	16.38	0.38	1.98	0.89
Sunset Creek	SE 30th	2379.636	25-year	157	62.75	66.78	65.33	4.03	0.00743	3.54	44.3	17.47	0.39	2.18	1.01
Sunset Creek	SE 30th	2379.636	100-year	212	62.75	67.35	65.72	4.6	0.007393	3.9	54.88	19.78	0.39	2.57	1.18
Sunset Creek	SE 30th	2361.19	1.01-year	52.48	62.58	64.92	64.13	2.34	0.012606	3.56	14.73	9.67	0.51	1.25	0.98
Sunset Creek	SE 30th	2361.19	2-year	79	62.58	65.38	64.63	2.8	0.013799	4.08	19.36	10.52	0.53	1.49	1.28
Sunset Creek	SE 30th	2361.19	10-year	126	62.58	66.02	65.17	3.44	0.014921	4.76	26.61	12.81	0.55	1.83	1.71
Sunset Creek	SE 30th	2361.19	25-year	157	62.58	66.36	65.44	3.78	0.015248	5.12	31.35	14.98	0.56	2.04	1.94
Sunset Creek	SE 30th	2361.19	100-year	212	62.58	66.91	65.9	4.33	0.015091	5.54	40.47	18.45	0.56	2.37	2.23
Sunset Creek	SE 30th	2341.739	1.01-year	52.48	62.4	64.62	63.99	2.22	0.014546	3.89	13.5	10.11	0.59	1.13	1.03
Sunset Creek	SE 30th	2341.739	2-year	79	62.4	65.07	64.5	2.67	0.014885	4.33	18.23	11	0.59	1.38	1.28
Sunset Creek	SE 30th	2341.739	10-year	126	62.4	65.69	64.99	3.29	0.015709	4.93	25.53	12.26	0.6	1.7	1.67
Sunset Creek	SE 30th	2341.739	25-year	157	62.4	66.02	65.26	3.62	0.016651	5.31	29.59	12.9	0.62	1.86	1.93
Sunset Creek	SE 30th	2341.739	100-year	212	62.4	66.56	65.7	4.16	0.016244	5.72	38.33	21.12	0.61	2.18	2.21
Sunset Creek	SE 30th	2313.296	1.01-year	52.48	62.13	64.24	63.58	2.11	0.013079	3.76	13.95	10.54	0.58	1.13	0.92
Sunset Creek	SE 30th	2313.296	2-year	79	62.13	64.67	63.98	2.54	0.013495	4.21	18.75	11.38	0.58	1.38	1.17
Sunset Creek	SE 30th	2313.296	10-year	126	62.13	65.27	64.58	3.14	0.01487	4.88	25.81	12.51	0.6	1.7	1.58
Sunset Creek	SE 30th	2313.296	25-year	157	62.13	65.55	64.85	3.42	0.015936	5.32	29.85	16.98	0.62	1.87	1.86
Sunset Creek	SE 30th	2313.296	100-year	212	62.13	66.07	65.27	3.94	0.021872	5.42	41.98	28.25	0.67	1.77	2.41
Sunset Creek	SE 30th	2297.254	1.01-year	52.48	61.98	64.14	63.24	2.16	0.009569	2.52	20.84	17.77	0.41	1.11	0.66
Sunset Creek	SE 30th	2297.254	2-year	79	61.98	64.62	63.57	2.64	0.008908	2.65	29.78	19.99	0.38	1.4	0.78
Sunset Creek	SE 30th	2297.254	10-year	126	61.98	65.25	64.12	3.27	0.008775	2.9	43.45	23.13	0.37	1.79	0.98
Sunset Creek	SE 30th	2297.254	25-year	157	61.98	65.57	64.33	3.59	0.008509	3.08	51.55	29.48	0.37	2.03	1.08
Sunset Creek	SE 30th	2297.254	100-year	212	61.98	66.07	64.64	4.09	0.007536	3.32	66.72	31.92	0.36	2.5	1.17
Sunset Creek	SE 30th	2285.55	1.01-year	52.48	61.88	64.02	63.15	2.14	0.010206	2.56	20.52	17.87	0.42	1.09	0.69
Sunset Creek	SE 30th	2285.55	2-year	79	61.88	64.51	63.47	2.63	0.009562	2.64	29.91	20.82	0.39	1.36	0.81
Sunset Creek	SE 30th	2285.55	10-year	126	61.88	65.15	64.04	3.27	0.009385	2.83	44.5	24.7	0.37	1.7	1
Sunset Creek	SE 30th	2285.55	25-year	157	61.88	65.48	64.24	3.6	0.009387	2.97	52.86	26.8	0.37	1.9	1.11
Sunset Creek	SE 30th	2285.55	100-year	212	61.88	65.99	64.56	4.11	0.007799	3.14	70.28	34.96	0.35	2.38	1.16
Sunset Creek	SE 30th	2261.889	1.01-year	52.48	61.65	63.78	62.91	2.13	0.009712	2.61	20.12	16.04	0.41	1.18	0.72
Sunset Creek	SE 30th	2261.889	2-year	79	61.65	64.27	63.24	2.62	0.009308	2.78	28.45	18	0.39	1.48	0.86
Sunset Creek	SE 30th	2261.889	10-year	126	61.65	64.91	63.77	3.26	0.008921	3.1	41.23	23.73	0.38	1.92	1.07
Sunset Creek	SE 30th	2261.889	25-year	157	61.65	65.23	63.99	3.58	0.008338	3.3	49.41	26.57	0.38	2.22	1.16
Sunset Creek	SE 30th	2261.889	100-year	212	61.65	65.77	64.33	4.12	0.007247	3.53	64.88	30.01	0.36	2.73	1.23
Sunset Creek	SE 30th	2238.42	1.01-year	52.48	61.44	63.61	62.6	2.17	0.006768	2.29	22.9	17.19	0.35	1.26	0.53
Sunset Creek	SE 30th	2238.42	2-year	79	61.44	64.11	62.92	2.67	0.006762	2.48	31.87	19.16	0.34	1.56	0.66
Sunset Creek	SE 30th	2238.42	10-year	126	61.44	64.75	63.36	3.31	0.006286	2.8	45.92	24.5	0.33	2.07	0.81
Sunset Creek	SE 30th	2238.42	25-year	157	61.44	65.09	63.66	3.65	0.005972	3	54.43	26.01	0.33	2.38	0.89
Sunset Creek	SE 30th	2238.42	100-year	212	61.44	65.65	63.99	4.21	0.005424	3.26	69.57	28.51	0.33	2.9	0.98

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	2205.456	1.01-year	52.48	61.13	63.36	62.39	2.23	0.008068	2.44	21.51	15.91	0.37	1.27	0.64
Sunset Creek	SE 30th	2205.456	2-year	79	61.13	63.84	62.73	2.71	0.00827	2.66	29.74	17.86	0.36	1.55	0.8
Sunset Creek	SE 30th	2205.456	10-year	126	61.13	64.49	63.24	3.36	0.008668	2.99	42.25	23.94	0.36	1.94	1.05
Sunset Creek	SE 30th	2205.456	25-year	157	61.13	64.85	63.46	3.72	0.007841	3.16	51.23	26.42	0.36	2.27	1.11
Sunset Creek	SE 30th	2205.456	100-year	212	61.13	65.44	63.81	4.31	0.006588	3.35	67.77	29.64	0.34	2.82	1.16
Sunset Creek	SE 30th	2189.813	1.01-year	52.48	60.98	63.24	62.25	2.26	0.007643	2.39	21.99	16.03	0.36	1.29	0.61
Sunset Creek	SE 30th	2189.813	2-year	79	60.98	63.72	62.57	2.74	0.007968	2.62	30.19	17.96	0.36	1.57	0.78
Sunset Creek	SE 30th	2189.813	10-year	126	60.98	64.36	63.09	3.38	0.008769	2.97	42.44	20.51	0.36	1.92	1.05
Sunset Creek	SE 30th	2189.813	25-year	157	60.98	64.73	63.31	3.75	0.007976	3.12	51.26	25.73	0.35	2.24	1.11
Sunset Creek	SE 30th	2189.813	100-year	212	60.98	65.34	63.66	4.36	0.00656	3.29	68.09	30.21	0.33	2.81	1.15
Sunset Creek	SE 30th	2175.255	1.01-year	52.48	60.85	63.13	62.12	2.28	0.007336	2.35	22.37	16.12	0.35	1.3	0.6
Sunset Creek	SE 30th	2175.255	2-year	79	60.85	63.61	62.44	2.76	0.007775	2.59	30.49	18.03	0.35	1.58	0.77
Sunset Creek	SE 30th	2175.255	10-year	126	60.85	64.23	62.96	3.38	0.00874	2.96	42.5	20.52	0.36	1.92	1.05
Sunset Creek	SE 30th	2175.255	25-year	157	60.85	64.6	63.18	3.75	0.008876	3.11	50.46	22.02	0.36	2.12	1.18
Sunset Creek	SE 30th	2175.255	100-year	212	60.85	65.24	63.53	4.39	0.007955	3.25	65.92	27.53	0.35	2.55	1.26
Sunset Creek	SE 30th	2121.292	1.01-year	52.48	60.34	62.85	61.71	2.51	0.004023	2.25	23.31	15.4	0.32	1.41	0.35
Sunset Creek	SE 30th	2121.292	2-year	79	60.34	63.29	62.06	2.95	0.004524	2.59	30.63	20.1	0.34	1.66	0.47
Sunset Creek	SE 30th	2121.292	10-year	126	60.34	63.94	62.57	3.6	0.003743	2.89	47.61	28.1	0.33	2.26	0.53
Sunset Creek	SE 30th	2121.292	25-year	157	60.34	64.35	62.8	4.01	0.003192	2.96	59.25	28.74	0.31	2.64	0.53
Sunset Creek	SE 30th	2121.292	100-year	212	60.34	65.04	63.17	4.7	0.002515	3.04	79.36	29.8	0.28	3.27	0.51
Sunset Creek	SE 30th	2107.746	1.01-year	52.48	60.22	62.81	61.6	2.59	0.002806	2.1	24.96	16.36	0.3	1.42	0.25
Sunset Creek	SE 30th	2107.746	2-year	79	60.22	63.25	61.94	3.03	0.00287	2.42	33.62	25.29	0.31	1.77	0.32
Sunset Creek	SE 30th	2107.746	10-year	126	60.22	63.91	62.45	3.69	0.002441	2.72	50.78	26.53	0.3	2.39	0.36
Sunset Creek	SE 30th	2107.746	25-year	157	60.22	64.33	62.69	4.11	0.002163	2.83	61.85	27.2	0.29	2.77	0.37
Sunset Creek	SE 30th	2107.746	100-year	212	60.22	65.02	63.02	4.8	0.001796	2.96	80.97	27.99	0.27	3.41	0.38
Sunset Creek	SE 30th	2098.229	1.01-year	100.32	60.13	62.65	62.12	2.52	0.010475	3.15	32.57	42.26	0.54	0.99	0.65
Sunset Creek	SE 30th	2098.229	2-year	151	60.13	63.04	62.51	2.91	0.007654	3.32	49.35	42.91	0.49	1.36	0.65
Sunset Creek	SE 30th	2098.229	10-year	236	60.13	63.64	62.88	3.51	0.005318	3.49	75.38	43.89	0.43	1.92	0.64
Sunset Creek	SE 30th	2098.229	25-year	297	60.13	64.04	63.06	3.91	0.004469	3.6	92.74	44.54	0.41	2.29	0.64
Sunset Creek	SE 30th	2098.229	100-year	412	60.13	64.71	63.38	4.58	0.003592	3.79	123.02	45.64	0.38	2.92	0.66
Sunset Creek	SE 30th	2070.489	1.01-year	100.32	60.45	62.56	61.73	2.11	0.003482	2.02	49.67	39.18	0.32	1.23	0.27
Sunset Creek	SE 30th	2070.489	2-year	151	60.45	62.98	61.98	2.53	0.003054	2.26	68.63	47.19	0.31	1.62	0.31
Sunset Creek	SE 30th	2070.489	10-year	236	60.45	63.6	62.31	3.15	0.002468	2.51	98.67	48.8	0.29	2.23	0.34
Sunset Creek	SE 30th	2070.489	25-year	297	60.45	64.01	62.49	3.56	0.00222	2.65	118.56	49.83	0.28	2.62	0.36
Sunset Creek	SE 30th	2070.489	100-year	412	60.45	64.69	62.82	4.24	0.001935	2.88	153.29	51.47	0.28	3.29	0.4
Sunset Creek	SE 30th	2050.566	1.01-year	100.32	59.65	62.37	61.97	2.72	0.009256	2.98	33.92	34.24	0.51	0.99	0.57
Sunset Creek	SE 30th	2050.566	2-year	151	59.65	62.82	62.19	3.17	0.006281	3.1	51.85	45.37	0.44	1.4	0.55
Sunset Creek	SE 30th	2050.566	10-year	236	59.65	63.49	62.51	3.84	0.004056	3.18	82.72	47.24	0.38	2.01	0.51
Sunset Creek	SE 30th	2050.566	25-year	297	59.65	63.9	62.75	4.25	0.003383	3.26	102.68	48.41	0.36	2.4	0.51
Sunset Creek	SE 30th	2050.566	100-year	412	59.65	64.6	63.07	4.95	0.002728	3.43	137.18	50.17	0.33	3.04	0.52
Sunset Creek	SE 30th	2036.451	1.01-year	100.32	60.13	62.26	61.72	2.13	0.008428	2.83	38.52	47.32	0.48	1.04	0.55
Sunset Creek	SE 30th	2036.451	2-year	151	60.13	62.77	62.03	2.64	0.004602	2.7	63.41	49	0.37	1.54	0.44
Sunset Creek	SE 30th	2036.451	10-year	236	60.13	63.47	62.39	3.34	0.003026	2.78	98.07	51.26	0.32	2.19	0.41
Sunset Creek	SE 30th	2036.451	25-year	297	60.13	63.89	62.57	3.76	0.002585	2.87	120.11	52.64	0.31	2.6	0.42
Sunset Creek	SE 30th	2036.451	100-year	412	60.13	64.6	62.85	4.47	0.002145	3.05	157.45	52.87	0.29	3.27	0.44
Sunset Creek	SE 30th	2016.641	1.01-year	100.32	59.66	62.2	61.35	2.54	0.003075	2.06	50.21	42.43	0.31	1.32	0.25
Sunset Creek	SE 30th	2016.641	2-year	151	59.66	62.74	61.64	3.08	0.002219	2.18	73.92	45.1	0.28	1.83	0.25
Sunset Creek	SE 30th	2016.641	10-year	236	59.66	63.43	61.94	3.77	0.00181	2.42	106.01	46.8	0.26	2.5	0.28
Sunset Creek	SE 30th	2016.641	25-year	297	59.66	63.86	62.14	4.2	0.001683	2.58	126.14	47.83	0.26	2.9	0.3
Sunset Creek	SE 30th	2016.641	100-year	412	59.66	64.57	62.47	4.91	0.001548	2.84	160.54	49.55	0.26	3.57	0.35
Sunset Creek	SE 30th	1988.07	1.01-year	100.32	59.15	62.15	61.01	3	0.001716	1.9	60.17	42	0.24	1.79	0.19
Sunset Creek	SE 30th	1988.07	2-year	151	59.15	62.69	61.27	3.54	0.001511	2.11	83.51	43.62	0.24	2.3	0.22
Sunset Creek	SE 30th	1988.07	10-year	236	59.15	63.39	61.63	4.24	0.001441	2.43	114.86	45.7	0.24	2.95	0.27
Sunset Creek	SE 30th	1988.07	25-year	297	59.15	63.82	61.84	4.67	0.001424	2.63	134.61	46.96	0.24	3.35	0.3
Sunset Creek	SE 30th	1988.07	100-year	412	59.15	64.53	62.24	5.38	0.001405	2.94	168.55	49.05	0.25	4.01	0.35
Sunset Creek	SE 30th	1968.444	1.01-year	100.32	59.73	62.1	61.04	2.37	0.001844	2.08	57.87	41.14	0.26	1.88	0.22
Sunset Creek	SE 30th	1968.444	2-year	151	59.73	62.65	61.33	2.92	0.001616	2.3	81.33	44.08	0.26	2.41	0.24
Sunset Creek	SE 30th	1968.444	10-year	236	59.73	63.35	61.71	3.62	0.001517	2.63	112.72	45.23	0.26	3.1	0.29
Sunset Creek	SE 30th	1968.444	25-year	297	59.73	63.78	61.92	4.05	0.001501	2.84	132.2	46.26	0.26	3.51	0.33
Sunset Creek	SE 30th	1968.444	100-year	412	59.73	64.48	62.27	4.75	0.001487	3.19	165.42	47.96	0.27	4.2	0.39
Sunset Creek	SE 30th	1954.61	1.01-year	100.32	59.63	61.99	61.33	2.36	0.008212	3.06	43.17	38.25	0.38	1.89	0.97
Sunset Creek	SE 30th	1954.61	2-year	151	59.63	62.57	61.66	2.94	0.005902	3.07	67.43	43.67	0.33	2.43	0.9
Sunset Creek	SE 30th	1954.61	10-year	236	59.63	63.29	62.03	3.66	0.00473	3.23	99.74	45.74	0.31	3.1	0.92
Sunset Creek	SE 30th	1954.61	25-year	297	59.63	63.73	62.3	4.1	0.004372	3.37	119.83	46.98	0.31	3.51	0.96
Sunset Creek	SE 30th	1954.61	100-year	412	59.63	64.44	62.62	4.81	0.003986	3.61	154.17	49.03	0.3	4.17	1.04
Sunset Creek	SE 30th	1928.749	1.01-year	100.32	59.16	61.96	60.54	2.8	0.001812	1.53	68.09	38.44	0.19	2.04	0.23
Sunset Creek	SE 30th	1928.749	2-year	151	59.16	62.54	60.77	3.38	0.001734	1.77	91.52	42.78	0.19	2.61	0.28
Sunset Creek	SE 30th	1928.749	10-year	236	59.16	63.26	61.1	4.1	0.001786	2.11	122.71	43.96	0.2	3.32	0.37
Sunset Creek	SE 30th	1928.749	25-year	297	59.16	63.69	61.31	4.53	0.001837	2.32	141.81	44.64	0.21	3.74	0.43
Sunset Creek	SE 30th	1928.749	100-year	412	59.16	64.4	61.66	5.24	0.001915	2.65	173.95	45.74	0.22	4.44	0.53
Sunset Creek	SE 30th	1881.347	1.01-year	100.32	58.45	61.71	60.37	3.26	0.005655	3.04	36.16	22.84	0.34	2.28	0.81
Sunset Creek	SE 30th	1881.347	2-year	151	58.45	62.25	60.8	3.8	0.006073	3.59	50.66	36.83	0.36	2.77	1.05
Sunset Creek	SE 30th	1881.347	10-year	236	58.45	62.96	61.48	4.51	0.005834	4.04	78.11	39.28	0.37	3.4	1.24
Sunset Creek	SE 30th	1881.347	25-year	297	58.45	63.39	61.9	4.94	0.005589	4.25	95.35	40.41	0.36	3.79	1.32
Sunset Creek	SE 30th	1881.347	100-year	412	58.45	64.1	62.64	5.65	0.005316	4.6	124.4	40.94	0.36	4.43	1.47

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	1868.66	1.01-year	100.32	59.05	61.67	60.65	2.62	0.004449	2.64	45.34	33.4	0.33	1.96	0.54
Sunset Creek	SE 30th	1868.66	2-year	151	59.05	62.24	61.01	3.19	0.003885	2.91	64.72	35.17	0.32	2.5	0.61
Sunset Creek	SE 30th	1868.66	10-year	236	59.05	62.95	61.52	3.9	0.003739	3.35	90.37	36.56	0.32	3.17	0.74
Sunset Creek	SE 30th	1868.66	25-year	297	59.05	63.38	61.76	4.33	0.003734	3.63	105.99	36.56	0.33	3.58	0.84
Sunset Creek	SE 30th	1868.66	100-year	412	59.05	64.07	62.15	5.02	0.003805	4.1	131.53	36.56	0.34	4.25	1.01
Sunset Creek	SE 30th	1856.084	1.01-year	100.32	58.51	61.54	60.64	3.03	0.009194	3.18	36.92	28.3	0.39	1.96	1.13
Sunset Creek	SE 30th	1856.084	2-year	151	58.51	62.12	61.06	3.61	0.007785	3.44	53.97	30.95	0.37	2.51	1.22
Sunset Creek	SE 30th	1856.084	10-year	236	58.51	62.83	61.6	4.32	0.007328	3.91	77.03	34.26	0.38	3.18	1.45
Sunset Creek	SE 30th	1856.084	25-year	297	58.51	63.25	61.86	4.74	0.007228	4.21	92.07	36.27	0.38	3.58	1.62
Sunset Creek	SE 30th	1856.084	100-year	412	58.51	63.96	62.31	5.45	0.00691	4.61	117.72	36.27	0.38	4.25	1.83
Sunset Creek	SE 30th	1817.494	1.01-year	100.32	58.15	61.26	59.86	3.11	0.004924	3.33	30.99	17.77	0.36	2.1	0.65
Sunset Creek	SE 30th	1817.494	2-year	151	58.15	61.77	60.34	3.62	0.005847	4.07	41.58	23.46	0.41	2.5	0.91
Sunset Creek	SE 30th	1817.494	10-year	236	58.15	62.37	61.03	4.22	0.00705	5.03	56.84	25.61	0.46	2.98	1.31
Sunset Creek	SE 30th	1817.494	25-year	297	58.15	62.73	61.59	4.58	0.007687	5.58	66.11	25.61	0.49	3.27	1.57
Sunset Creek	SE 30th	1817.494	100-year	412	58.15	63.33	62.25	5.18	0.008613	6.47	81.33	25.61	0.53	3.75	2.01
Sunset Creek	SE 30th	1805.019	1.01-year	100.32	58.22	61.22	59.92	3	0.004481	3.25	37.73	28.54	0.36	2.11	0.59
Sunset Creek	SE 30th	1805.019	2-year	151	58.22	61.74	60.37	3.52	0.004649	3.74	53.63	32.01	0.37	2.54	0.74
Sunset Creek	SE 30th	1805.019	10-year	236	58.22	62.39	61.23	4.17	0.004871	4.34	76.07	53.24	0.39	3.06	0.93
Sunset Creek	SE 30th	1805.019	25-year	297	58.22	62.78	61.56	4.56	0.00479	4.6	92.15	60.85	0.4	3.38	1.01
Sunset Creek	SE 30th	1805.019	100-year	412	58.22	63.46	62.1	5.24	0.004327	4.84	122.76	67.33	0.39	3.94	1.06
Sunset Creek	SE 30th	1791.536	1.01-year	100.32	58.58	61.12	60.26	2.54	0.005998	3.49	32.84	26.2	0.43	1.87	0.7
Sunset Creek	SE 30th	1791.536	2-year	151	58.58	61.65	60.74	3.07	0.005535	3.91	47.64	28.57	0.43	2.35	0.81
Sunset Creek	SE 30th	1791.536	10-year	236	58.58	62.25	61.28	3.67	0.005915	4.65	64.98	28.57	0.46	2.91	1.07
Sunset Creek	SE 30th	1791.536	25-year	297	58.58	62.61	61.59	4.03	0.006259	5.14	75.08	28.57	0.48	3.23	1.26
Sunset Creek	SE 30th	1791.536	100-year	412	58.58	63.18	62.03	4.6	0.006856	5.94	91.41	28.57	0.52	3.76	1.61
Sunset Creek	SE 30th	1777.213	1.01-year	100.32	58.04	61.1	59.79	3.06	0.00334	2.79	43.51	29.94	0.32	2.13	0.44
Sunset Creek	SE 30th	1777.213	2-year	151	58.04	61.64	60.25	3.6	0.003268	3.15	60.86	60.16	0.32	2.6	0.53
Sunset Creek	SE 30th	1777.213	10-year	236	58.04	62.27	60.89	4.23	0.003557	3.74	83.05	66.33	0.35	3.14	0.7
Sunset Creek	SE 30th	1777.213	25-year	297	58.04	62.64	61.24	4.6	0.003738	4.09	96.39	66.54	0.36	3.47	0.81
Sunset Creek	SE 30th	1777.213	100-year	412	58.04	63.24	61.67	5.2	0.004003	4.65	118.39	66.89	0.38	3.99	1
Sunset Creek	SE 30th	1749.718	1.01-year	100.32	57.73	60.91	59.77	3.18	0.005585	3.47	33.31	20.49	0.39	2.1	0.73
Sunset Creek	SE 30th	1749.718	2-year	151	57.73	61.39	60.31	3.66	0.006434	4.19	44.81	47.1	0.43	2.51	1.01
Sunset Creek	SE 30th	1749.718	10-year	236	57.73	61.91	60.9	4.18	0.008186	5.27	60.57	63.78	0.5	2.96	1.51
Sunset Creek	SE 30th	1749.718	25-year	297	57.73	62.21	61.31	4.48	0.009052	5.87	70.54	64.03	0.54	3.22	1.82
Sunset Creek	SE 30th	1749.718	100-year	412	57.73	62.72	61.95	4.99	0.010215	6.79	87.2	64.43	0.58	3.66	2.34
Sunset Creek	SE 30th	1689.563	1.01-year	100.32	57.21	60.02	59.59	2.81	0.020854	5.42	18.93	17.87	0.7	1.56	2.03
Sunset Creek	SE 30th	1689.563	2-year	151	57.21	60.43	60.37	3.22	0.020473	6.14	29.13	26.36	0.72	1.9	2.43
Sunset Creek	SE 30th	1689.563	10-year	236	57.21	61.02	60.84	3.81	0.016972	6.53	45.24	28.17	0.68	2.4	2.55
Sunset Creek	SE 30th	1689.563	25-year	297	57.21	61.38	61.07	4.17	0.015528	6.76	55.52	29.26	0.67	2.71	2.62
Sunset Creek	SE 30th	1689.563	100-year	412	57.21	61.97	61.51	4.76	0.013881	7.16	73.28	43.57	0.65	3.2	2.78
Sunset Creek	SE 30th	1668.393	1.01-year	100.32	56.93	59.91	59.04	2.98	0.008129	4.05	28.97	25.06	0.47	1.94	0.98
Sunset Creek	SE 30th	1668.393	2-year	151	56.93	60.35	59.81	3.42	0.008396	4.62	40.03	26.29	0.5	2.31	1.21
Sunset Creek	SE 30th	1668.393	10-year	236	56.93	60.91	60.31	3.98	0.008645	5.32	55.37	27.91	0.52	2.79	1.51
Sunset Creek	SE 30th	1668.393	25-year	297	56.93	61.26	60.56	4.33	0.008706	5.71	65.25	28.9	0.53	3.09	1.68
Sunset Creek	SE 30th	1668.393	100-year	412	56.93	61.84	61.01	4.91	0.008713	6.31	82.48	30.55	0.54	3.58	1.95
Sunset Creek	SE 30th	1626.318	1.01-year	100.32	56.89	59.65	58.71	2.76	0.006373	3.63	31.26	23.61	0.43	1.9	0.76
Sunset Creek	SE 30th	1626.318	2-year	151	56.89	60.03	59.27	3.14	0.007479	4.38	40.51	24.76	0.48	2.23	1.04
Sunset Creek	SE 30th	1626.318	10-year	236	56.89	60.51	59.87	3.62	0.009047	5.39	52.72	26.21	0.54	2.65	1.49
Sunset Creek	SE 30th	1626.318	25-year	297	56.89	60.8	60.15	3.91	0.009898	5.99	60.41	27.07	0.58	2.9	1.79
Sunset Creek	SE 30th	1626.318	100-year	412	56.89	61.3	60.62	4.41	0.010777	6.86	74.37	28.58	0.62	3.33	2.24
Sunset Creek	SE 30th	1613.357	1.01-year	100.32	56.46	59.63	58.27	3.17	0.003347	2.9	37.19	23.33	0.33	2.08	0.43
Sunset Creek	SE 30th	1613.357	2-year	151	56.46	60	58.69	3.54	0.004389	3.65	46.19	24.85	0.39	2.4	0.66
Sunset Creek	SE 30th	1613.357	10-year	236	56.46	60.47	59.4	4.01	0.0059	4.69	58.04	26.32	0.46	2.8	1.03
Sunset Creek	SE 30th	1613.357	25-year	297	56.46	60.74	59.77	4.28	0.006805	5.32	65.4	27.19	0.5	3.03	1.29
Sunset Creek	SE 30th	1613.357	100-year	412	56.46	61.23	60.29	4.77	0.00793	6.25	78.89	28.73	0.55	3.45	1.71
Sunset Creek	SE 30th	1592.728	1.01-year	100.32	56.02	59.65	57.91	3.63	0.001146	1.69	62.95	33.09	0.19	2.23	0.16
Sunset Creek	SE 30th	1592.728	2-year	151	56.02	60.04	58.23	4.02	0.001518	2.15	75.99	33.8	0.23	2.6	0.25
Sunset Creek	SE 30th	1592.728	10-year	236	56.02	60.54	58.66	4.52	0.002077	2.81	92.89	34.71	0.28	3.07	0.4
Sunset Creek	SE 30th	1592.728	25-year	297	56.02	60.83	58.92	4.81	0.00242	3.22	103.26	35.25	0.3	3.35	0.51
Sunset Creek	SE 30th	1592.728	100-year	412	56.02	61.35	59.38	5.33	0.002877	3.85	121.91	36.21	0.34	3.85	0.69
Sunset Creek	SE 30th	1583.59	1.01-year	100.32	56.87	59.48	58.8	2.61	0.007996	3.47	32.75	32.11	0.47	1.59	0.8
Sunset Creek	SE 30th	1583.59	2-year	151	56.87	59.81	59.2	2.94	0.009139	4.19	43.62	33.2	0.52	1.91	1.09
Sunset Creek	SE 30th	1583.59	10-year	236	56.87	60.21	59.7	3.34	0.01129	5.25	56.96	34.5	0.6	2.28	1.61
Sunset Creek	SE 30th	1583.59	25-year	297	56.87	60.43	59.97	3.56	0.012715	5.91	64.84	35.25	0.64	2.5	1.98
Sunset Creek	SE 30th	1583.59	100-year	412	56.87	60.87	60.38	4	0.013713	6.8	80.49	36.69	0.68	2.91	2.49
Sunset Creek	SE 30th	1583.5		Lat Struct											
Sunset Creek	SE 30th	1576.451	1.01-year	100.32	56.81	59.39	58.71	2.58	0.012871	3.58	28.98	25.93	0.53	1.27	1.02
Sunset Creek	SE 30th	1576.451	2-year	151	56.81	59.69	59.18	2.88	0.015583	4.33	37.2	28.01	0.6	1.47	1.43
Sunset Creek	SE 30th	1576.451	10-year	236	56.81	60.02	59.67	3.21	0.0201	5.52	46.94	31.92	0.7	1.76	2.2
Sunset Creek	SE 30th	1576.451	25-year	297	56.81	60.17	59.92	3.36	0.024449	6.39	51.81	33.88	0.78	1.89	2.89
Sunset Creek	SE 30th	1576.451	100-year	412	56.81	60.36	60.36	3.55	0.034449	8.04	58.39	36.3	0.94	2.06	4.43

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	1535.154	1.01-year	85.27	56.74	58.93	58.13	2.19	0.005318	2.02	47.26	66.37	0.3	1.34	0.44
Sunset Creek	SE 30th	1535.154	2-year	128.35	56.74	59.18	58.35	2.44	0.006315	2.43	65.04	75.58	0.34	1.55	0.61
Sunset Creek	SE 30th	1535.154	10-year	200.6	56.74	59.53	58.67	2.79	0.006614	2.81	96.01	107.2	0.36	1.86	0.77
Sunset Creek	SE 30th	1535.154	25-year	252.45	56.74	59.75	58.95	3.01	0.006459	2.98	118.93	107.2	0.36	2.06	0.83
Sunset Creek	SE 30th	1535.154	100-year	350.2	56.74	60.1	59.26	3.36	0.006199	3.23	156.44	107.2	0.36	2.41	0.93
Sunset Creek	SE 30th	1520.645	1.01-year	85.27	56.07	58.91	57.6	2.84	0.001449	1.5	77.84	109.73	0.2	1.56	0.14
Sunset Creek	SE 30th	1520.645	2-year	128.35	56.07	59.16	57.84	3.09	0.001768	1.81	105.41	109.75	0.23	1.79	0.2
Sunset Creek	SE 30th	1520.645	10-year	200.6	56.07	59.52	58.19	3.45	0.002023	2.16	144.72	109.75	0.25	2.11	0.27
Sunset Creek	SE 30th	1520.645	25-year	252.45	56.07	59.73	58.4	3.66	0.002178	2.38	167.84	109.75	0.26	2.3	0.31
Sunset Creek	SE 30th	1520.645	100-year	350.2	56.07	60.07	58.97	4	0.002407	2.72	205.62	109.75	0.28	2.61	0.39
Sunset Creek	SE 30th	1493.465	1.01-year	85.27	56.01	58.76	57.64	2.75	0.003732	2.79	44.72	88.29	0.34	1.95	0.45
Sunset Creek	SE 30th	1493.465	2-year	128.35	56.01	58.95	58.02	2.94	0.005356	3.54	61.29	88.29	0.41	2.12	0.71
Sunset Creek	SE 30th	1493.465	10-year	200.6	56.01	59.27	58.92	3.26	0.006302	4.18	89.66	88.29	0.45	2.42	0.95
Sunset Creek	SE 30th	1493.465	25-year	252.45	56.01	59.46	59.1	3.45	0.006746	4.54	106.66	88.29	0.47	2.59	1.09
Sunset Creek	SE 30th	1493.465	100-year	350.2	56.01	59.78	59.35	3.77	0.007278	5.06	134.89	88.29	0.5	2.89	1.31
Sunset Creek	SE 30th	1474.062	1.01-year	85.27	56.81	58.75	58.2	1.94	0.003103	2.1	77.95	110.27	0.3	1.43	0.28
Sunset Creek	SE 30th	1474.062	2-year	128.35	56.81	58.94	58.39	2.13	0.003906	2.54	99.08	110.27	0.34	1.61	0.39
Sunset Creek	SE 30th	1474.062	10-year	200.6	56.81	59.27	58.59	2.46	0.004086	2.92	135.43	110.27	0.36	1.92	0.49
Sunset Creek	SE 30th	1474.062	25-year	252.45	56.81	59.46	58.74	2.65	0.004232	3.16	156.98	110.27	0.37	2.1	0.55
Sunset Creek	SE 30th	1474.062	100-year	350.2	56.81	59.79	58.94	2.98	0.004434	3.54	192.74	110.27	0.39	2.4	0.66
Sunset Creek	SE 30th	1400.25	1.01-year	85.27	56.09	57.61	57.61	1.52	0.03905	6.08	14.03	12.5	1	1.05	2.56
Sunset Creek	SE 30th	1400.25	2-year	128.35	56.09	58.15	58.15	2.06	0.016614	4.89	46.97	83.59	0.67	1.51	1.57
Sunset Creek	SE 30th	1400.25	10-year	200.6	56.09	58.38	58.38	2.29	0.019637	5.79	65.88	83.59	0.74	1.71	2.1
Sunset Creek	SE 30th	1400.25	25-year	252.45	56.09	58.52	58.52	2.43	0.02105	6.28	77.39	83.59	0.78	1.84	2.42
Sunset Creek	SE 30th	1400.25	100-year	350.2	56.09	58.73	58.73	2.64	0.023625	7.11	95.29	83.59	0.84	2.03	3
Sunset Creek	SE 30th	1312.582	1.01-year	85.27	54.16	56.28	55.5	2.12	0.007801	3.28	26.48	24.35	0.45	1.53	0.75
Sunset Creek	SE 30th	1312.582	2-year	128.35	54.16	56.81	55.87	2.65	0.004929	3.15	66.25	87.46	0.38	2.03	0.63
Sunset Creek	SE 30th	1312.582	10-year	200.6	54.16	57.45	56.66	3.29	0.003088	2.96	122	87.46	0.31	2.63	0.51
Sunset Creek	SE 30th	1312.582	25-year	252.45	54.16	57.83	56.86	3.67	0.002577	2.95	155.49	87.46	0.29	2.99	0.48
Sunset Creek	SE 30th	1312.582	100-year	350.2	54.16	58.5	57.11	4.34	0.002022	2.96	213.74	87.46	0.27	3.62	0.46
Sunset Creek	SE 30th	1261.44	1.01-year	85.27	53.71	55.75	55.06	2.05	0.013004	3.45	24.75	16.19	0.49	1.44	1.17
Sunset Creek	SE 30th	1261.44	2-year	128.35	53.71	56.28	55.43	2.57	0.010454	3.75	39.87	52.27	0.46	1.93	1.26
Sunset Creek	SE 30th	1261.44	10-year	200.6	53.71	57.07	55.95	3.36	0.004781	3.15	102.52	82.84	0.33	2.68	0.8
Sunset Creek	SE 30th	1261.44	25-year	252.45	53.71	57.51	56.59	3.81	0.003497	2.97	139.14	82.84	0.29	3.09	0.68
Sunset Creek	SE 30th	1261.44	100-year	350.2	53.71	58.24	56.86	4.53	0.002466	2.85	199.47	82.84	0.25	3.78	0.58
Sunset Creek	SE 30th	1259.44*	1.01-year	85.27	53.21	55.79	54.59	2.58	0.004873	2.71	31.45	17.43	0.34	1.77	0.54
Sunset Creek	SE 30th	1259.44*	2-year	128.35	53.21	56.31	54.96	3.1	0.00473	3.14	48.16	58.31	0.35	2.25	0.67
Sunset Creek	SE 30th	1259.44*	10-year	200.6	53.21	57.06	55.49	3.85	0.003055	3.01	107.85	81.88	0.3	2.94	0.56
Sunset Creek	SE 30th	1259.44*	25-year	252.45	53.21	57.5	55.81	4.29	0.002482	2.95	143.4	81.88	0.27	3.34	0.52
Sunset Creek	SE 30th	1259.44*	100-year	350.2	53.21	58.22	56.71	5.01	0.001918	2.93	202.89	81.88	0.25	4.01	0.48
Sunset Creek	SE 30th	1210.31	1.01-year	85.27	53.26	55.38	54.6	2.13	0.011323	3.27	26.05	16.51	0.46	1.49	1.05
Sunset Creek	SE 30th	1210.31	2-year	128.35	53.26	55.93	54.97	2.67	0.009087	3.57	39.89	35.83	0.43	2	1.13
Sunset Creek	SE 30th	1210.31	10-year	200.6	53.26	56.71	55.47	3.46	0.005528	3.44	81.54	58.22	0.36	2.74	0.95
Sunset Creek	SE 30th	1210.31	25-year	252.45	53.26	57.18	55.85	3.92	0.004311	3.35	108.53	58.22	0.32	3.18	0.86
Sunset Creek	SE 30th	1210.31	100-year	350.2	53.26	57.94	56.49	4.68	0.003255	3.33	152.88	58.22	0.29	3.89	0.79
Sunset Creek	SE 30th	1208.31*	1.01-year	85.27	52.76	55.41	54.12	2.66	0.004222	2.58	33.13	18.44	0.32	1.83	0.48
Sunset Creek	SE 30th	1208.31*	2-year	128.35	52.76	55.96	54.5	3.2	0.004078	2.98	48.5	39.97	0.33	2.33	0.59
Sunset Creek	SE 30th	1208.31*	10-year	200.6	52.76	56.72	55.02	3.96	0.003161	3.12	89.98	57.1	0.3	3.03	0.6
Sunset Creek	SE 30th	1208.31*	25-year	252.45	52.76	57.17	55.33	4.42	0.002746	3.17	115.93	57.1	0.29	3.45	0.59
Sunset Creek	SE 30th	1208.31*	100-year	350.2	52.76	57.93	55.95	5.17	0.002309	3.28	159.04	57.1	0.27	4.14	0.6
Sunset Creek	SE 30th	1177.949	1.01-year	100.55	52.79	55.26	54.14	2.48	0.004585	2.74	42.21	36.57	0.34	1.91	0.55
Sunset Creek	SE 30th	1177.949	2-year	151.35	52.79	55.82	54.52	3.04	0.003855	2.96	64.41	40.15	0.32	2.45	0.59
Sunset Creek	SE 30th	1177.949	10-year	236.6	52.79	56.56	55.15	3.78	0.003385	3.28	94.1	40.15	0.32	3.14	0.66
Sunset Creek	SE 30th	1177.949	25-year	297.45	52.79	56.99	55.47	4.21	0.003309	3.51	111.35	40.15	0.32	3.55	0.73
Sunset Creek	SE 30th	1177.949	100-year	413.2	52.79	57.71	55.87	4.93	0.003255	3.91	140.21	40.15	0.33	4.22	0.86
Sunset Creek	SE 30th	1159.18	1.01-year	100.55	52.8	55.01	54.29	2.21	0.01378	3.67	27.36	16.82	0.51	1.53	1.32
Sunset Creek	SE 30th	1159.18	2-year	151.35	52.8	55.54	54.69	2.73	0.011771	4.1	39.87	30.67	0.49	2.03	1.49
Sunset Creek	SE 30th	1159.18	10-year	236.6	52.8	56.32	55.25	3.51	0.00816	4.19	71.28	43.4	0.43	2.76	1.41
Sunset Creek	SE 30th	1159.18	25-year	297.45	52.8	56.77	55.64	3.97	0.006882	4.24	91.09	43.4	0.41	3.19	1.37
Sunset Creek	SE 30th	1159.18	100-year	413.2	52.8	57.52	56.23	4.72	0.005727	4.41	123.56	43.4	0.38	3.9	1.39
Sunset Creek	SE 30th	1157.18	1.01-year	100.55	52.3	55.04	53.82	2.74	0.005434	2.94	34.19	17.7	0.36	1.86	0.63
Sunset Creek	SE 30th	1157.18	2-year	151.35	52.3	55.57	54.24	3.27	0.00552	3.46	47.19	31.79	0.38	2.35	0.81
Sunset Creek	SE 30th	1157.18	10-year	236.6	52.3	56.32	54.81	4.02	0.004882	3.86	75.6	39.4	0.37	3.03	0.92
Sunset Creek	SE 30th	1157.18	25-year	297.45	52.3	56.76	55.16	4.46	0.004604	4.07	92.96	39.4	0.37	3.44	0.99
Sunset Creek	SE 30th	1157.18	100-year	413.2	52.3	57.48	55.94	5.18	0.004343	4.45	121.48	39.4	0.37	4.1	1.11
Sunset Creek	SE 30th	1108.05	1.01-year	100.55	52.35	54.56	53.84	2.21	0.013668	3.66	27.45	16.84	0.51	1.53	1.31
Sunset Creek	SE 30th	1108.05	2-year	151.35	52.35	55.09	54.24	2.74	0.011937	4.09	38.87	27.02	0.49	2.01	1.5
Sunset Creek	SE 30th	1108.05	10-year	236.6	52.35	55.88	54.78	3.52	0.008646	4.29	67.18	42.28	0.44	2.75	1.48
Sunset Creek	SE 30th	1108.05	25-year	297.45	52.35	56.35	55.17	4	0.007102	4.3	87.27	42.28	0.41	3.19	1.42
Sunset Creek	SE 30th	1108.05	100-year	413.2	52.35	57.1	55.83	4.75	0.005857	4.46	119.12	42.28	0.39	3.9	1.43

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	1106.05*	1.01-year	100.55	51.85	54.6	53.37	2.75	0.005424	2.92	34.41	17.06	0.36	1.85	0.63
Sunset Creek	SE 30th	1106.05*	2-year	151.35	51.85	55.13	53.78	3.28	0.005519	3.44	46.37	28.11	0.38	2.33	0.8
Sunset Creek	SE 30th	1106.05*	10-year	236.6	51.85	55.89	54.35	4.04	0.004919	3.86	74.62	43.14	0.37	3.03	0.93
Sunset Creek	SE 30th	1106.05*	25-year	297.45	51.85	56.35	54.69	4.5	0.004438	4.01	94.58	43.14	0.36	3.46	0.96
Sunset Creek	SE 30th	1106.05*	100-year	413.2	51.85	57.1	55.36	5.25	0.003998	4.29	126.7	43.14	0.36	4.14	1.03
Sunset Creek	SE 30th	1056.91	1.01-year	100.55	51.9	54.12	53.39	2.22	0.013496	3.65	27.58	16.87	0.5	1.54	1.3
Sunset Creek	SE 30th	1056.91	2-year	151.35	51.9	54.66	53.79	2.76	0.011912	4.06	38.5	24.82	0.49	2	1.49
Sunset Creek	SE 30th	1056.91	10-year	236.6	51.9	55.45	54.32	3.55	0.008915	4.34	62.41	34.28	0.45	2.74	1.53
Sunset Creek	SE 30th	1056.91	25-year	297.45	51.9	55.9	54.68	4.01	0.007909	4.5	79.51	41.18	0.43	3.17	1.57
Sunset Creek	SE 30th	1056.91	100-year	413.2	51.9	56.68	55.27	4.78	0.00641	4.65	116.7	55.19	0.4	3.9	1.56
Sunset Creek	SE 30th	1054.91*	1.01-year	100.55	51.4	54.15	52.91	2.75	0.005358	2.91	34.61	17.14	0.36	1.85	0.62
Sunset Creek	SE 30th	1054.91*	2-year	151.35	51.4	54.69	53.33	3.3	0.005502	3.41	45.97	25.71	0.38	2.32	0.8
Sunset Creek	SE 30th	1054.91*	10-year	236.6	51.4	55.47	53.9	4.07	0.00498	3.88	69.93	34.72	0.38	3.03	0.94
Sunset Creek	SE 30th	1054.91*	25-year	297.45	51.4	55.92	54.24	4.52	0.004781	4.14	86.93	41.63	0.38	3.44	1.03
Sunset Creek	SE 30th	1054.91*	100-year	413.2	51.4	56.68	54.91	5.28	0.004303	4.44	123.54	55.17	0.37	4.14	1.11
Sunset Creek	SE 30th	1005.78	1.01-year	100.55	51.45	53.68	52.94	2.23	0.013128	3.61	27.86	16.94	0.5	1.55	1.27
Sunset Creek	SE 30th	1005.78	2-year	151.35	51.45	54.23	53.34	2.78	0.011693	4.01	38.57	23.39	0.49	2	1.46
Sunset Creek	SE 30th	1005.78	10-year	236.6	51.45	55.05	53.87	3.61	0.008499	4.26	63.47	37.48	0.44	2.77	1.47
Sunset Creek	SE 30th	1005.78	25-year	297.45	51.45	55.53	54.22	4.09	0.007171	4.33	82.22	41.09	0.41	3.22	1.44
Sunset Creek	SE 30th	1005.78	100-year	413.2	51.45	56.32	54.83	4.87	0.005725	4.44	118.5	51.19	0.38	3.96	1.41
Sunset Creek	SE 30th	1003.78*	1.01-year	100.55	50.95	53.72	52.47	2.77	0.005234	2.88	34.94	17.24	0.36	1.86	0.61
Sunset Creek	SE 30th	1003.78*	2-year	151.35	50.95	54.27	52.88	3.32	0.005419	3.37	46.01	24.15	0.37	2.32	0.78
Sunset Creek	SE 30th	1003.78*	10-year	236.6	50.95	55.08	53.44	4.13	0.004758	3.81	71.05	37.65	0.37	3.06	0.91
Sunset Creek	SE 30th	1003.78*	25-year	297.45	50.95	55.55	53.79	4.6	0.004404	4	89.39	41.24	0.36	3.49	0.96
Sunset Creek	SE 30th	1003.78*	100-year	413.2	50.95	56.32	54.4	5.37	0.003905	4.26	125.01	51.02	0.35	4.2	1.02
Sunset Creek	SE 30th	954.652	1.01-year	100.55	50.99	53.27	52.48	2.28	0.012283	3.52	28.55	17.1	0.48	1.57	1.2
Sunset Creek	SE 30th	954.652	2-year	151.35	50.99	53.83	52.88	2.83	0.01107	3.92	39.26	22.64	0.47	2.01	1.39
Sunset Creek	SE 30th	954.652	10-year	236.6	50.99	54.7	53.42	3.71	0.007695	4.11	64.6	35.61	0.42	2.84	1.36
Sunset Creek	SE 30th	954.652	25-year	297.45	50.99	55.19	53.75	4.19	0.006588	4.2	82.6	38.39	0.4	3.29	1.35
Sunset Creek	SE 30th	954.652	100-year	413.2	50.99	55.97	54.35	4.98	0.005437	4.37	115.24	45	0.37	4.03	1.37
Sunset Creek	SE 30th	952.651*	1.01-year	100.55	50.49	53.3	52.01	2.81	0.004965	2.82	35.67	17.4	0.35	1.88	0.58
Sunset Creek	SE 30th	952.651*	2-year	151.35	50.49	53.86	52.42	3.37	0.005185	3.31	46.68	23.28	0.37	2.33	0.75
Sunset Creek	SE 30th	952.651*	10-year	236.6	50.49	54.72	52.99	4.23	0.004363	3.69	72.14	36.08	0.35	3.12	0.85
Sunset Creek	SE 30th	952.651*	25-year	297.45	50.49	55.2	53.33	4.7	0.004066	3.88	89.81	38.43	0.35	3.56	0.9
Sunset Creek	SE 30th	952.651*	100-year	413.2	50.49	55.97	53.92	5.48	0.003697	4.18	121.98	44.91	0.34	4.27	0.98
Sunset Creek	SE 30th	903.519	1.01-year	100.55	50.54	52.9	52.03	2.36	0.010777	3.35	29.98	17.43	0.45	1.62	1.09
Sunset Creek	SE 30th	903.519	2-year	151.35	50.54	53.46	52.43	2.92	0.009883	3.76	40.86	22.55	0.45	2.06	1.27
Sunset Creek	SE 30th	903.519	10-year	236.6	50.54	54.41	52.97	3.86	0.006509	3.88	67.84	34.82	0.39	2.95	1.2
Sunset Creek	SE 30th	903.519	25-year	297.45	50.54	54.89	53.29	4.34	0.005734	4	85.18	36.97	0.37	3.4	1.22
Sunset Creek	SE 30th	903.519	100-year	413.2	50.54	55.67	53.88	5.12	0.004911	4.22	115.44	41	0.35	4.14	1.27
Sunset Creek	SE 30th	901.518*	1.01-year	100.55	50.04	52.93	51.56	2.89	0.004484	2.71	37.11	17.71	0.33	1.92	0.54
Sunset Creek	SE 30th	901.518*	2-year	151.35	50.04	53.49	51.97	3.45	0.004729	3.19	48.25	23.07	0.35	2.38	0.7
Sunset Creek	SE 30th	901.518*	10-year	236.6	50.04	54.42	52.54	4.38	0.003772	3.5	75.29	35.18	0.33	3.23	0.76
Sunset Creek	SE 30th	901.518*	25-year	297.45	50.04	54.89	52.88	4.85	0.003585	3.71	92.38	36.99	0.33	3.67	0.82
Sunset Creek	SE 30th	901.518*	100-year	413.2	50.04	55.67	53.45	5.63	0.003352	4.03	122.3	40.95	0.33	4.37	0.92
Sunset Creek	SE 30th	852.3866	1.01-year	100.55	50.09	52.65	51.57	2.56	0.005699	2.99	33.66	18.26	0.39	1.73	0.62
Sunset Creek	SE 30th	852.3866	2-year	151.35	50.09	53.21	51.98	3.12	0.005331	3.42	45.32	23.81	0.39	2.23	0.74
Sunset Creek	SE 30th	852.3866	10-year	236.6	50.09	54.21	52.52	4.12	0.003613	3.56	74.69	35.1	0.34	3.17	0.71
Sunset Creek	SE 30th	852.3866	25-year	297.45	50.09	54.68	52.83	4.59	0.003391	3.75	91.19	36.03	0.34	3.6	0.76
Sunset Creek	SE 30th	852.3866	100-year	413.2	50.09	55.44	53.41	5.35	0.003153	4.08	119.38	38.43	0.34	4.31	0.85
Sunset Creek	SE 30th	834.4796	1.01-year	100.55	50.42	52.35	52.05	1.93	0.01469	4.18	24.06	20.51	0.68	1.14	1.04
Sunset Creek	SE 30th	834.4796	2-year	151.35	50.42	53.04	52.37	2.62	0.007446	3.91	39.73	25.09	0.51	1.75	0.81
Sunset Creek	SE 30th	834.4796	10-year	236.6	50.42	54.14	52.8	3.72	0.003764	3.62	71.26	32.4	0.38	2.65	0.62
Sunset Creek	SE 30th	834.4796	25-year	297.45	50.42	54.61	53.07	4.19	0.003505	3.79	86.83	33.42	0.37	3.02	0.66
Sunset Creek	SE 30th	834.4796	100-year	413.2	50.42	55.37	53.54	4.95	0.003281	4.09	112.53	33.91	0.36	3.6	0.74
Sunset Creek	SE 30th	816.2844	1.01-year	100.55	50.18	52.24	51.75	2.06	0.008119	3.12	32.26	26.81	0.5	1.17	0.59
Sunset Creek	SE 30th	816.2844	2-year	151.35	50.18	53.02	52.01	2.84	0.004056	2.78	54.43	30.02	0.36	1.73	0.44
Sunset Creek	SE 30th	816.2844	10-year	236.6	50.18	54.15	52.38	3.97	0.002	2.58	96.79	43.1	0.27	2.69	0.34
Sunset Creek	SE 30th	816.2844	25-year	297.45	50.18	54.63	52.61	4.45	0.001856	2.72	117.38	43.46	0.26	3.08	0.36
Sunset Creek	SE 30th	816.2844	100-year	413.2	50.18	55.4	53	5.22	0.001737	2.95	151.26	44.04	0.26	3.71	0.4
Sunset Creek	SE 30th	795.8286	1.01-year	100.55	50.27	52.19	51.34	1.92	0.00315	2.32	44.91	31.92	0.32	1.49	0.29
Sunset Creek	SE 30th	795.8286	2-year	151.35	50.27	53	51.59	2.73	0.001784	2.23	72.03	35.08	0.26	2.18	0.24
Sunset Creek	SE 30th	795.8286	10-year	236.6	50.27	54.14	51.96	3.87	0.001152	2.25	114.08	37.65	0.21	3.11	0.22
Sunset Creek	SE 30th	795.8286	25-year	297.45	50.27	54.62	52.18	4.35	0.001187	2.44	131.93	37.82	0.22	3.47	0.26
Sunset Creek	SE 30th	795.8286	100-year	413.2	50.27	55.38	52.55	5.11	0.001271	2.78	161.13	38.09	0.23	4.05	0.32
Sunset Creek	SE 30th	772.6812	1.01-year	100.55	49.8	52.11	51.34	2.31	0.00363	2.31	43.79	31.6	0.34	1.35	0.31
Sunset Creek	SE 30th	772.6812	2-year	151.35	49.8	52.96	51.57	3.16	0.001804	2.16	72.62	36.28	0.25	2.08	0.23
Sunset Creek	SE 30th	772.6812	10-year	236.6	49.8	54.12	51.89	4.32	0.001109	2.15	115.02	45.55	0.21	3.03	0.21
Sunset Creek	SE 30th	772.6812	25-year	297.45	49.8	54.59	52.11	4.79	0.001113	2.35	132.48	46.93	0.21	3.44	0.24
Sunset Creek	SE 30th	772.6812	100-year	413.2	49.8	55.36	52.47	5.56	0.001142	2.68	160.86	49.35	0.22	4.13	0.29

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	742.021	1.01-year	100.55	49.76	52.02	51.21	2.26	0.003164	2.1	47.78	33.86	0.31	1.33	0.26
Sunset Creek	SE 30th	742.021	2-year	151.35	49.76	52.92	51.43	3.16	0.001523	1.91	79.33	41.34	0.23	2.05	0.19
Sunset Creek	SE 30th	742.021	10-year	236.6	49.76	54.1	51.73	4.34	0.000905	1.94	122.07	51.49	0.19	3.11	0.18
Sunset Creek	SE 30th	742.021	25-year	297.45	49.76	54.57	51.93	4.81	0.000921	2.14	139.3	53.01	0.19	3.55	0.2
Sunset Creek	SE 30th	742.021	100-year	413.2	49.76	55.34	52.27	5.58	0.000966	2.47	167.27	53.01	0.2	4.27	0.26
Sunset Creek	SE 30th	704.0906		Bridge											
Sunset Creek	SE 30th	637.1669	1.01-year	100.55	49	51.91	50.27	2.91	0.000848	1.45	70.2	47.21	0.17	2.09	0.11
Sunset Creek	SE 30th	637.1669	2-year	151.35	49	52.51	50.53	3.51	0.000908	1.72	88.85	47.46	0.18	2.59	0.15
Sunset Creek	SE 30th	637.1669	10-year	236.6	49	53.12	50.86	4.12	0.001179	2.21	108.51	50.82	0.21	3.12	0.23
Sunset Creek	SE 30th	637.1669	25-year	297.45	49	53.46	51.05	4.46	0.001351	2.52	121.12	55.09	0.23	3.42	0.29
Sunset Creek	SE 30th	637.1669	100-year	413.2	49	54.01	51.41	5.01	0.001627	3.02	142.47	55.09	0.26	3.92	0.4
Sunset Creek	SE 30th	616.5581	1.01-year	100.55	48.88	51.91	49.89	3.03	0.000323	1.03	110.99	63.74	0.11	2.53	0.05
Sunset Creek	SE 30th	616.5581	2-year	151.35	48.88	52.51	50.12	3.63	0.00037	1.24	138.24	68.09	0.12	3.03	0.07
Sunset Creek	SE 30th	616.5581	10-year	236.6	48.88	53.13	50.44	4.25	0.000508	1.6	166.47	68.5	0.14	3.53	0.11
Sunset Creek	SE 30th	616.5581	25-year	297.45	48.88	53.48	50.61	4.6	0.000595	1.83	182.93	71.65	0.16	3.84	0.14
Sunset Creek	SE 30th	616.5581	100-year	413.2	48.88	54.04	50.91	5.16	0.000742	2.22	211.02	73.22	0.18	4.35	0.2
Sunset Creek	SE 30th	596.5916	1.01-year	100.55	48.52	51.89	49.66	3.37	0.000467	1.22	86.58	39.79	0.13	2.65	0.08
Sunset Creek	SE 30th	596.5916	2-year	151.35	48.52	52.49	49.91	3.97	0.000583	1.52	105.26	41.8	0.14	3.12	0.11
Sunset Creek	SE 30th	596.5916	10-year	236.6	48.52	53.09	50.27	4.57	0.000843	2.01	124.53	43.09	0.18	3.62	0.19
Sunset Creek	SE 30th	596.5916	25-year	297.45	48.52	53.42	50.49	4.9	0.001019	2.33	135.73	44.4	0.2	3.92	0.25
Sunset Creek	SE 30th	596.5916	100-year	413.2	48.52	53.95	50.89	5.43	0.001329	2.88	154.47	46.49	0.23	4.39	0.36
Sunset Creek	SE 30th	572.9708	1.01-year	100.55	47.8	51.79	50.11	3.99	0.007538	2.48	40.59	22.01	0.31	1.85	0.87
Sunset Creek	SE 30th	572.9708	2-year	151.35	47.8	52.36	50.59	4.56	0.007033	2.83	57.4	34.91	0.31	2.37	1.04
Sunset Creek	SE 30th	572.9708	10-year	236.6	47.8	52.92	51.28	5.12	0.007889	3.42	77.89	37.52	0.34	2.89	1.42
Sunset Creek	SE 30th	572.9708	25-year	297.45	47.8	53.24	51.64	5.44	0.008498	3.78	89.82	38.6	0.36	3.18	1.69
Sunset Creek	SE 30th	572.9708	100-year	413.2	47.8	53.73	52.3	5.93	0.009453	4.37	109.03	38.6	0.39	3.64	2.15
Sunset Creek	SE 30th	554.7107	1.01-year	100.55	47.62	51.53	49.85	3.91	0.008664	3.51	29.65	16.97	0.36	2.05	1.11
Sunset Creek	SE 30th	554.7107	2-year	151.35	47.62	52.02	50.4	4.4	0.010876	4.35	43.97	52.7	0.41	2.38	1.62
Sunset Creek	SE 30th	554.7107	10-year	236.6	47.62	52.65	51.17	5.03	0.009955	4.65	78.01	55.51	0.4	2.81	1.75
Sunset Creek	SE 30th	554.7107	25-year	297.45	47.62	53.01	52.36	5.39	0.009395	4.77	98.04	57.1	0.4	3.05	1.79
Sunset Creek	SE 30th	554.7107	100-year	413.2	47.62	53.57	52.75	5.95	0.008626	4.95	134.54	116.88	0.39	3.44	1.85
Sunset Creek	SE 30th	543.1325	1.01-year	100.55	47.65	51.52	49.72	3.87	0.003274	2.92	35.23	50.97	0.3	2.2	0.45
Sunset Creek	SE 30th	543.1325	2-year	151.35	47.65	52.04	50.19	4.39	0.003644	3.37	63.54	55.1	0.32	2.55	0.58
Sunset Creek	SE 30th	543.1325	10-year	236.6	47.65	52.64	50.87	4.99	0.003872	3.88	98.61	117.31	0.34	3	0.73
Sunset Creek	SE 30th	543.1325	25-year	297.45	47.65	52.98	51.29	5.33	0.003881	4.1	121.75	117.31	0.35	3.26	0.79
Sunset Creek	SE 30th	543.1325	100-year	413.2	47.65	53.53	52.3	5.88	0.003888	4.45	158.79	117.31	0.36	3.68	0.89
Sunset Creek	SE 30th	529.8341	1.01-year	100.55	47.8	51.47	49.72	3.67	0.003859	2.94	34.89	19.26	0.31	2.17	0.52
Sunset Creek	SE 30th	529.8341	2-year	151.35	47.8	51.99	50.2	4.19	0.004265	3.39	59.3	104.45	0.33	2.5	0.67
Sunset Creek	SE 30th	529.8341	10-year	236.6	47.8	52.59	50.88	4.79	0.004205	3.77	94.29	110.85	0.34	2.97	0.78
Sunset Creek	SE 30th	529.8341	25-year	297.45	47.8	52.94	51.3	5.14	0.004211	3.99	115.69	114.45	0.34	3.24	0.85
Sunset Creek	SE 30th	529.8341	100-year	413.2	47.8	53.48	52.33	5.68	0.004245	4.35	152.44	120.21	0.35	3.66	0.97
Sunset Creek	SE 30th	420.6496	1.01-year	100.55	47.11	51.29	48.76	4.18	0.001295	1.95	52.9	25.45	0.19	2.57	0.21
Sunset Creek	SE 30th	420.6496	2-year	151.35	47.11	51.75	49.16	4.64	0.001814	2.47	75.05	54.14	0.23	2.87	0.32
Sunset Creek	SE 30th	420.6496	10-year	236.6	47.11	52.3	49.73	5.19	0.002274	3.04	110.85	118.2	0.26	3.31	0.47
Sunset Creek	SE 30th	420.6496	25-year	297.45	47.11	52.62	50.1	5.51	0.002461	3.33	132.79	118.2	0.28	3.56	0.55
Sunset Creek	SE 30th	420.6496	100-year	413.2	47.11	53.14	50.75	6.03	0.002707	3.75	168.33	118.2	0.3	3.97	0.67
Sunset Creek	SE 30th	48.9477	1.01-year	100.55	47.18	50.65	49.5	3.47	0.002442	2.13	71.26	131.31	0.26	1.84	0.28
Sunset Creek	SE 30th	48.9477	2-year	151.35	47.18	50.99	49.88	3.81	0.002463	2.37	98.49	131.31	0.27	2.15	0.33
Sunset Creek	SE 30th	48.9477	10-year	236.6	47.18	51.5	50.55	4.32	0.002215	2.56	140.72	131.31	0.27	2.62	0.36
Sunset Creek	SE 30th	48.9477	25-year	297.45	47.18	51.8	50.7	4.62	0.002179	2.72	165.12	131.31	0.27	2.9	0.39
Sunset Creek	SE 30th	48.9477	100-year	413.2	47.18	52.3	50.92	5.12	0.00215	2.98	205.72	131.31	0.27	3.36	0.45
Richards Creek	Historical	1507.208	1.01-year	15.05	57.05	58.62	57.65	1.57	0.002703	0.91	16.56	17.45	0.16	0.89	0.15
Richards Creek	Historical	1507.208	2-year	22.65	57.05	58.81	57.8	1.76	0.003796	1.13	20.06	19	0.19	0.98	0.23
Richards Creek	Historical	1507.208	10-year	35.4	57.05	59.03	58	1.98	0.005265	1.45	24.62	23.46	0.23	1.14	0.37
Richards Creek	Historical	1507.208	25-year	44.55	57.05	59.13	58.13	2.08	0.006525	1.69	27.09	26.94	0.26	1.21	0.49
Richards Creek	Historical	1507.208	100-year	61.8	57.05	59.27	58.31	2.22	0.00875	2.09	31.13	30.61	0.31	1.34	0.73
Richards Creek	Historical	1481.097	1.01-year	15.05	57.41	58.45	58.08	1.04	0.012687	1.84	10.58	30.74	0.37	0.74	0.58
Richards Creek	Historical	1481.097	2-year	22.65	57.41	58.65	58.32	1.24	0.009489	1.77	20.33	70.02	0.32	0.88	0.52
Richards Creek	Historical	1481.097	10-year	35.4	57.41	58.91	58.51	1.5	0.005138	1.48	44.41	115.25	0.24	1.09	0.35
Richards Creek	Historical	1481.097	25-year	44.55	57.41	59	58.61	1.59	0.004818	1.51	56.33	131.14	0.24	1.18	0.36
Richards Creek	Historical	1481.097	100-year	61.8	57.41	59.14	58.72	1.73	0.004481	1.57	76.03	145.39	0.24	1.32	0.37
Richards Creek	Historical	1291.987	1.01-year	15.05	55.48	56.38	56.05	0.9	0.009455	1.94	7.75	12.07	0.43	0.63	0.37
Richards Creek	Historical	1291.987	2-year	22.65	55.48	56.5	56.19	1.02	0.012864	2.44	9.29	12.84	0.5	0.71	0.57
Richards Creek	Historical	1291.987	10-year	35.4	55.48	56.41	56.38	0.93	0.046374	4.38	8.09	12.25	0.95	0.65	1.87
Richards Creek	Historical	1291.987	25-year	44.55	55.48	56.5	56.5	1.02	0.050988	4.83	9.21	12.8	1	0.7	2.24
Richards Creek	Historical	1291.987	100-year	61.8	55.48	56.68	56.68	1.2	0.049454	5.28	11.71	13.74	1.01	0.83	2.56
Richards Creek	Historical	999.2128	1.01-year	15.05	51.78	52.33	52.21	0.55	0.021643	2.41	6.26	14.62	0.65	0.42	0.57
Richards Creek	Historical	999.2128	2-year	22.65	51.78	52.53	52.32	0.75	0.014271	2.42	9.35	15.49	0.55	0.59	0.53
Richards Creek	Historical	999.2128	10-year	35.4	51.78	53.02	52.47	1.24	0.005472	2.03	17.43	17.57	0.36	0.97	0.33
Richards Creek	Historical	999.2128	25-year	44.55	51.78	54.1	52.56	2.32	0.000868	1.14	38.96	21.98	0.15	1.7	0.09
Richards Creek	Historical	999.2128	100-year	61.8	51.78	56.66	52.72	4.88	0.000065	0.49	191.13	214.45	0.04	3.44	0.01

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Richards Creek	Historical	968.151	1.01-year	15.05	51.3	52.1	51.71	0.8	0.00443	1.44	10.46	15.61	0.31	0.66	0.18
Richards Creek	Historical	968.151	2-year	22.65	51.3	52.38	51.82	1.08	0.003527	1.53	14.82	16.66	0.29	0.87	0.19
Richards Creek	Historical	968.151	10-year	35.4	51.3	52.95	51.97	1.65	0.001863	1.41	25.07	18.89	0.22	1.28	0.15
Richards Creek	Historical	968.151	25-year	44.55	51.3	54.09	52.06	2.79	0.000439	0.91	49.03	22.93	0.11	2.02	0.06
Richards Creek	Historical	968.151	100-year	61.8	51.3	56.66	52.22	5.36	0.000067	0.53	116.81	217.23	0.05	3.8	0.02
Richards Creek	Historical	913.9713		Culvert											
Richards Creek	Historical	875.7664	1.01-year	15.05	49.6	50.72	49.88	1.12	0.000498	0.6	24.93	27.65	0.11	0.88	0.03
Richards Creek	Historical	875.7664	2-year	22.65	49.6	51.06	49.97	1.46	0.000432	0.65	34.86	30.91	0.11	1.1	0.03
Richards Creek	Historical	875.7664	10-year	35.4	49.6	51.58	50.09	1.98	0.00035	0.68	52.33	35.78	0.1	1.42	0.03
Richards Creek	Historical	875.7664	25-year	44.55	49.6	51.89	50.17	2.29	0.000327	0.7	63.72	38.62	0.1	1.6	0.03
Richards Creek	Historical	875.7664	100-year	61.8	49.6	52.4	50.29	2.8	0.000295	0.73	84.69	122.23	0.09	1.89	0.03
Richards Creek	Historical	843.4692	1.01-year	15.05	49.48	50.71	49.76	1.23	0.000354	0.53	28.16	29.03	0.1	0.95	0.02
Richards Creek	Historical	843.4692	2-year	22.65	49.48	51.05	49.85	1.57	0.000327	0.59	38.63	32.37	0.09	1.17	0.02
Richards Creek	Historical	843.4692	10-year	35.4	49.48	51.57	49.97	2.09	0.000279	0.62	56.91	37.17	0.09	1.49	0.03
Richards Creek	Historical	843.4692	25-year	44.55	49.48	51.88	50.05	2.4	0.000266	0.65	68.74	45.44	0.09	1.67	0.03
Richards Creek	Historical	843.4692	100-year	61.8	49.48	52.39	50.17	2.91	0.000246	0.68	90.4	144.04	0.08	1.96	0.03
Richards Creek	Historical	240.4131	1.01-year	15.05	45.9	50.71	46.6	4.81	0.000001	0.1	402.64	212.34	0.01	3.72	0
Richards Creek	Historical	240.4131	2-year	22.65	45.9	51.05	46.73	5.15	0.000001	0.13	477.23	225.63	0.01	4.02	0
Richards Creek	Historical	240.4131	10-year	35.4	45.9	51.57	46.92	5.67	0.000002	0.17	600.44	238.56	0.01	4.49	0
Richards Creek	Historical	240.4131	25-year	44.55	45.9	51.88	47.05	5.98	0.000002	0.19	673.57	238.56	0.01	4.76	0
Richards Creek	Historical	240.4131	100-year	61.8	45.9	52.39	47.25	6.49	0.000002	0.22	795.71	238.56	0.02	5.21	0
Richards Creek	Lower	85.48712	1.01-year	120.25	47.08	50.66	49.54	3.58	0.001315	2.1	131.45	256.31	0.25	1.94	0.16
Richards Creek	Lower	85.48712	2-year	181	47.08	50.99	50.28	3.91	0.001312	2.31	184.25	256.31	0.26	2.25	0.18
Richards Creek	Lower	85.48712	10-year	297	47.08	51.51	50.56	4.43	0.00131	2.62	265.35	256.31	0.27	2.72	0.22
Richards Creek	Lower	85.48712	25-year	376	47.08	51.82	50.7	4.74	0.001309	2.8	312.53	256.31	0.27	3	0.25
Richards Creek	Lower	85.48712	100-year	525	47.08	52.32	50.93	5.24	0.001308	3.07	391.18	256.31	0.28	3.46	0.28
Richards Creek	Lower	26.62222	1.01-year	120.25	47	50.58	49.45	3.58	0.0013	2.09	132.08	256.31	0.25	1.94	0.16
Richards Creek	Lower	26.62222	2-year	181	47	50.92	50.2	3.92	0.001301	2.3	184.88	256.31	0.26	2.25	0.18
Richards Creek	Lower	26.62222	10-year	297	47	51.44	50.48	4.44	0.0013	2.62	266.03	256.31	0.27	2.73	0.22
Richards Creek	Lower	26.62222	25-year	376	47	51.74	50.62	4.74	0.001301	2.79	313.23	256.31	0.27	3	0.24
Richards Creek	Lower	26.62222	100-year	525	47	52.24	50.85	5.24	0.001301	3.07	391.89	256.31	0.28	3.46	0.28

PHASE III ALTERNATIVE 4
NO BEAVERS OUTPUT TABLE

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	3272.859	1.01-year	52.48	82.49	85.22	83.99	2.73	0.006909	2.99	17.54	7.87	0.35	1.53	0.66
Sunset Creek	SE 30th	3272.859	2-year	79	82.49	85.87	84.38	3.38	0.007726	3.46	22.83	8.32	0.37	1.77	0.86
Sunset Creek	SE 30th	3272.859	10-year	126	82.49	86.72	84.96	4.23	0.009492	4.19	30.1	8.9	0.4	2.06	1.22
Sunset Creek	SE 30th	3272.859	25-year	157	82.49	87.13	85.3	4.64	0.010441	4.63	34.08	10.3	0.42	2.24	1.46
Sunset Creek	SE 30th	3272.859	100-year	212	82.49	87.79	85.83	5.3	0.011482	5.24	41.64	12.71	0.45	2.52	1.81
Sunset Creek	SE 30th	3251.92	1.01-year	52.48	82.52	84.68	84.21	2.16	0.024525	5.08	10.33	5.78	0.67	1.2	1.84
Sunset Creek	SE 30th	3251.92	2-year	79	82.52	85.22	84.69	2.7	0.027799	5.84	13.53	6.22	0.7	1.39	2.41
Sunset Creek	SE 30th	3251.92	10-year	126	82.52	86	85.54	3.48	0.031764	6.33	19.9	8.8	0.74	1.5	2.97
Sunset Creek	SE 30th	3251.92	25-year	157	82.52	86.34	85.88	3.82	0.033201	6.84	22.96	9.05	0.76	1.64	3.39
Sunset Creek	SE 30th	3251.92	100-year	212	82.52	86.88	86.38	4.36	0.035496	7.59	27.92	9.43	0.78	1.84	4.08
Sunset Creek	SE 30th	3230.282	1.01-year	52.48	81.37	84.02	83.73	2.65	0.030615	5.49	9.55	6.31	0.79	1.09	2.08
Sunset Creek	SE 30th	3230.282	2-year	79	81.37	84.46	84.23	3.09	0.033662	6.29	12.56	7.21	0.84	1.24	2.61
Sunset Creek	SE 30th	3230.282	10-year	126	81.37	85.18	84.92	3.81	0.034461	6.77	18.62	9.27	0.84	1.45	3.12
Sunset Creek	SE 30th	3230.282	25-year	157	81.37	85.54	85.24	4.17	0.03394	7.15	21.97	9.59	0.83	1.61	3.42
Sunset Creek	SE 30th	3230.282	100-year	212	81.37	86.11	85.72	4.74	0.033218	7.67	27.63	10.1	0.82	1.86	3.85
Sunset Creek	SE 30th	3207.655	1.01-year	52.48	81.58	83.02	83.02	1.44	0.045494	6.27	8.36	6.93	1.01	0.98	2.8
Sunset Creek	SE 30th	3207.655	2-year	79	81.58	83.43	83.43	1.85	0.044215	7.02	11.25	7.41	1.01	1.19	3.29
Sunset Creek	SE 30th	3207.655	10-year	126	81.58	84.06	84.06	2.48	0.044338	7.75	16.25	8.79	1	1.42	3.92
Sunset Creek	SE 30th	3207.655	25-year	157	81.58	84.37	84.37	2.79	0.044896	8.25	19.02	9.07	1	1.57	4.39
Sunset Creek	SE 30th	3207.655	100-year	212	81.58	84.86	84.86	3.28	0.045967	8.98	23.6	9.51	1	1.78	5.12
Sunset Creek	SE 30th	3193.525	1.01-year	52.48	81.39	82.96	82.47	1.57	0.012631	3.2	16.4	13.89	0.52	0.99	0.78
Sunset Creek	SE 30th	3193.525	2-year	79	81.39	83.44	82.75	2.05	0.010801	3.36	23.53	15.91	0.49	1.2	0.81
Sunset Creek	SE 30th	3193.525	10-year	126	81.39	84.14	83.16	2.75	0.008933	3.52	35.78	18.79	0.45	1.5	0.84
Sunset Creek	SE 30th	3193.525	25-year	157	81.39	84.54	83.39	3.15	0.00785	3.62	43.42	19.42	0.43	1.74	0.85
Sunset Creek	SE 30th	3193.525	100-year	212	81.39	85.16	83.75	3.77	0.00686	3.82	55.51	19.91	0.4	2.11	0.9
Sunset Creek	SE 30th	3181.277	1.01-year	52.48	80.83	82.23	82.23	1.4	0.049653	6.06	8.66	7.7	1.01	0.97	3.01
Sunset Creek	SE 30th	3181.277	2-year	79	80.83	82.63	82.61	1.8	0.047241	6.68	11.83	8.35	0.99	1.19	3.51
Sunset Creek	SE 30th	3181.277	10-year	126	80.83	83.26	83.16	2.43	0.04141	7.2	17.49	9.4	0.93	1.5	3.89
Sunset Creek	SE 30th	3181.277	25-year	157	80.83	83.58	83.46	2.75	0.039203	7.67	20.55	10.44	0.92	1.73	4.22
Sunset Creek	SE 30th	3181.277	100-year	212	80.83	84.06	83.99	3.23	0.035379	8.35	26.15	12.35	0.91	2.12	4.68
Sunset Creek	SE 30th	3171.478	1.01-year	52.48	79.8	82.09	81.5	2.29	0.017938	4.34	12.08	6.96	0.58	1.29	1.44
Sunset Creek	SE 30th	3171.478	2-year	79	79.8	82.53	81.92	2.73	0.020229	5.19	15.34	7.97	0.63	1.55	1.96
Sunset Creek	SE 30th	3171.478	10-year	126	79.8	83.09	82.55	3.29	0.022901	6.46	20.2	9.36	0.7	1.96	2.8
Sunset Creek	SE 30th	3171.478	25-year	157	79.8	83.37	82.91	3.57	0.024983	7.2	22.91	10.06	0.74	2.16	3.37
Sunset Creek	SE 30th	3171.478	100-year	212	79.8	83.77	83.5	3.97	0.0285	8.38	27.21	11.07	0.81	2.46	4.38
Sunset Creek	SE 30th	3160.526	1.01-year	52.48	79.96	81.89	81.42	1.93	0.018375	4.34	12.09	7.93	0.62	1.24	1.42
Sunset Creek	SE 30th	3160.526	2-year	79	79.96	82.32	81.81	2.36	0.020239	5.05	15.65	8.81	0.66	1.47	1.86
Sunset Creek	SE 30th	3160.526	10-year	126	79.96	82.89	82.38	2.93	0.022223	6.07	21.16	10.52	0.7	1.82	2.53
Sunset Creek	SE 30th	3160.526	25-year	157	79.96	83.18	82.72	3.22	0.022836	6.66	24.36	11.4	0.73	2.05	2.92
Sunset Creek	SE 30th	3160.526	100-year	212	79.96	83.62	83.23	3.66	0.023797	7.55	29.71	12.74	0.76	2.4	3.56
Sunset Creek	SE 30th	3145.921	1.01-year	52.48	78.83	81.92	80.46	3.09	0.003732	2.52	21.19	10.58	0.29	1.92	0.45
Sunset Creek	SE 30th	3145.921	2-year	79	78.83	82.37	80.86	3.54	0.004594	3.15	26.22	11.91	0.33	2.29	0.66
Sunset Creek	SE 30th	3145.921	10-year	126	78.83	82.97	81.42	4.14	0.005759	4.01	33.92	13.69	0.38	2.78	1
Sunset Creek	SE 30th	3145.921	25-year	157	78.83	83.29	81.74	4.46	0.006411	4.49	38.41	14.63	0.41	3.04	1.22
Sunset Creek	SE 30th	3145.921	100-year	212	78.83	83.77	82.27	4.94	0.007307	5.21	45.89	16.07	0.45	3.44	1.57
Sunset Creek	SE 30th	3119.845	1.01-year	52.48	79.67	81.65	81.05	1.98	0.011764	3.56	14.77	10.26	0.51	1.32	0.97
Sunset Creek	SE 30th	3119.845	2-year	79	79.67	82.05	81.4	2.38	0.011998	4.21	19.08	11.5	0.54	1.67	1.25
Sunset Creek	SE 30th	3119.845	10-year	126	79.67	82.57	81.89	2.9	0.013116	5.17	25.47	13.13	0.59	2.13	1.74
Sunset Creek	SE 30th	3119.845	25-year	157	79.67	82.82	82.17	3.15	0.014262	5.77	28.89	13.92	0.62	2.35	2.1
Sunset Creek	SE 30th	3119.845	100-year	212	79.67	83.2	82.63	3.53	0.016027	6.69	34.41	15.12	0.68	2.69	2.69
Sunset Creek	SE 30th	3103.342	1.01-year	52.48	79.66	81.46	80.89	1.8	0.011936	3.47	15.11	10.95	0.52	1.24	0.92
Sunset Creek	SE 30th	3103.342	2-year	79	79.66	81.86	81.22	2.2	0.01343	4.03	19.62	12.1	0.56	1.44	1.21
Sunset Creek	SE 30th	3103.342	10-year	126	79.66	82.36	81.7	2.7	0.01577	4.81	26.17	13.61	0.61	1.7	1.67
Sunset Creek	SE 30th	3103.342	25-year	157	79.66	82.61	81.98	2.95	0.016334	5.31	29.67	14.35	0.63	1.92	1.95
Sunset Creek	SE 30th	3103.342	100-year	212	79.66	82.99	82.39	3.33	0.017504	6.1	35.2	15.45	0.67	2.24	2.45
Sunset Creek	SE 30th	3082.734	1.01-year	52.48	79.61	81.15	80.76	1.54	0.015717	3.74	14.02	11.68	0.6	1.11	1.09
Sunset Creek	SE 30th	3082.734	2-year	79	79.61	81.52	81.06	1.91	0.015628	4.26	18.63	13.16	0.61	1.37	1.33
Sunset Creek	SE 30th	3082.734	10-year	126	79.61	82	81.5	2.39	0.015851	5.1	25.43	15.76	0.64	1.78	1.76
Sunset Creek	SE 30th	3082.734	25-year	157	79.61	82.23	81.76	2.62	0.01654	5.61	29.26	17.06	0.67	1.99	2.06
Sunset Creek	SE 30th	3082.734	100-year	212	79.61	82.61	82.16	3	0.016909	6.32	36.13	19.16	0.7	2.34	2.47
Sunset Creek	SE 30th	3066.484	1.01-year	52.48	79.15	80.44	80.44	1.29	0.045593	5.66	9.27	9.44	1.01	0.91	2.59
Sunset Creek	SE 30th	3066.484	2-year	79	79.15	80.77	80.77	1.62	0.041061	6.3	12.68	11.37	0.98	1.17	2.99
Sunset Creek	SE 30th	3066.484	10-year	126	79.15	81.27	81.27	2.12	0.032155	6.97	19.39	15.18	0.92	1.63	3.27
Sunset Creek	SE 30th	3066.484	25-year	157	79.15	81.55	81.55	2.4	0.028891	7.28	23.84	16.54	0.89	1.88	3.4
Sunset Creek	SE 30th	3066.484	100-year	212	79.15	81.92	81.92	2.77	0.027733	7.96	30.23	17.83	0.9	2.23	3.85
Sunset Creek	SE 30th	3034.622	1.01-year	52.48	77.36	78.8	78.83	1.44	0.053489	6	8.75	8.57	1.05	0.94	3.13
Sunset Creek	SE 30th	3034.622	2-year	79	77.36	79.11	79.19	1.75	0.057465	6.84	11.54	9.56	1.1	1.1	3.94
Sunset Creek	SE 30th	3034.622	10-year	126	77.36	79.48	79.7	2.12	0.068201	8.2	15.36	10.77	1.21	1.29	5.48
Sunset Creek	SE 30th	3034.622	25-year	157	77.36	79.7	79.98	2.34	0.071417	8.82	17.81	11.47	1.25	1.39	6.22
Sunset Creek	SE 30th	3034.622	100-year	212	77.36	80.11	80.4	2.75	0.068713	9.35	22.66	12.75	1.24	1.59	6.81

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	3020.31	1.01-year	52.48	76.74	78.69	78.18	1.95	0.011941	3.74	14.04	11.02	0.58	1.14	0.85
Sunset Creek	SE 30th	3020.31	2-year	79	76.74	79.07	78.53	2.33	0.012354	4.22	18.74	13.76	0.63	1.24	0.96
Sunset Creek	SE 30th	3020.31	10-year	126	76.74	79.57	79.08	2.83	0.012503	4.77	26.69	17.98	0.67	1.45	1.13
Sunset Creek	SE 30th	3020.31	25-year	157	76.74	79.84	79.34	3.1	0.012582	5.03	31.75	19.91	0.68	1.59	1.25
Sunset Creek	SE 30th	3020.31	100-year	212	76.74	80.22	79.74	3.48	0.012788	5.51	39.63	21.2	0.67	1.94	1.55
Sunset Creek	SE 30th	2982.026	1.01-year	52.48	76.27	77.64	77.64	1.37	0.041864	5.49	9.57	10.28	1	0.86	2.24
Sunset Creek	SE 30th	2982.026	2-year	79	76.27	77.97	77.97	1.7	0.041566	5.98	13.22	12.11	1.01	1	2.6
Sunset Creek	SE 30th	2982.026	10-year	126	76.27	78.42	78.42	2.15	0.042101	6.55	19.23	14.7	1.01	1.2	3.15
Sunset Creek	SE 30th	2982.026	25-year	157	76.27	78.66	78.66	2.39	0.042096	6.84	22.94	16.1	1.01	1.3	3.42
Sunset Creek	SE 30th	2982.026	100-year	212	76.27	79.03	79.03	2.76	0.041059	7.23	29.3	18.1	1	1.48	3.78
Sunset Creek	SE 30th	2969.117	1.01-year	52.48	75.88	76.97	77.07	1.09	0.065542	5.54	9.48	14.93	1.22	0.62	2.54
Sunset Creek	SE 30th	2969.117	2-year	79	75.88	77.13	77.29	1.25	0.07752	6.56	12.04	16.63	1.36	0.71	3.42
Sunset Creek	SE 30th	2969.117	10-year	126	75.88	77.99	77.62	2.11	0.016637	4.66	27.04	18.12	0.67	1.39	1.44
Sunset Creek	SE 30th	2969.117	25-year	157	75.88	78.3	77.81	2.42	0.014764	4.81	32.64	18.59	0.64	1.61	1.49
Sunset Creek	SE 30th	2969.117	100-year	212	75.88	78.72	78.12	2.84	0.014239	5.23	40.57	19.24	0.63	1.9	1.69
Sunset Creek	SE 30th	2939.869	1.01-year	52.48	73.61	76.82	75.69	3.21	0.0053	2.32	22.64	14.71	0.33	1.38	0.46
Sunset Creek	SE 30th	2939.869	2-year	79	73.61	77.25	76.05	3.64	0.006353	2.69	29.37	16.87	0.36	1.56	0.62
Sunset Creek	SE 30th	2939.869	10-year	126	73.61	77.81	76.54	4.2	0.007148	3.22	39.19	18.18	0.39	1.91	0.85
Sunset Creek	SE 30th	2939.869	25-year	157	73.61	78.11	76.8	4.5	0.007632	3.51	44.79	18.85	0.4	2.09	1
Sunset Creek	SE 30th	2939.869	100-year	212	73.61	78.51	77.2	4.9	0.008977	4.04	52.43	19.74	0.44	2.32	1.3
Sunset Creek	SE 30th	2904.859	1.01-year	52.48	74.07	76.39	75.43	2.32	0.035368	2.86	18.34	15.88	0.47	1.03	2.28
Sunset Creek	SE 30th	2904.859	2-year	79	74.07	76.76	75.8	2.69	0.035055	3.22	24.51	17.55	0.48	1.25	2.74
Sunset Creek	SE 30th	2904.859	10-year	126	74.07	77.28	76.48	3.21	0.034618	3.67	34.34	19.94	0.49	1.54	3.34
Sunset Creek	SE 30th	2904.859	25-year	157	74.07	77.58	76.7	3.51	0.033762	3.86	41.26	28.12	0.49	1.7	3.59
Sunset Creek	SE 30th	2904.859	100-year	212	74.07	77.99	77.03	3.92	0.029905	4.01	54.84	34.28	0.48	1.98	3.69
Sunset Creek	SE 30th	2887.542	1.01-year	52.48	73.52	76	75.02	2.48	0.016879	2.48	21.15	16.68	0.39	1.13	1.19
Sunset Creek	SE 30th	2887.542	2-year	79	73.52	76.35	75.58	2.83	0.018402	2.91	27.15	17.78	0.41	1.36	1.56
Sunset Creek	SE 30th	2887.542	10-year	126	73.52	76.85	75.94	3.33	0.020043	3.46	36.45	19.36	0.44	1.66	2.08
Sunset Creek	SE 30th	2887.542	25-year	157	73.52	77.14	76.13	3.62	0.020645	3.73	42.11	20.26	0.46	1.83	2.36
Sunset Creek	SE 30th	2887.542	100-year	212	73.52	77.55	76.47	4.03	0.020458	4.12	54.02	31.33	0.46	2.14	2.74
Sunset Creek	SE 30th	2869.669	1.01-year	52.48	73.86	74.99	74.99	1.13	0.1141	5.38	9.76	11.01	1.01	0.84	6
Sunset Creek	SE 30th	2869.669	2-year	79	73.86	75.45	75.31	1.59	0.077457	5.1	15.48	13.75	0.85	1.07	5.16
Sunset Creek	SE 30th	2869.669	10-year	126	73.86	76.06	75.72	2.2	0.052374	5.13	24.65	16.55	0.73	1.46	4.78
Sunset Creek	SE 30th	2869.669	25-year	157	73.86	76.37	75.95	2.51	0.045904	5.28	30.08	18.64	0.7	1.69	4.84
Sunset Creek	SE 30th	2869.669	100-year	212	73.86	76.83	76.3	2.97	0.037413	5.55	40.53	26.66	0.65	2.13	4.96
Sunset Creek	SE 30th	2850.365	1.01-year	52.48	72.12	74.78	73.51	2.66	0.008734	2.49	21.71	12.12	0.3	1.82	0.99
Sunset Creek	SE 30th	2850.365	2-year	79	72.12	75.2	73.85	3.08	0.01057	3.08	27.12	14.28	0.34	2.16	1.43
Sunset Creek	SE 30th	2850.365	10-year	126	72.12	75.73	74.37	3.61	0.013553	3.95	34.65	18.53	0.39	2.6	2.2
Sunset Creek	SE 30th	2850.365	25-year	157	72.12	76	74.67	3.88	0.015301	4.43	38.77	20.55	0.42	2.83	2.7
Sunset Creek	SE 30th	2850.365	100-year	212	72.12	76.4	75.15	4.28	0.018224	5.21	45	23.52	0.47	3.16	3.6
Sunset Creek	SE 30th	2823.726	1.01-year	52.48	72.56	74.28	73.76	1.72	0.030371	3.5	15.06	12.76	0.54	1.22	2.31
Sunset Creek	SE 30th	2823.726	2-year	79	72.56	74.63	74.08	2.07	0.03169	4.05	20.53	17.35	0.56	1.48	2.92
Sunset Creek	SE 30th	2823.726	10-year	126	72.56	75.07	74.62	2.51	0.032689	4.79	28.7	19.84	0.59	1.86	3.79
Sunset Creek	SE 30th	2823.726	25-year	157	72.56	75.31	74.85	2.75	0.03308	5.19	33.61	21.42	0.61	2.08	4.29
Sunset Creek	SE 30th	2823.726	100-year	212	72.56	75.67	75.2	3.11	0.033877	5.79	41.7	23.79	0.63	2.4	5.08
Sunset Creek	SE 30th	2794.948	1.01-year	52.48	71.19	73.47	72.93	2.28	0.026753	3.41	16.36	16.09	0.51	1.29	2.16
Sunset Creek	SE 30th	2794.948	2-year	79	71.19	73.91	73.29	2.72	0.022637	3.63	24.42	20.59	0.48	1.62	2.28
Sunset Creek	SE 30th	2794.948	10-year	126	71.19	74.34	73.8	3.15	0.023419	4.28	34.12	23.97	0.51	2.01	2.94
Sunset Creek	SE 30th	2794.948	25-year	157	71.19	74.52	74.01	3.33	0.026317	4.78	38.53	25.36	0.54	2.17	3.57
Sunset Creek	SE 30th	2794.948	100-year	212	71.19	74.86	74.32	3.67	0.027583	5.34	47.48	27.94	0.57	2.48	4.27
Sunset Creek	SE 30th	2760.247	1.01-year	52.48	70.04	71.78	71.78	1.74	0.048883	6.25	8.4	7.05	1.01	1.02	3.1
Sunset Creek	SE 30th	2760.247	2-year	79	70.04	72.19	72.19	2.15	0.048803	6.92	11.41	7.83	1.01	1.22	3.71
Sunset Creek	SE 30th	2760.247	10-year	126	70.04	72.94	72.94	2.9	0.031018	6.76	20.98	19.47	0.83	1.68	3.25
Sunset Creek	SE 30th	2760.247	25-year	157	70.04	73.26	73.26	3.22	0.025632	6.75	27.92	23.44	0.77	1.93	3.1
Sunset Creek	SE 30th	2760.247	100-year	212	70.04	73.59	73.59	3.55	0.025171	7.29	35.9	25.15	0.78	2.2	3.46
Sunset Creek	SE 30th	2717.8	1.01-year	52.48	68.16	69.95	69.54	1.79	0.048405	4.18	12.55	11.02	0.69	0.99	2.99
Sunset Creek	SE 30th	2717.8	2-year	79	68.16	70.31	69.97	2.15	0.046019	4.76	16.61	11.62	0.7	1.22	3.5
Sunset Creek	SE 30th	2717.8	10-year	126	68.16	70.79	70.42	2.63	0.046934	5.62	22.4	12.43	0.74	1.5	4.4
Sunset Creek	SE 30th	2717.8	25-year	157	68.16	71.06	70.68	2.9	0.047497	6.08	25.81	12.89	0.76	1.65	4.9
Sunset Creek	SE 30th	2717.8	100-year	212	68.16	71.5	71.09	3.34	0.047432	6.72	31.57	13.62	0.78	1.88	5.58
Sunset Creek	SE 30th	2702.718	1.01-year	52.48	67.5	69.37	68.88	1.87	0.034923	3.89	13.5	11.29	0.63	1.04	2.27
Sunset Creek	SE 30th	2702.718	2-year	79	67.5	69.59	69.32	2.09	0.045781	4.9	16.13	11.7	0.74	1.19	3.39
Sunset Creek	SE 30th	2702.718	10-year	126	67.5	70.08	69.75	2.58	0.045004	5.71	22.06	12.56	0.76	1.48	4.16
Sunset Creek	SE 30th	2702.718	25-year	157	67.5	70.37	70.01	2.87	0.044172	6.11	25.7	13.06	0.77	1.64	4.53
Sunset Creek	SE 30th	2702.718	100-year	212	67.5	70.85	70.41	3.35	0.04122	6.58	32.2	13.91	0.76	1.9	4.89
Sunset Creek	SE 30th	2676.488	1.01-year	52.48	66.34	67.98	67.73	1.64	0.06808	4.84	10.85	10.69	0.85	0.89	3.76
Sunset Creek	SE 30th	2676.488	2-year	79	66.34	68.56	68.16	2.22	0.036744	4.58	17.26	11.64	0.66	1.26	2.88
Sunset Creek	SE 30th	2676.488	10-year	126	66.34	69.11	68.62	2.77	0.034664	5.26	23.96	12.56	0.67	1.58	3.42
Sunset Creek	SE 30th	2676.488	25-year	157	66.34	69.49	68.86	3.15	0.030777	5.43	28.9	13.19	0.65	1.79	3.43
Sunset Creek	SE 30th	2676.488	100-year	212	66.34	70.14	69.27	3.8	0.025381	5.6	37.83	14.27	0.61	2.12	3.36

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	2651.525	1.01-year	52.48	65.23	67.11	66.59	1.88	0.02436	4.01	13.07	8.91	0.58	1.25	1.91
Sunset Creek	SE 30th	2651.525	2-year	79	65.23	67.77	66.97	2.54	0.030738	4.04	19.54	13.29	0.59	1.27	2.45
Sunset Creek	SE 30th	2651.525	10-year	126	65.23	68.64	67.51	3.41	0.01769	3.95	31.88	15.1	0.48	1.79	1.97
Sunset Creek	SE 30th	2651.525	25-year	157	65.23	69.14	67.93	3.91	0.014316	3.96	39.67	16.14	0.44	2.06	1.84
Sunset Creek	SE 30th	2651.525	100-year	212	65.23	69.9	68.32	4.67	0.011391	4.03	52.57	17.72	0.41	2.45	1.74
Sunset Creek	SE 30th	2643.063	1.01-year	52.48	64.86	66.99	66.26	2.13	0.012101	3.81	13.79	7.97	0.51	1.35	1.02
Sunset Creek	SE 30th	2643.063	2-year	79	64.86	67.61	66.66	2.75	0.013404	4	19.76	11.77	0.54	1.35	1.13
Sunset Creek	SE 30th	2643.063	10-year	126	64.86	68.51	67.43	3.65	0.009535	4.08	30.88	12.8	0.46	1.84	1.1
Sunset Creek	SE 30th	2643.063	25-year	157	64.86	69.01	67.69	4.15	0.00869	4.2	37.38	13.36	0.44	2.09	1.13
Sunset Creek	SE 30th	2643.063	100-year	212	64.86	69.76	68.12	4.9	0.008109	4.44	47.7	14.21	0.43	2.43	1.23
Sunset Creek	SE 30th	2640.568	1.01-year	52.48	64.75	67.07	65.54	2.32	0.000602	1.74	30.18	13	0.2	1.71	0.06
Sunset Creek	SE 30th	2640.568	2-year	79	64.75	67.7	65.79	2.95	0.000676	2.06	38.3	13	0.21	2.03	0.09
Sunset Creek	SE 30th	2640.568	10-year	126	64.75	68.59	66.17	3.84	0.000802	2.52	49.91	13	0.23	2.41	0.12
Sunset Creek	SE 30th	2640.568	25-year	157	64.75	69.08	66.4	4.33	0.000886	2.79	56.33	13	0.24	2.6	0.14
Sunset Creek	SE 30th	2640.568	100-year	212	64.75	69.83	66.76	5.08	0.000977	3.21	66.01	13.99	0.25	2.99	0.18
Sunset Creek	SE 30th	2625.968		Bridge											
Sunset Creek	SE 30th	2611.37	1.01-year	52.48	63.5	67.09	64.29	3.59	0.000168	1.12	46.68	13	0.1	2.31	0.02
Sunset Creek	SE 30th	2611.37	2-year	79	63.5	67.72	64.54	4.22	0.000242	1.44	54.84	13	0.12	2.56	0.04
Sunset Creek	SE 30th	2611.37	10-year	126	63.5	68.62	64.92	5.12	0.00036	1.89	66.53	13	0.15	2.86	0.06
Sunset Creek	SE 30th	2611.37	25-year	157	63.5	69.11	65.15	5.61	0.000434	2.15	72.99	13	0.16	3.01	0.08
Sunset Creek	SE 30th	2611.37	100-year	212	63.5	69.83	65.51	6.33	0.00054	2.57	82.34	14.02	0.18	3.35	0.11
Sunset Creek	SE 30th	2610.895		Bridge											
Sunset Creek	SE 30th	2610.42	1.01-year	52.48	63.5	67.09	64.29	3.59	0.000117	1.12	46.68	13	0.1	2.31	0.02
Sunset Creek	SE 30th	2610.42	2-year	79	63.5	67.72	64.54	4.22	0.000168	1.44	54.84	13	0.12	2.56	0.03
Sunset Creek	SE 30th	2610.42	10-year	126	63.5	68.62	64.92	5.12	0.00025	1.89	66.52	13	0.15	2.86	0.04
Sunset Creek	SE 30th	2610.42	25-year	157	63.5	69.11	65.15	5.61	0.000301	2.15	72.98	13	0.16	3.01	0.06
Sunset Creek	SE 30th	2610.42	100-year	212	63.5	69.83	65.51	6.33	0.000375	2.58	82.32	14.05	0.18	3.35	0.08
Sunset Creek	SE 30th	2610.395		Bridge											
Sunset Creek	SE 30th	2610.37	1.01-year	52.48	63.5	67.09	64.29	3.59	0.000117	1.12	46.68	13	0.1	2.31	0.02
Sunset Creek	SE 30th	2610.37	2-year	79	63.5	67.72	64.54	4.22	0.000168	1.44	54.84	13	0.12	2.56	0.03
Sunset Creek	SE 30th	2610.37	10-year	126	63.5	68.62	64.92	5.12	0.00025	1.89	66.52	13	0.15	2.86	0.04
Sunset Creek	SE 30th	2610.37	25-year	157	63.5	69.11	65.15	5.61	0.000301	2.15	72.98	13	0.16	3.01	0.06
Sunset Creek	SE 30th	2610.37	100-year	212	63.5	69.83	65.51	6.33	0.000375	2.58	82.32	14.05	0.18	3.35	0.08
Sunset Creek	SE 30th	2596.365		Bridge											
Sunset Creek	SE 30th	2582.37	1.01-year	52.48	64	67.08	64.79	3.08	0.000182	1.31	40.03	13	0.13	2.09	0.02
Sunset Creek	SE 30th	2582.37	2-year	79	64	67.7	65.05	3.7	0.000243	1.64	48.14	13	0.15	2.36	0.04
Sunset Creek	SE 30th	2582.37	10-year	126	64	68.6	65.42	4.6	0.000336	2.11	59.75	13	0.17	2.69	0.06
Sunset Creek	SE 30th	2582.37	25-year	157	64	69.09	65.65	5.09	0.000394	2.37	66.15	13	0.19	2.85	0.07
Sunset Creek	SE 30th	2582.37	100-year	212	64	69.78	66.01	5.78	0.00048	2.82	75.19	16.09	0.21	3.19	0.1
Sunset Creek	SE 30th	2582.335		Bridge											
Sunset Creek	SE 30th	2582.32	1.01-year	52.48	64	67.08	64.79	3.08	0.000182	1.31	40.03	13	0.13	2.09	0.02
Sunset Creek	SE 30th	2582.32	2-year	79	64	67.7	65.05	3.7	0.000243	1.64	48.14	13	0.15	2.36	0.04
Sunset Creek	SE 30th	2582.32	10-year	126	64	68.6	65.42	4.6	0.000336	2.11	59.75	13	0.17	2.69	0.06
Sunset Creek	SE 30th	2582.32	25-year	157	64	69.09	65.65	5.09	0.000394	2.37	66.15	13	0.19	2.85	0.07
Sunset Creek	SE 30th	2582.32	100-year	212	64	69.78	66.01	5.78	0.000481	2.82	75.16	16.08	0.21	3.18	0.1
Sunset Creek	SE 30th	2581.843		Bridge											
Sunset Creek	SE 30th	2581.368	1.01-year	52.48	64	67.08	64.79	3.08	0.000262	1.31	40.03	13	0.13	2.09	0.03
Sunset Creek	SE 30th	2581.368	2-year	79	64	67.7	65.05	3.7	0.00035	1.64	48.14	13	0.15	2.36	0.05
Sunset Creek	SE 30th	2581.368	10-year	126	64	68.6	65.43	4.6	0.000484	2.11	59.74	13	0.17	2.69	0.08
Sunset Creek	SE 30th	2581.368	25-year	157	64	69.09	65.65	5.09	0.000567	2.37	66.15	13	0.19	2.85	0.1
Sunset Creek	SE 30th	2581.368	100-year	212	64	69.78	66.01	5.78	0.000693	2.82	75.14	16.22	0.21	3.18	0.14
Sunset Creek	SE 30th	2578.872	1.01-year	52.48	64	67.08	64.79	3.08	0.000368	1.17	44.71	16.02	0.12	2.25	0.05
Sunset Creek	SE 30th	2578.872	2-year	79	64	67.71	65.03	3.71	0.000489	1.44	54.92	16.63	0.14	2.58	0.08
Sunset Creek	SE 30th	2578.872	10-year	126	64	68.6	65.4	4.6	0.000624	1.8	70.11	17.51	0.16	3.11	0.12
Sunset Creek	SE 30th	2578.872	25-year	157	64	69.1	65.61	5.1	0.000694	2	78.63	18	0.16	3.41	0.15
Sunset Creek	SE 30th	2578.872	100-year	212	64	69.8	65.96	5.8	0.000837	2.34	90.78	18.68	0.18	3.81	0.2
Sunset Creek	SE 30th	2576.368	1.01-year	52.48	64.5	67.04	65.55	2.54	0.003514	1.9	27.69	13.24	0.23	1.78	0.39
Sunset Creek	SE 30th	2576.368	2-year	79	64.5	67.66	65.84	3.16	0.003851	2.18	36.16	14.23	0.24	2.11	0.51
Sunset Creek	SE 30th	2576.368	10-year	126	64.5	68.54	66.27	4.04	0.004244	2.55	49.41	15.66	0.25	2.54	0.67
Sunset Creek	SE 30th	2576.368	25-year	157	64.5	69.04	66.53	4.54	0.004418	2.74	57.3	16.6	0.26	2.78	0.77
Sunset Creek	SE 30th	2576.368	100-year	212	64.5	69.73	66.93	5.23	0.004381	3.08	70.16	20.69	0.27	3.33	0.91
Sunset Creek	SE 30th	2541.368	1.01-year	52.48	64.3	66.81	65.69	2.51	0.006401	2.71	19.38	10.11	0.34	1.53	0.61
Sunset Creek	SE 30th	2541.368	2-year	79	64.3	67.4	66.04	3.1	0.006972	3.09	25.53	10.95	0.36	1.81	0.79
Sunset Creek	SE 30th	2541.368	10-year	126	64.3	68.24	66.56	3.94	0.007581	3.57	35.29	12.16	0.37	2.18	1.03
Sunset Creek	SE 30th	2541.368	25-year	157	64.3	68.71	66.85	4.41	0.007885	3.81	41.16	12.83	0.38	2.37	1.17
Sunset Creek	SE 30th	2541.368	100-year	212	64.3	69.38	67.33	5.08	0.008044	4.24	50.54	16.7	0.39	2.76	1.39

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	2539.81	1.01-year	52.48	64.28	66.8	65.68	2.52	0.005041	2.72	19.29	9.97	0.34	1.53	0.48
Sunset Creek	SE 30th	2539.81	2-year	79	64.28	67.38	66.02	3.1	0.005495	3.12	25.32	10.78	0.36	1.8	0.62
Sunset Creek	SE 30th	2539.81	10-year	126	64.28	68.23	66.54	3.95	0.005983	3.61	34.88	11.94	0.37	2.17	0.81
Sunset Creek	SE 30th	2539.81	25-year	157	64.28	68.7	66.84	4.42	0.006229	3.86	40.62	12.58	0.38	2.36	0.92
Sunset Creek	SE 30th	2539.81	100-year	212	64.28	69.36	67.31	5.08	0.006415	4.31	49.56	15.31	0.39	2.74	1.1
Sunset Creek	SE 30th	2527.427	1.01-year	52.48	64.16	66.75	65.55	2.59	0.004357	2.55	20.55	10.63	0.32	1.56	0.43
Sunset Creek	SE 30th	2527.427	2-year	79	64.16	67.33	65.9	3.17	0.004761	2.93	26.99	11.6	0.34	1.84	0.55
Sunset Creek	SE 30th	2527.427	10-year	126	64.16	68.18	66.41	4.02	0.005129	3.37	37.36	13.01	0.35	2.22	0.71
Sunset Creek	SE 30th	2527.427	25-year	157	64.16	68.65	66.7	4.49	0.005249	3.6	43.65	14.07	0.36	2.43	0.8
Sunset Creek	SE 30th	2527.427	100-year	212	64.16	69.32	67.16	5.16	0.00496	3.97	55.18	20.31	0.36	2.94	0.91
Sunset Creek	SE 30th	2513.681	1.01-year	52.48	64.02	66.63	65.66	2.61	0.006964	3.08	17.03	9.26	0.4	1.43	0.62
Sunset Creek	SE 30th	2513.681	2-year	79	64.02	67.19	66.02	3.17	0.00757	3.52	22.43	10.06	0.42	1.69	0.8
Sunset Creek	SE 30th	2513.681	10-year	126	64.02	68	66.56	3.98	0.008132	4.05	31.12	11.24	0.43	2.03	1.03
Sunset Creek	SE 30th	2513.681	25-year	157	64.02	68.46	66.87	4.44	0.008439	4.31	36.39	11.98	0.44	2.2	1.16
Sunset Creek	SE 30th	2513.681	100-year	212	64.02	69.12	67.36	5.1	0.008866	4.71	46.09	29.37	0.45	2.47	1.36
Sunset Creek	SE 30th	2492.185	1.01-year	52.48	63.81	66.45	65.46	2.64	0.008364	3.22	16.28	10.06	0.45	1.3	0.68
Sunset Creek	SE 30th	2492.185	2-year	79	63.81	67.02	65.9	3.21	0.008106	3.56	22.21	10.92	0.44	1.59	0.81
Sunset Creek	SE 30th	2492.185	10-year	126	63.81	67.84	66.52	4.03	0.007933	3.98	31.7	12.17	0.43	1.98	0.98
Sunset Creek	SE 30th	2492.185	25-year	157	63.81	68.29	66.81	4.48	0.007931	4.2	37.42	12.87	0.43	2.18	1.08
Sunset Creek	SE 30th	2492.185	100-year	212	63.81	68.95	67.26	5.14	0.007895	4.59	46.81	18.11	0.44	2.53	1.25
Sunset Creek	SE 30th	2481.368	1.01-year	52.48	63.7	66.31	65.37	2.61	0.012788	3.45	15.23	9.63	0.48	1.25	1
Sunset Creek	SE 30th	2481.368	2-year	79	63.7	66.88	65.81	3.18	0.012635	3.78	20.9	10.44	0.47	1.54	1.22
Sunset Creek	SE 30th	2481.368	10-year	126	63.7	67.7	66.48	4	0.012743	4.21	29.91	11.61	0.46	1.92	1.53
Sunset Creek	SE 30th	2481.368	25-year	157	63.7	68.15	66.79	4.45	0.012942	4.45	35.31	12.25	0.46	2.12	1.71
Sunset Creek	SE 30th	2481.368	100-year	212	63.7	68.8	67.24	5.1	0.013137	4.86	44.21	16.62	0.47	2.45	2.01
Sunset Creek	SE 30th	2464.334	1.01-year	52.48	63.54	66.02	65.24	2.48	0.016416	3.8	13.8	8.77	0.53	1.21	1.24
Sunset Creek	SE 30th	2464.334	2-year	79	63.54	66.58	65.78	3.04	0.016439	4.19	18.87	9.5	0.52	1.48	1.52
Sunset Creek	SE 30th	2464.334	10-year	126	63.54	67.37	66.32	3.83	0.016923	4.69	26.84	10.55	0.52	1.83	1.93
Sunset Creek	SE 30th	2464.334	25-year	157	63.54	67.81	66.62	4.27	0.017396	4.98	31.56	11.12	0.52	2.01	2.18
Sunset Creek	SE 30th	2464.334	100-year	212	63.54	68.42	67.11	4.88	0.018294	5.48	39.02	14.59	0.53	2.29	2.61
Sunset Creek	SE 30th	2429.853	1.01-year	52.48	63.22	65.71	64.62	2.49	0.007757	2.95	17.79	10.5	0.4	1.36	0.66
Sunset Creek	SE 30th	2429.853	2-year	79	63.22	66.26	65.04	3.04	0.008311	3.33	23.75	11.27	0.4	1.65	0.85
Sunset Creek	SE 30th	2429.853	10-year	126	63.22	67.03	65.65	3.81	0.009229	3.82	32.95	12.47	0.41	2.01	1.16
Sunset Creek	SE 30th	2429.853	25-year	157	63.22	67.46	65.93	4.24	0.009782	4.09	38.36	13.14	0.42	2.2	1.34
Sunset Creek	SE 30th	2429.853	100-year	212	63.22	68.07	66.37	4.85	0.01001	4.52	47.9	18.01	0.43	2.55	1.59
Sunset Creek	SE 30th	2407.706	1.01-year	52.48	63.01	65.37	64.6	2.36	0.015283	3.84	13.68	8.62	0.54	1.23	1.17
Sunset Creek	SE 30th	2407.706	2-year	79	63.01	65.87	65.13	2.86	0.016981	4.37	18.1	9.28	0.55	1.47	1.55
Sunset Creek	SE 30th	2407.706	10-year	126	63.01	66.56	65.68	3.55	0.019474	5.08	24.82	10.2	0.57	1.77	2.15
Sunset Creek	SE 30th	2407.706	25-year	157	63.01	66.92	65.99	3.91	0.02111	5.48	28.64	10.69	0.59	1.92	2.53
Sunset Creek	SE 30th	2407.706	100-year	212	63.01	67.44	66.48	4.43	0.024318	6.16	34.41	11.39	0.62	2.13	3.24
Sunset Creek	SE 30th	2379.636	1.01-year	52.48	62.75	65.18	64.11	2.43	0.006687	2.65	19.8	13.33	0.38	1.3	0.54
Sunset Creek	SE 30th	2379.636	2-year	79	62.75	65.69	64.48	2.94	0.006831	2.94	26.88	14.6	0.38	1.59	0.68
Sunset Creek	SE 30th	2379.636	10-year	126	62.75	66.4	65.09	3.65	0.00717	3.32	37.91	16.38	0.38	1.98	0.89
Sunset Creek	SE 30th	2379.636	25-year	157	62.75	66.78	65.33	4.03	0.00743	3.54	44.3	17.47	0.39	2.18	1.01
Sunset Creek	SE 30th	2379.636	100-year	212	62.75	67.35	65.72	4.6	0.007393	3.9	54.88	19.78	0.39	2.57	1.18
Sunset Creek	SE 30th	2361.19	1.01-year	52.48	62.58	64.92	64.13	2.34	0.012606	3.56	14.73	9.67	0.51	1.25	0.98
Sunset Creek	SE 30th	2361.19	2-year	79	62.58	65.38	64.63	2.8	0.013799	4.08	19.36	10.52	0.53	1.49	1.28
Sunset Creek	SE 30th	2361.19	10-year	126	62.58	66.02	65.17	3.44	0.014921	4.76	26.61	12.81	0.55	1.83	1.71
Sunset Creek	SE 30th	2361.19	25-year	157	62.58	66.36	65.44	3.78	0.015248	5.12	31.35	14.98	0.56	2.04	1.94
Sunset Creek	SE 30th	2361.19	100-year	212	62.58	66.91	65.9	4.33	0.015091	5.54	40.47	18.45	0.56	2.37	2.23
Sunset Creek	SE 30th	2341.739	1.01-year	52.48	62.4	64.62	63.99	2.22	0.014546	3.89	13.5	10.11	0.59	1.13	1.03
Sunset Creek	SE 30th	2341.739	2-year	79	62.4	65.07	64.5	2.67	0.014885	4.33	18.23	11	0.59	1.38	1.28
Sunset Creek	SE 30th	2341.739	10-year	126	62.4	65.69	64.99	3.29	0.015709	4.93	25.53	12.26	0.6	1.7	1.67
Sunset Creek	SE 30th	2341.739	25-year	157	62.4	66.02	65.26	3.62	0.016651	5.31	29.59	12.9	0.62	1.86	1.93
Sunset Creek	SE 30th	2341.739	100-year	212	62.4	66.56	65.7	4.16	0.016244	5.72	38.33	21.12	0.61	2.18	2.21
Sunset Creek	SE 30th	2313.296	1.01-year	52.48	62.13	64.24	63.58	2.11	0.013079	3.76	13.95	10.54	0.58	1.13	0.92
Sunset Creek	SE 30th	2313.296	2-year	79	62.13	64.67	63.98	2.54	0.013495	4.21	18.75	11.38	0.58	1.38	1.17
Sunset Creek	SE 30th	2313.296	10-year	126	62.13	65.27	64.58	3.14	0.01487	4.88	25.81	12.51	0.6	1.7	1.58
Sunset Creek	SE 30th	2313.296	25-year	157	62.13	65.55	64.85	3.42	0.015936	5.32	29.85	16.98	0.62	1.87	1.86
Sunset Creek	SE 30th	2313.296	100-year	212	62.13	66.07	65.27	3.94	0.021872	5.42	41.98	28.25	0.67	1.77	2.41
Sunset Creek	SE 30th	2297.254	1.01-year	52.48	61.98	64.14	63.24	2.16	0.009569	2.52	20.84	17.77	0.41	1.11	0.66
Sunset Creek	SE 30th	2297.254	2-year	79	61.98	64.62	63.57	2.64	0.008908	2.65	29.78	19.99	0.38	1.4	0.78
Sunset Creek	SE 30th	2297.254	10-year	126	61.98	65.25	64.12	3.27	0.008775	2.9	43.45	23.13	0.37	1.79	0.98
Sunset Creek	SE 30th	2297.254	25-year	157	61.98	65.57	64.33	3.59	0.008509	3.08	51.55	29.48	0.37	2.03	1.08
Sunset Creek	SE 30th	2297.254	100-year	212	61.98	66.07	64.64	4.09	0.007536	3.32	66.72	31.92	0.36	2.5	1.17
Sunset Creek	SE 30th	2285.55	1.01-year	52.48	61.88	64.02	63.15	2.14	0.010206	2.56	20.52	17.87	0.42	1.09	0.69
Sunset Creek	SE 30th	2285.55	2-year	79	61.88	64.51	63.47	2.63	0.009562	2.64	29.91	20.82	0.39	1.36	0.81
Sunset Creek	SE 30th	2285.55	10-year	126	61.88	65.15	64.04	3.27	0.009385	2.83	44.5	24.7	0.37	1.7	1
Sunset Creek	SE 30th	2285.55	25-year	157	61.88	65.48	64.24	3.6	0.009387	2.97	52.86	26.8	0.37	1.9	1.11
Sunset Creek	SE 30th	2285.55	100-year	212	61.88	65.99	64.56	4.11	0.007799	3.14	70.28	34.96	0.35	2.38	1.16
Sunset Creek	SE 30th	2261.889	1.01-year	52.48	61.65	63.78	62.91	2.13	0.009712	2.61	20.12	16.04	0.41	1.18	0.72
Sunset Creek	SE 30th	2261.889	2-year	79	61.65	64.27	63.24	2.62	0.009308	2.78	28.45	18	0.39	1.48	0.86
Sunset Creek	SE 30th	2261.889	10-year	126	61.65	64.91	63.77	3.26	0.008921	3.1	41.23	23.73	0.38	1.92	1.07
Sunset Creek	SE 30th	2261.889	25-year	157	61.65	65.23	63.99	3.58	0.008338	3.3	49.41	26.57	0.38	2.22	1.16
Sunset Creek	SE 30th	2261.889	100-year	212	61.65	65.77	64.33	4.12	0.007247	3.53	64.88	30.01	0.36	2.73	1.23

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	2238.42	1.01-year	52.48	61.44	63.61	62.6	2.17	0.006768	2.29	22.9	17.19	0.35	1.26	0.53
Sunset Creek	SE 30th	2238.42	2-year	79	61.44	64.11	62.92	2.67	0.006762	2.48	31.87	19.16	0.34	1.56	0.66
Sunset Creek	SE 30th	2238.42	10-year	126	61.44	64.75	63.36	3.31	0.006286	2.8	45.92	24.5	0.33	2.07	0.81
Sunset Creek	SE 30th	2238.42	25-year	157	61.44	65.09	63.66	3.65	0.005972	3	54.43	26.01	0.33	2.38	0.89
Sunset Creek	SE 30th	2238.42	100-year	212	61.44	65.65	63.99	4.21	0.005424	3.26	69.57	28.51	0.33	2.9	0.98
Sunset Creek	SE 30th	2205.456	1.01-year	52.48	61.13	63.36	62.39	2.23	0.008068	2.44	21.51	15.91	0.37	1.27	0.64
Sunset Creek	SE 30th	2205.456	2-year	79	61.13	63.84	62.73	2.71	0.00827	2.66	29.74	17.86	0.36	1.55	0.8
Sunset Creek	SE 30th	2205.456	10-year	126	61.13	64.49	63.24	3.36	0.008668	2.99	42.25	23.94	0.36	1.94	1.05
Sunset Creek	SE 30th	2205.456	25-year	157	61.13	64.85	63.46	3.72	0.007841	3.16	51.23	26.42	0.36	2.27	1.11
Sunset Creek	SE 30th	2205.456	100-year	212	61.13	65.44	63.81	4.31	0.006588	3.35	67.77	29.64	0.34	2.82	1.16
Sunset Creek	SE 30th	2189.813	1.01-year	52.48	60.98	63.24	62.25	2.26	0.007643	2.39	21.99	16.03	0.36	1.29	0.61
Sunset Creek	SE 30th	2189.813	2-year	79	60.98	63.72	62.57	2.74	0.007968	2.62	30.19	17.96	0.36	1.57	0.78
Sunset Creek	SE 30th	2189.813	10-year	126	60.98	64.36	63.09	3.38	0.008769	2.97	42.44	20.51	0.36	1.92	1.05
Sunset Creek	SE 30th	2189.813	25-year	157	60.98	64.73	63.31	3.75	0.007976	3.12	51.26	25.73	0.35	2.24	1.11
Sunset Creek	SE 30th	2189.813	100-year	212	60.98	65.34	63.66	4.36	0.00656	3.29	68.09	30.21	0.33	2.81	1.15
Sunset Creek	SE 30th	2175.255	1.01-year	52.48	60.85	63.13	62.12	2.28	0.007336	2.35	22.37	16.12	0.35	1.3	0.6
Sunset Creek	SE 30th	2175.255	2-year	79	60.85	63.61	62.44	2.76	0.007775	2.59	30.49	18.03	0.35	1.58	0.77
Sunset Creek	SE 30th	2175.255	10-year	126	60.85	64.23	62.96	3.38	0.00874	2.96	42.5	20.52	0.36	1.92	1.05
Sunset Creek	SE 30th	2175.255	25-year	157	60.85	64.6	63.18	3.75	0.008876	3.11	50.46	22.02	0.36	2.12	1.18
Sunset Creek	SE 30th	2175.255	100-year	212	60.85	65.24	63.53	4.39	0.007955	3.25	65.92	27.53	0.35	2.55	1.26
Sunset Creek	SE 30th	2121.292	1.01-year	52.48	60.34	62.85	61.71	2.51	0.004023	2.25	23.31	15.4	0.32	1.41	0.35
Sunset Creek	SE 30th	2121.292	2-year	79	60.34	63.29	62.06	2.95	0.004524	2.59	30.63	20.1	0.34	1.66	0.47
Sunset Creek	SE 30th	2121.292	10-year	126	60.34	63.94	62.57	3.6	0.003743	2.89	47.61	28.1	0.33	2.26	0.53
Sunset Creek	SE 30th	2121.292	25-year	157	60.34	64.35	62.8	4.01	0.003192	2.96	59.25	28.74	0.31	2.64	0.53
Sunset Creek	SE 30th	2121.292	100-year	212	60.34	65.04	63.17	4.7	0.002515	3.04	79.36	29.8	0.28	3.27	0.51
Sunset Creek	SE 30th	2107.746	1.01-year	52.48	60.22	62.81	61.6	2.59	0.002806	2.1	24.96	16.36	0.3	1.42	0.25
Sunset Creek	SE 30th	2107.746	2-year	79	60.22	63.25	61.94	3.03	0.00287	2.42	33.62	25.29	0.31	1.77	0.32
Sunset Creek	SE 30th	2107.746	10-year	126	60.22	63.91	62.45	3.69	0.002441	2.72	50.78	26.53	0.3	2.39	0.36
Sunset Creek	SE 30th	2107.746	25-year	157	60.22	64.33	62.69	4.11	0.002163	2.83	61.85	27.2	0.29	2.77	0.37
Sunset Creek	SE 30th	2107.746	100-year	212	60.22	65.02	63.02	4.8	0.001796	2.96	80.97	27.99	0.27	3.41	0.38
Sunset Creek	SE 30th	2098.229	1.01-year	100.32	60.13	62.65	62.12	2.52	0.010475	3.15	32.57	42.26	0.54	0.99	0.65
Sunset Creek	SE 30th	2098.229	2-year	151	60.13	63.04	62.51	2.91	0.007654	3.32	49.35	42.91	0.49	1.36	0.65
Sunset Creek	SE 30th	2098.229	10-year	236	60.13	63.64	62.88	3.51	0.005318	3.49	75.38	43.89	0.43	1.92	0.64
Sunset Creek	SE 30th	2098.229	25-year	297	60.13	64.04	63.06	3.91	0.004469	3.6	92.74	44.54	0.41	2.29	0.64
Sunset Creek	SE 30th	2098.229	100-year	412	60.13	64.71	63.38	4.58	0.003592	3.79	123.02	45.64	0.38	2.92	0.66
Sunset Creek	SE 30th	2070.489	1.01-year	100.32	60.45	62.56	61.73	2.11	0.003482	2.02	49.67	39.18	0.32	1.23	0.27
Sunset Creek	SE 30th	2070.489	2-year	151	60.45	62.98	61.98	2.53	0.003054	2.26	68.63	47.19	0.31	1.62	0.31
Sunset Creek	SE 30th	2070.489	10-year	236	60.45	63.6	62.31	3.15	0.002468	2.51	98.67	48.8	0.29	2.23	0.34
Sunset Creek	SE 30th	2070.489	25-year	297	60.45	64.01	62.49	3.56	0.00222	2.65	118.56	49.83	0.28	2.62	0.36
Sunset Creek	SE 30th	2070.489	100-year	412	60.45	64.69	62.82	4.24	0.001935	2.88	153.29	51.47	0.28	3.29	0.4
Sunset Creek	SE 30th	2050.566	1.01-year	100.32	59.65	62.37	61.97	2.72	0.009256	2.98	33.92	34.24	0.51	0.99	0.57
Sunset Creek	SE 30th	2050.566	2-year	151	59.65	62.82	62.19	3.17	0.006281	3.1	51.85	45.37	0.44	1.4	0.55
Sunset Creek	SE 30th	2050.566	10-year	236	59.65	63.49	62.51	3.84	0.004056	3.18	82.72	47.24	0.38	2.01	0.51
Sunset Creek	SE 30th	2050.566	25-year	297	59.65	63.9	62.75	4.25	0.003383	3.26	102.68	48.41	0.36	2.4	0.51
Sunset Creek	SE 30th	2050.566	100-year	412	59.65	64.6	63.07	4.95	0.002728	3.43	137.18	50.17	0.33	3.04	0.52
Sunset Creek	SE 30th	2036.451	1.01-year	100.32	60.13	62.26	61.72	2.13	0.008428	2.83	38.52	47.32	0.48	1.04	0.55
Sunset Creek	SE 30th	2036.451	2-year	151	60.13	62.77	62.03	2.64	0.004602	2.7	63.41	49	0.37	1.54	0.44
Sunset Creek	SE 30th	2036.451	10-year	236	60.13	63.47	62.39	3.34	0.003026	2.78	98.07	51.26	0.32	2.19	0.41
Sunset Creek	SE 30th	2036.451	25-year	297	60.13	63.89	62.57	3.76	0.002585	2.87	120.11	52.64	0.31	2.6	0.42
Sunset Creek	SE 30th	2036.451	100-year	412	60.13	64.6	62.85	4.47	0.002145	3.05	157.45	52.87	0.29	3.27	0.44
Sunset Creek	SE 30th	2016.641	1.01-year	100.32	59.66	62.2	61.35	2.54	0.003075	2.06	50.21	42.43	0.31	1.32	0.25
Sunset Creek	SE 30th	2016.641	2-year	151	59.66	62.74	61.64	3.08	0.002219	2.18	73.92	45.1	0.28	1.83	0.25
Sunset Creek	SE 30th	2016.641	10-year	236	59.66	63.43	61.94	3.77	0.00181	2.42	106.01	46.8	0.26	2.5	0.28
Sunset Creek	SE 30th	2016.641	25-year	297	59.66	63.86	62.14	4.2	0.001683	2.58	126.14	47.83	0.26	2.9	0.3
Sunset Creek	SE 30th	2016.641	100-year	412	59.66	64.57	62.47	4.91	0.001548	2.84	160.54	49.55	0.26	3.57	0.35
Sunset Creek	SE 30th	1988.07	1.01-year	100.32	59.15	62.15	61.01	3	0.001716	1.9	60.17	42	0.24	1.79	0.19
Sunset Creek	SE 30th	1988.07	2-year	151	59.15	62.69	61.27	3.54	0.001511	2.11	83.51	43.62	0.24	2.3	0.22
Sunset Creek	SE 30th	1988.07	10-year	236	59.15	63.39	61.63	4.24	0.001441	2.43	114.86	45.7	0.24	2.95	0.27
Sunset Creek	SE 30th	1988.07	25-year	297	59.15	63.82	61.84	4.67	0.001424	2.63	134.61	46.96	0.24	3.35	0.3
Sunset Creek	SE 30th	1988.07	100-year	412	59.15	64.53	62.24	5.38	0.001405	2.94	168.55	49.05	0.25	4.01	0.35
Sunset Creek	SE 30th	1968.444	1.01-year	100.32	59.73	62.1	61.04	2.37	0.001844	2.08	57.87	41.14	0.26	1.88	0.22
Sunset Creek	SE 30th	1968.444	2-year	151	59.73	62.65	61.33	2.92	0.001616	2.3	81.33	44.08	0.26	2.41	0.24
Sunset Creek	SE 30th	1968.444	10-year	236	59.73	63.35	61.71	3.62	0.001517	2.63	112.72	45.23	0.26	3.1	0.29
Sunset Creek	SE 30th	1968.444	25-year	297	59.73	63.78	61.92	4.05	0.001501	2.84	132.2	46.26	0.26	3.51	0.33
Sunset Creek	SE 30th	1968.444	100-year	412	59.73	64.48	62.27	4.75	0.001487	3.19	165.42	47.96	0.27	4.2	0.39
Sunset Creek	SE 30th	1954.61	1.01-year	100.32	59.63	61.99	61.33	2.36	0.008212	3.06	43.17	38.25	0.38	1.89	0.97
Sunset Creek	SE 30th	1954.61	2-year	151	59.63	62.57	61.66	2.94	0.005902	3.07	67.43	43.67	0.33	2.43	0.9
Sunset Creek	SE 30th	1954.61	10-year	236	59.63	63.29	62.03	3.66	0.00473	3.23	99.74	45.74	0.31	3.1	0.92
Sunset Creek	SE 30th	1954.61	25-year	297	59.63	63.73	62.3	4.1	0.004372	3.37	119.83	46.98	0.31	3.51	0.96
Sunset Creek	SE 30th	1954.61	100-year	412	59.63	64.44	62.62	4.81	0.003986	3.61	154.17	49.03	0.3	4.17	1.04

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	1928.749	1.01-year	100.32	59.16	61.96	60.54	2.8	0.001812	1.53	68.09	38.44	0.19	2.04	0.23
Sunset Creek	SE 30th	1928.749	2-year	151	59.16	62.54	60.77	3.38	0.001734	1.77	91.52	42.78	0.19	2.61	0.28
Sunset Creek	SE 30th	1928.749	10-year	236	59.16	63.26	61.1	4.1	0.001786	2.11	122.71	43.96	0.2	3.32	0.37
Sunset Creek	SE 30th	1928.749	25-year	297	59.16	63.69	61.31	4.53	0.001837	2.32	141.81	44.64	0.21	3.74	0.43
Sunset Creek	SE 30th	1928.749	100-year	412	59.16	64.4	61.66	5.24	0.001915	2.65	173.95	45.74	0.22	4.44	0.53
Sunset Creek	SE 30th	1881.347	1.01-year	100.32	58.45	61.71	60.37	3.26	0.005655	3.04	36.16	22.84	0.34	2.28	0.81
Sunset Creek	SE 30th	1881.347	2-year	151	58.45	62.25	60.8	3.8	0.006073	3.59	50.66	36.83	0.36	2.77	1.05
Sunset Creek	SE 30th	1881.347	10-year	236	58.45	62.96	61.48	4.51	0.005834	4.04	78.11	39.28	0.37	3.4	1.24
Sunset Creek	SE 30th	1881.347	25-year	297	58.45	63.39	61.9	4.94	0.005589	4.25	95.35	40.41	0.36	3.79	1.32
Sunset Creek	SE 30th	1881.347	100-year	412	58.45	64.1	62.64	5.65	0.005316	4.6	124.4	40.94	0.36	4.43	1.47
Sunset Creek	SE 30th	1868.66	1.01-year	100.32	59.05	61.67	60.65	2.62	0.004449	2.64	45.34	33.4	0.33	1.96	0.54
Sunset Creek	SE 30th	1868.66	2-year	151	59.05	62.24	61.01	3.19	0.003885	2.91	64.72	35.17	0.32	2.5	0.61
Sunset Creek	SE 30th	1868.66	10-year	236	59.05	62.95	61.52	3.9	0.003739	3.35	90.37	36.56	0.32	3.17	0.74
Sunset Creek	SE 30th	1868.66	25-year	297	59.05	63.38	61.76	4.33	0.003734	3.63	105.99	36.56	0.33	3.58	0.84
Sunset Creek	SE 30th	1868.66	100-year	412	59.05	64.07	62.15	5.02	0.003805	4.1	131.53	36.56	0.34	4.25	1.01
Sunset Creek	SE 30th	1856.084	1.01-year	100.32	58.51	61.54	60.64	3.03	0.009194	3.18	36.92	28.3	0.39	1.96	1.13
Sunset Creek	SE 30th	1856.084	2-year	151	58.51	62.12	61.06	3.61	0.007785	3.44	53.97	30.95	0.37	2.51	1.22
Sunset Creek	SE 30th	1856.084	10-year	236	58.51	62.83	61.6	4.32	0.007328	3.91	77.03	34.26	0.38	3.18	1.45
Sunset Creek	SE 30th	1856.084	25-year	297	58.51	63.25	61.86	4.74	0.007228	4.21	92.07	36.27	0.38	3.58	1.62
Sunset Creek	SE 30th	1856.084	100-year	412	58.51	63.96	62.31	5.45	0.00691	4.61	117.72	36.27	0.38	4.25	1.83
Sunset Creek	SE 30th	1817.494	1.01-year	100.32	58.15	61.26	59.86	3.11	0.004924	3.33	30.99	17.77	0.36	2.1	0.65
Sunset Creek	SE 30th	1817.494	2-year	151	58.15	61.77	60.34	3.62	0.005847	4.07	41.58	23.46	0.41	2.5	0.91
Sunset Creek	SE 30th	1817.494	10-year	236	58.15	62.37	61.03	4.22	0.00705	5.03	56.84	25.61	0.46	2.98	1.31
Sunset Creek	SE 30th	1817.494	25-year	297	58.15	62.73	61.59	4.58	0.007687	5.58	66.11	25.61	0.49	3.27	1.57
Sunset Creek	SE 30th	1817.494	100-year	412	58.15	63.33	62.25	5.18	0.008613	6.47	81.33	25.61	0.53	3.75	2.01
Sunset Creek	SE 30th	1805.019	1.01-year	100.32	58.22	61.22	59.92	3	0.004481	3.25	37.73	28.54	0.36	2.11	0.59
Sunset Creek	SE 30th	1805.019	2-year	151	58.22	61.74	60.37	3.52	0.004649	3.74	53.63	32.01	0.37	2.54	0.74
Sunset Creek	SE 30th	1805.019	10-year	236	58.22	62.39	61.23	4.17	0.004871	4.34	76.07	53.24	0.39	3.06	0.93
Sunset Creek	SE 30th	1805.019	25-year	297	58.22	62.78	61.56	4.56	0.00479	4.6	92.15	60.85	0.4	3.38	1.01
Sunset Creek	SE 30th	1805.019	100-year	412	58.22	63.46	62.1	5.24	0.004327	4.84	122.76	67.33	0.39	3.94	1.06
Sunset Creek	SE 30th	1791.536	1.01-year	100.32	58.58	61.12	60.26	2.54	0.005998	3.49	32.84	26.2	0.43	1.87	0.7
Sunset Creek	SE 30th	1791.536	2-year	151	58.58	61.65	60.74	3.07	0.005535	3.91	47.64	28.57	0.43	2.35	0.81
Sunset Creek	SE 30th	1791.536	10-year	236	58.58	62.25	61.28	3.67	0.005915	4.65	64.98	28.57	0.46	2.91	1.07
Sunset Creek	SE 30th	1791.536	25-year	297	58.58	62.61	61.59	4.03	0.006259	5.14	75.08	28.57	0.48	3.23	1.26
Sunset Creek	SE 30th	1791.536	100-year	412	58.58	63.18	62.03	4.6	0.006856	5.94	91.41	28.57	0.52	3.76	1.61
Sunset Creek	SE 30th	1777.213	1.01-year	100.32	58.04	61.1	59.79	3.06	0.00334	2.79	43.51	29.94	0.32	2.13	0.44
Sunset Creek	SE 30th	1777.213	2-year	151	58.04	61.64	60.25	3.6	0.003268	3.15	60.86	60.16	0.32	2.6	0.53
Sunset Creek	SE 30th	1777.213	10-year	236	58.04	62.27	60.89	4.23	0.003557	3.74	83.05	66.33	0.35	3.14	0.7
Sunset Creek	SE 30th	1777.213	25-year	297	58.04	62.64	61.24	4.6	0.003738	4.09	96.39	66.54	0.36	3.47	0.81
Sunset Creek	SE 30th	1777.213	100-year	412	58.04	63.24	61.67	5.2	0.004003	4.65	118.39	66.89	0.38	3.99	1
Sunset Creek	SE 30th	1749.718	1.01-year	100.32	57.73	60.91	59.77	3.18	0.005585	3.47	33.31	20.49	0.39	2.1	0.73
Sunset Creek	SE 30th	1749.718	2-year	151	57.73	61.39	60.31	3.66	0.006434	4.19	44.81	47.1	0.43	2.51	1.01
Sunset Creek	SE 30th	1749.718	10-year	236	57.73	61.91	60.9	4.18	0.008186	5.27	60.57	63.78	0.5	2.96	1.51
Sunset Creek	SE 30th	1749.718	25-year	297	57.73	62.21	61.31	4.48	0.009052	5.87	70.54	64.03	0.54	3.22	1.82
Sunset Creek	SE 30th	1749.718	100-year	412	57.73	62.72	61.95	4.99	0.010215	6.79	87.2	64.43	0.58	3.66	2.34
Sunset Creek	SE 30th	1689.563	1.01-year	100.32	57.21	60.02	59.59	2.81	0.020854	5.42	18.93	17.87	0.7	1.56	2.03
Sunset Creek	SE 30th	1689.563	2-year	151	57.21	60.43	60.37	3.22	0.020473	6.14	29.13	26.36	0.72	1.9	2.43
Sunset Creek	SE 30th	1689.563	10-year	236	57.21	61.02	60.84	3.81	0.016972	6.53	45.24	28.17	0.68	2.4	2.55
Sunset Creek	SE 30th	1689.563	25-year	297	57.21	61.38	61.07	4.17	0.015528	6.76	55.52	29.26	0.67	2.71	2.62
Sunset Creek	SE 30th	1689.563	100-year	412	57.21	61.97	61.51	4.76	0.013881	7.16	73.28	43.57	0.65	3.2	2.78
Sunset Creek	SE 30th	1668.393	1.01-year	100.32	56.93	59.91	59.04	2.98	0.008129	4.05	28.97	25.06	0.47	1.94	0.98
Sunset Creek	SE 30th	1668.393	2-year	151	56.93	60.35	59.81	3.42	0.008396	4.62	40.03	26.29	0.5	2.31	1.21
Sunset Creek	SE 30th	1668.393	10-year	236	56.93	60.91	60.31	3.98	0.008645	5.32	55.37	27.91	0.52	2.79	1.51
Sunset Creek	SE 30th	1668.393	25-year	297	56.93	61.26	60.56	4.33	0.008706	5.71	65.25	28.9	0.53	3.09	1.68
Sunset Creek	SE 30th	1668.393	100-year	412	56.93	61.84	61.01	4.91	0.008713	6.31	82.48	30.55	0.54	3.58	1.95
Sunset Creek	SE 30th	1626.318	1.01-year	100.32	56.89	59.65	58.71	2.76	0.006373	3.63	31.26	23.61	0.43	1.9	0.76
Sunset Creek	SE 30th	1626.318	2-year	151	56.89	60.03	59.27	3.14	0.007479	4.38	40.51	24.76	0.48	2.23	1.04
Sunset Creek	SE 30th	1626.318	10-year	236	56.89	60.51	59.87	3.62	0.009047	5.39	52.72	26.21	0.54	2.65	1.49
Sunset Creek	SE 30th	1626.318	25-year	297	56.89	60.8	60.15	3.91	0.009898	5.99	60.41	27.07	0.58	2.9	1.79
Sunset Creek	SE 30th	1626.318	100-year	412	56.89	61.3	60.62	4.41	0.010777	6.86	74.37	28.58	0.62	3.33	2.24
Sunset Creek	SE 30th	1613.357	1.01-year	100.32	56.46	59.63	58.27	3.17	0.003347	2.9	37.19	23.33	0.33	2.08	0.43
Sunset Creek	SE 30th	1613.357	2-year	151	56.46	60	58.69	3.54	0.004389	3.65	46.19	24.85	0.39	2.4	0.66
Sunset Creek	SE 30th	1613.357	10-year	236	56.46	60.47	59.4	4.01	0.0059	4.69	58.04	26.32	0.46	2.8	1.03
Sunset Creek	SE 30th	1613.357	25-year	297	56.46	60.74	59.77	4.28	0.006805	5.32	65.4	27.19	0.5	3.03	1.29
Sunset Creek	SE 30th	1613.357	100-year	412	56.46	61.23	60.29	4.77	0.00793	6.25	78.89	28.73	0.55	3.45	1.71
Sunset Creek	SE 30th	1592.728	1.01-year	100.32	56.02	59.65	57.91	3.63	0.001146	1.69	62.95	33.09	0.19	2.23	0.16
Sunset Creek	SE 30th	1592.728	2-year	151	56.02	60.04	58.23	4.02	0.001518	2.15	75.99	33.8	0.23	2.6	0.25
Sunset Creek	SE 30th	1592.728	10-year	236	56.02	60.54	58.66	4.52	0.002077	2.81	92.89	34.71	0.28	3.07	0.4
Sunset Creek	SE 30th	1592.728	25-year	297	56.02	60.83	58.92	4.81	0.00242	3.22	103.26	35.25	0.3	3.35	0.51
Sunset Creek	SE 30th	1592.728	100-year	412	56.02	61.35	59.38	5.33	0.002877	3.85	121.91	36.21	0.34	3.85	0.69

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	1583.59	1.01-year	100.32	56.87	59.48	58.8	2.61	0.007996	3.47	32.75	32.11	0.47	1.59	0.8
Sunset Creek	SE 30th	1583.59	2-year	151	56.87	59.81	59.2	2.94	0.009139	4.19	43.62	33.2	0.52	1.91	1.09
Sunset Creek	SE 30th	1583.59	10-year	236	56.87	60.21	59.7	3.34	0.01129	5.25	56.96	34.5	0.6	2.28	1.61
Sunset Creek	SE 30th	1583.59	25-year	297	56.87	60.43	59.97	3.56	0.012715	5.91	64.84	35.25	0.64	2.5	1.98
Sunset Creek	SE 30th	1583.59	100-year	412	56.87	60.87	60.38	4	0.013713	6.8	80.49	36.69	0.68	2.91	2.49
Sunset Creek	SE 30th	1583.5		Lat Struct											
Sunset Creek	SE 30th	1576.451	1.01-year	100.32	56.81	59.39	58.71	2.58	0.012871	3.58	28.98	25.93	0.53	1.27	1.02
Sunset Creek	SE 30th	1576.451	2-year	151	56.81	59.69	59.18	2.88	0.015583	4.33	37.2	28.01	0.6	1.47	1.43
Sunset Creek	SE 30th	1576.451	10-year	236	56.81	60.02	59.67	3.21	0.0201	5.52	46.94	31.92	0.7	1.76	2.2
Sunset Creek	SE 30th	1576.451	25-year	297	56.81	60.17	59.92	3.36	0.024449	6.39	51.81	33.88	0.78	1.89	2.89
Sunset Creek	SE 30th	1576.451	100-year	412	56.81	60.36	60.36	3.55	0.034449	8.04	58.39	36.3	0.94	2.06	4.43
Sunset Creek	SE 30th	1535.154	1.01-year	85.27	56.74	58.93	58.13	2.19	0.005318	2.02	47.26	66.37	0.3	1.34	0.44
Sunset Creek	SE 30th	1535.154	2-year	128.35	56.74	59.18	58.35	2.44	0.006315	2.43	65.04	75.58	0.34	1.55	0.61
Sunset Creek	SE 30th	1535.154	10-year	200.6	56.74	59.53	58.67	2.79	0.006614	2.81	96.01	107.2	0.36	1.86	0.77
Sunset Creek	SE 30th	1535.154	25-year	252.45	56.74	59.75	58.95	3.01	0.006459	2.98	118.93	107.2	0.36	2.06	0.83
Sunset Creek	SE 30th	1535.154	100-year	350.2	56.74	60.1	59.26	3.36	0.006199	3.23	156.44	107.2	0.36	2.41	0.93
Sunset Creek	SE 30th	1520.645	1.01-year	85.27	56.07	58.91	57.6	2.84	0.001449	1.5	77.84	109.73	0.2	1.56	0.14
Sunset Creek	SE 30th	1520.645	2-year	128.35	56.07	59.16	57.84	3.09	0.001768	1.81	105.41	109.75	0.23	1.79	0.2
Sunset Creek	SE 30th	1520.645	10-year	200.6	56.07	59.52	58.19	3.45	0.002023	2.16	144.72	109.75	0.25	2.11	0.27
Sunset Creek	SE 30th	1520.645	25-year	252.45	56.07	59.73	58.4	3.66	0.002178	2.38	167.84	109.75	0.26	2.3	0.31
Sunset Creek	SE 30th	1520.645	100-year	350.2	56.07	60.07	58.97	4	0.002407	2.72	205.62	109.75	0.28	2.61	0.39
Sunset Creek	SE 30th	1493.465	1.01-year	85.27	56.01	58.76	57.64	2.75	0.003732	2.79	44.72	88.29	0.34	1.95	0.45
Sunset Creek	SE 30th	1493.465	2-year	128.35	56.01	58.95	58.02	2.94	0.005356	3.54	61.29	88.29	0.41	2.12	0.71
Sunset Creek	SE 30th	1493.465	10-year	200.6	56.01	59.27	58.92	3.26	0.006302	4.18	89.66	88.29	0.45	2.42	0.95
Sunset Creek	SE 30th	1493.465	25-year	252.45	56.01	59.46	59.1	3.45	0.006746	4.54	106.66	88.29	0.47	2.59	1.09
Sunset Creek	SE 30th	1493.465	100-year	350.2	56.01	59.78	59.35	3.77	0.007278	5.06	134.89	88.29	0.5	2.89	1.31
Sunset Creek	SE 30th	1474.062	1.01-year	85.27	56.81	58.75	58.2	1.94	0.003103	2.1	77.95	110.27	0.3	1.43	0.28
Sunset Creek	SE 30th	1474.062	2-year	128.35	56.81	58.94	58.39	2.13	0.003906	2.54	99.08	110.27	0.34	1.61	0.39
Sunset Creek	SE 30th	1474.062	10-year	200.6	56.81	59.27	58.59	2.46	0.004086	2.92	135.43	110.27	0.36	1.92	0.49
Sunset Creek	SE 30th	1474.062	25-year	252.45	56.81	59.46	58.74	2.65	0.004232	3.16	156.98	110.27	0.37	2.1	0.55
Sunset Creek	SE 30th	1474.062	100-year	350.2	56.81	59.79	58.94	2.98	0.004434	3.54	192.74	110.27	0.39	2.4	0.66
Sunset Creek	SE 30th	1400.25	1.01-year	85.27	56.09	57.61	57.61	1.52	0.03905	6.08	14.03	12.5	1	1.05	2.56
Sunset Creek	SE 30th	1400.25	2-year	128.35	56.09	58.15	58.15	2.06	0.016614	4.89	46.97	83.59	0.67	1.51	1.57
Sunset Creek	SE 30th	1400.25	10-year	200.6	56.09	58.38	58.38	2.29	0.019637	5.79	65.88	83.59	0.74	1.71	2.1
Sunset Creek	SE 30th	1400.25	25-year	252.45	56.09	58.52	58.52	2.43	0.02105	6.28	77.39	83.59	0.78	1.84	2.42
Sunset Creek	SE 30th	1400.25	100-year	350.2	56.09	58.73	58.73	2.64	0.023625	7.11	95.29	83.59	0.84	2.03	3
Sunset Creek	SE 30th	1312.582	1.01-year	85.27	54.16	56.28	55.5	2.12	0.007801	3.28	26.48	24.35	0.45	1.53	0.75
Sunset Creek	SE 30th	1312.582	2-year	128.35	54.16	56.81	55.87	2.65	0.004929	3.15	66.25	87.46	0.38	2.03	0.63
Sunset Creek	SE 30th	1312.582	10-year	200.6	54.16	57.45	56.66	3.29	0.003088	2.96	122	87.46	0.31	2.63	0.51
Sunset Creek	SE 30th	1312.582	25-year	252.45	54.16	57.83	56.86	3.67	0.002578	2.95	155.48	87.46	0.29	2.99	0.48
Sunset Creek	SE 30th	1312.582	100-year	350.2	54.16	58.5	57.11	4.34	0.002022	2.96	213.74	87.46	0.27	3.62	0.46
Sunset Creek	SE 30th	1261.44	1.01-year	85.27	53.71	55.75	55.06	2.05	0.013004	3.45	24.75	16.19	0.49	1.44	1.17
Sunset Creek	SE 30th	1261.44	2-year	128.35	53.71	56.28	55.43	2.57	0.010454	3.75	39.87	52.27	0.46	1.93	1.26
Sunset Creek	SE 30th	1261.44	10-year	200.6	53.71	57.07	55.95	3.36	0.004782	3.15	102.52	82.84	0.33	2.68	0.8
Sunset Creek	SE 30th	1261.44	25-year	252.45	53.71	57.51	56.59	3.81	0.003498	2.97	139.13	82.84	0.29	3.09	0.68
Sunset Creek	SE 30th	1261.44	100-year	350.2	53.71	58.24	56.86	4.53	0.002467	2.85	199.46	82.84	0.25	3.78	0.58
Sunset Creek	SE 30th	1259.44*	1.01-year	85.27	53.21	55.79	54.59	2.58	0.004873	2.71	31.45	17.43	0.34	1.77	0.54
Sunset Creek	SE 30th	1259.44*	2-year	128.35	53.21	56.31	54.96	3.1	0.00473	3.14	48.16	58.31	0.35	2.25	0.67
Sunset Creek	SE 30th	1259.44*	10-year	200.6	53.21	57.06	55.49	3.85	0.003055	3.01	107.85	81.88	0.3	2.94	0.56
Sunset Creek	SE 30th	1259.44*	25-year	252.45	53.21	57.5	55.81	4.29	0.002483	2.95	143.39	81.88	0.27	3.34	0.52
Sunset Creek	SE 30th	1259.44*	100-year	350.2	53.21	58.22	56.71	5.01	0.001918	2.93	202.88	81.88	0.25	4.01	0.48
Sunset Creek	SE 30th	1210.31	1.01-year	85.27	53.26	55.38	54.6	2.13	0.011323	3.27	26.05	16.51	0.46	1.49	1.05
Sunset Creek	SE 30th	1210.31	2-year	128.35	53.26	55.93	54.97	2.67	0.009087	3.57	39.89	35.83	0.43	2	1.13
Sunset Creek	SE 30th	1210.31	10-year	200.6	53.26	56.71	55.47	3.46	0.005529	3.44	81.54	58.22	0.36	2.74	0.95
Sunset Creek	SE 30th	1210.31	25-year	252.45	53.26	57.18	55.85	3.92	0.004313	3.35	108.52	58.22	0.32	3.18	0.86
Sunset Creek	SE 30th	1210.31	100-year	350.2	53.26	57.94	56.49	4.68	0.003255	3.33	152.87	58.22	0.29	3.89	0.79
Sunset Creek	SE 30th	1208.31*	1.01-year	85.27	52.76	55.41	54.12	2.66	0.004222	2.58	33.13	18.44	0.32	1.83	0.48
Sunset Creek	SE 30th	1208.31*	2-year	128.35	52.76	55.96	54.5	3.2	0.004078	2.98	48.5	39.97	0.33	2.33	0.59
Sunset Creek	SE 30th	1208.31*	10-year	200.6	52.76	56.72	55.02	3.96	0.003161	3.12	89.97	57.1	0.3	3.03	0.6
Sunset Creek	SE 30th	1208.31*	25-year	252.45	52.76	57.17	55.33	4.42	0.002747	3.17	115.91	57.1	0.29	3.45	0.59
Sunset Creek	SE 30th	1208.31*	100-year	350.2	52.76	57.93	55.95	5.17	0.002309	3.29	159.03	57.1	0.27	4.14	0.6
Sunset Creek	SE 30th	1177.949	1.01-year	100.55	52.79	55.26	54.14	2.48	0.004585	2.74	42.21	36.57	0.34	1.91	0.55
Sunset Creek	SE 30th	1177.949	2-year	151.35	52.79	55.82	54.52	3.04	0.003855	2.96	64.41	40.15	0.32	2.45	0.59
Sunset Creek	SE 30th	1177.949	10-year	236.6	52.79	56.56	55.15	3.78	0.003386	3.28	94.1	40.15	0.32	3.14	0.66
Sunset Creek	SE 30th	1177.949	25-year	297.45	52.79	56.99	55.47	4.21	0.00331	3.51	111.34	40.15	0.32	3.55	0.73
Sunset Creek	SE 30th	1177.949	100-year	413.2	52.79	57.71	55.87	4.93	0.003256	3.91	140.2	40.15	0.33	4.22	0.86
Sunset Creek	SE 30th	1159.18	1.01-year	100.55	52.8	55.01	54.29	2.21	0.01378	3.67	27.36	16.82	0.51	1.53	1.32
Sunset Creek	SE 30th	1159.18	2-year	151.35	52.8	55.54	54.69	2.73	0.01177	4.1	39.87	30.67	0.49	2.03	1.49
Sunset Creek	SE 30th	1159.18	10-year	236.6	52.8	56.32	55.25	3.51	0.008161	4.19	71.28	43.4	0.43	2.76	1.41
Sunset Creek	SE 30th	1159.18	25-year	297.45	52.8	56.77	55.64	3.97	0.006885	4.24	91.08	43.4	0.41	3.19	1.37
Sunset Creek	SE 30th	1159.18	100-year	413.2	52.8	57.52	56.23	4.72	0.005729	4.41	123.55	43.4	0.38	3.9	1.39

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	1157.18	1.01-year	100.55	52.3	55.04	53.82	2.74	0.005434	2.94	34.19	17.7	0.36	1.86	0.63
Sunset Creek	SE 30th	1157.18	2-year	151.35	52.3	55.57	54.24	3.27	0.00552	3.46	47.19	31.79	0.38	2.35	0.81
Sunset Creek	SE 30th	1157.18	10-year	236.6	52.3	56.32	54.81	4.02	0.004882	3.86	75.6	39.4	0.37	3.03	0.92
Sunset Creek	SE 30th	1157.18	25-year	297.45	52.3	56.76	55.16	4.46	0.004606	4.08	92.94	39.4	0.37	3.44	0.99
Sunset Creek	SE 30th	1157.18	100-year	413.2	52.3	57.48	55.94	5.18	0.004344	4.45	121.47	39.4	0.37	4.1	1.11
Sunset Creek	SE 30th	1108.05	1.01-year	100.55	52.35	54.56	53.84	2.21	0.013668	3.66	27.45	16.84	0.51	1.53	1.31
Sunset Creek	SE 30th	1108.05	2-year	151.35	52.35	55.09	54.24	2.74	0.011936	4.09	38.87	27.02	0.49	2.01	1.5
Sunset Creek	SE 30th	1108.05	10-year	236.6	52.35	55.88	54.78	3.52	0.008648	4.29	67.18	42.28	0.44	2.75	1.48
Sunset Creek	SE 30th	1108.05	25-year	297.45	52.35	56.35	55.17	4	0.007108	4.3	87.24	42.28	0.41	3.19	1.42
Sunset Creek	SE 30th	1108.05	100-year	413.2	52.35	57.1	55.83	4.75	0.005859	4.46	119.1	42.28	0.39	3.9	1.43
Sunset Creek	SE 30th	1106.05*	1.01-year	100.55	51.85	54.6	53.37	2.75	0.005424	2.92	34.41	17.06	0.36	1.85	0.63
Sunset Creek	SE 30th	1106.05*	2-year	151.35	51.85	55.13	53.78	3.28	0.005519	3.44	46.37	28.11	0.38	2.33	0.8
Sunset Creek	SE 30th	1106.05*	10-year	236.6	51.85	55.89	54.35	4.04	0.00492	3.86	74.61	43.14	0.37	3.03	0.93
Sunset Creek	SE 30th	1106.05*	25-year	297.45	51.85	56.35	54.69	4.5	0.004441	4.01	94.55	43.14	0.36	3.46	0.96
Sunset Creek	SE 30th	1106.05*	100-year	413.2	51.85	57.1	55.36	5.25	0.003999	4.29	126.68	43.14	0.36	4.14	1.03
Sunset Creek	SE 30th	1056.91	1.01-year	100.55	51.9	54.12	53.39	2.22	0.013496	3.65	27.58	16.87	0.5	1.54	1.3
Sunset Creek	SE 30th	1056.91	2-year	151.35	51.9	54.66	53.79	2.76	0.011911	4.06	38.5	24.82	0.49	2	1.49
Sunset Creek	SE 30th	1056.91	10-year	236.6	51.9	55.45	54.32	3.55	0.008919	4.34	62.4	34.28	0.45	2.74	1.53
Sunset Creek	SE 30th	1056.91	25-year	297.45	51.9	55.9	54.68	4	0.00792	4.51	79.46	41.16	0.43	3.17	1.57
Sunset Creek	SE 30th	1056.91	100-year	413.2	51.9	56.68	55.27	4.78	0.006414	4.65	116.66	55.18	0.4	3.9	1.56
Sunset Creek	SE 30th	1054.91*	1.01-year	100.55	51.4	54.15	52.91	2.75	0.005358	2.91	34.61	17.14	0.36	1.85	0.62
Sunset Creek	SE 30th	1054.91*	2-year	151.35	51.4	54.69	53.33	3.3	0.005502	3.41	45.97	25.71	0.38	2.32	0.8
Sunset Creek	SE 30th	1054.91*	10-year	236.6	51.4	55.47	53.9	4.07	0.004982	3.88	69.92	34.72	0.38	3.03	0.94
Sunset Creek	SE 30th	1054.91*	25-year	297.45	51.4	55.92	54.24	4.52	0.004786	4.14	86.89	41.61	0.38	3.44	1.03
Sunset Creek	SE 30th	1054.91*	100-year	413.2	51.4	56.67	54.91	5.28	0.004306	4.44	123.51	55.16	0.37	4.14	1.11
Sunset Creek	SE 30th	1005.78	1.01-year	100.55	51.45	53.68	52.94	2.23	0.013129	3.61	27.86	16.94	0.5	1.55	1.27
Sunset Creek	SE 30th	1005.78	2-year	151.35	51.45	54.23	53.34	2.78	0.011692	4.01	38.57	23.39	0.49	2	1.46
Sunset Creek	SE 30th	1005.78	10-year	236.6	51.45	55.05	53.87	3.61	0.008505	4.26	63.45	37.48	0.44	2.77	1.47
Sunset Creek	SE 30th	1005.78	25-year	297.45	51.45	55.53	54.22	4.09	0.007187	4.33	82.15	41.07	0.41	3.22	1.44
Sunset Creek	SE 30th	1005.78	100-year	413.2	51.45	56.32	54.83	4.87	0.00573	4.44	118.46	51.18	0.38	3.96	1.42
Sunset Creek	SE 30th	1003.78*	1.01-year	100.55	50.95	53.72	52.47	2.77	0.005234	2.88	34.94	17.24	0.36	1.86	0.61
Sunset Creek	SE 30th	1003.78*	2-year	151.35	50.95	54.27	52.88	3.32	0.005418	3.37	46.01	24.15	0.37	2.32	0.78
Sunset Creek	SE 30th	1003.78*	10-year	236.6	50.95	55.08	53.44	4.13	0.004761	3.81	71.03	37.65	0.37	3.06	0.91
Sunset Creek	SE 30th	1003.78*	25-year	297.45	50.95	55.54	53.79	4.6	0.004412	4	89.32	41.22	0.36	3.49	0.96
Sunset Creek	SE 30th	1003.78*	100-year	413.2	50.95	56.32	54.4	5.37	0.003908	4.26	124.97	51.01	0.35	4.2	1.02
Sunset Creek	SE 30th	954.652	1.01-year	100.55	50.99	53.27	52.48	2.28	0.012284	3.52	28.55	17.1	0.48	1.57	1.2
Sunset Creek	SE 30th	954.652	2-year	151.35	50.99	53.83	52.88	2.83	0.011067	3.92	39.27	22.64	0.47	2.01	1.39
Sunset Creek	SE 30th	954.652	10-year	236.6	50.99	54.7	53.42	3.71	0.007704	4.11	64.57	35.59	0.42	2.84	1.36
Sunset Creek	SE 30th	954.652	25-year	297.45	50.99	55.18	53.75	4.19	0.00661	4.2	82.5	38.38	0.4	3.29	1.36
Sunset Creek	SE 30th	954.652	100-year	413.2	50.99	55.97	54.35	4.98	0.005444	4.37	115.19	44.99	0.37	4.03	1.37
Sunset Creek	SE 30th	952.651*	1.01-year	100.55	50.49	53.3	52.01	2.81	0.004965	2.82	35.67	17.4	0.35	1.88	0.58
Sunset Creek	SE 30th	952.651*	2-year	151.35	50.49	53.86	52.42	3.37	0.005184	3.31	46.68	23.28	0.37	2.33	0.75
Sunset Creek	SE 30th	952.651*	10-year	236.6	50.49	54.72	52.99	4.23	0.004367	3.69	72.11	36.07	0.35	3.12	0.85
Sunset Creek	SE 30th	952.651*	25-year	297.45	50.49	55.19	53.33	4.7	0.004078	3.88	89.71	38.42	0.35	3.55	0.9
Sunset Creek	SE 30th	952.651*	100-year	413.2	50.49	55.97	53.92	5.48	0.003701	4.18	121.92	44.9	0.34	4.27	0.99
Sunset Creek	SE 30th	903.519	1.01-year	100.55	50.54	52.9	52.03	2.36	0.010779	3.35	29.98	17.43	0.45	1.62	1.09
Sunset Creek	SE 30th	903.519	2-year	151.35	50.54	53.46	52.43	2.92	0.009878	3.76	40.87	22.55	0.45	2.06	1.27
Sunset Creek	SE 30th	903.519	10-year	236.6	50.54	54.4	52.97	3.86	0.006519	3.88	67.79	34.8	0.39	2.95	1.2
Sunset Creek	SE 30th	903.519	25-year	297.45	50.54	54.88	53.29	4.34	0.00576	4.01	85.03	36.96	0.37	3.4	1.22
Sunset Creek	SE 30th	903.519	100-year	413.2	50.54	55.67	53.88	5.12	0.004919	4.22	115.38	40.99	0.35	4.13	1.27
Sunset Creek	SE 30th	901.518*	1.01-year	100.55	50.04	52.93	51.56	2.89	0.004484	2.71	37.1	17.71	0.33	1.92	0.54
Sunset Creek	SE 30th	901.518*	2-year	151.35	50.04	53.49	51.97	3.45	0.004727	3.19	48.26	23.07	0.35	2.38	0.7
Sunset Creek	SE 30th	901.518*	10-year	236.6	50.04	54.42	52.54	4.38	0.003777	3.5	75.25	35.17	0.33	3.23	0.76
Sunset Creek	SE 30th	901.518*	25-year	297.45	50.04	54.89	52.88	4.85	0.003599	3.71	92.24	36.98	0.33	3.66	0.82
Sunset Creek	SE 30th	901.518*	100-year	413.2	50.04	55.67	53.45	5.62	0.003356	4.04	122.23	40.94	0.33	4.37	0.92
Sunset Creek	SE 30th	852.3866	1.01-year	100.55	50.09	52.65	51.57	2.56	0.0057	2.99	33.65	18.25	0.39	1.73	0.62
Sunset Creek	SE 30th	852.3866	2-year	151.35	50.09	53.21	51.98	3.12	0.005327	3.42	45.34	23.81	0.39	2.23	0.74
Sunset Creek	SE 30th	852.3866	10-year	236.6	50.09	54.21	52.52	4.12	0.00362	3.56	74.63	35.1	0.34	3.16	0.72
Sunset Creek	SE 30th	852.3866	25-year	297.45	50.09	54.67	52.83	4.58	0.003408	3.76	91.02	36.02	0.34	3.6	0.77
Sunset Creek	SE 30th	852.3866	100-year	413.2	50.09	55.43	53.41	5.34	0.003158	4.08	119.31	38.42	0.34	4.31	0.85
Sunset Creek	SE 30th	834.4796	1.01-year	100.55	50.42	52.35	52.05	1.93	0.014712	4.18	24.05	20.5	0.68	1.14	1.05
Sunset Creek	SE 30th	834.4796	2-year	151.35	50.42	53.04	52.37	2.62	0.007437	3.91	39.74	25.09	0.51	1.75	0.81
Sunset Creek	SE 30th	834.4796	10-year	236.6	50.42	54.14	52.8	3.72	0.003772	3.63	71.21	32.39	0.38	2.65	0.62
Sunset Creek	SE 30th	834.4796	25-year	297.45	50.42	54.6	53.07	4.18	0.003524	3.8	86.65	33.41	0.37	3.02	0.66
Sunset Creek	SE 30th	834.4796	100-year	413.2	50.42	55.37	53.54	4.95	0.003287	4.09	112.46	33.9	0.36	3.6	0.74
Sunset Creek	SE 30th	816.2844	1.01-year	100.55	50.18	52.24	51.75	2.06	0.008136	3.12	32.24	26.8	0.5	1.16	0.59
Sunset Creek	SE 30th	816.2844	2-year	151.35	50.18	53.02	52.01	2.84	0.004051	2.78	54.46	30.02	0.36	1.73	0.44
Sunset Creek	SE 30th	816.2844	10-year	236.6	50.18	54.15	52.38	3.97	0.002004	2.59	96.71	43.1	0.27	2.69	0.34
Sunset Creek	SE 30th	816.2844	25-year	297.45	50.18	54.62	52.61	4.44	0.001865	2.72	117.16	43.45	0.26	3.08	0.36
Sunset Creek	SE 30th	816.2844	100-year	413.2	50.18	55.4	53	5.22	0.00174	2.96	151.17	44.04	0.26	3.71	0.4

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Sunset Creek	SE 30th	795.8286	1.01-year	100.55	50.27	52.19	51.34	1.92	0.003156	2.32	44.88	31.92	0.32	1.48	0.29
Sunset Creek	SE 30th	795.8286	2-year	151.35	50.27	53	51.59	2.73	0.001782	2.23	72.06	35.09	0.25	2.18	0.24
Sunset Creek	SE 30th	795.8286	10-year	236.6	50.27	54.14	51.96	3.87	0.001154	2.25	114.01	37.65	0.21	3.1	0.22
Sunset Creek	SE 30th	795.8286	25-year	297.45	50.27	54.61	52.18	4.34	0.001192	2.45	131.73	37.82	0.22	3.47	0.26
Sunset Creek	SE 30th	795.8286	100-year	413.2	50.27	55.38	52.55	5.11	0.001273	2.79	161.05	38.09	0.23	4.05	0.32
Sunset Creek	SE 30th	772.6812	1.01-year	100.55	49.8	52.11	51.34	2.31	0.00364	2.31	43.75	31.59	0.34	1.35	0.31
Sunset Creek	SE 30th	772.6812	2-year	151.35	49.8	52.96	51.57	3.16	0.001802	2.15	72.65	36.28	0.25	2.08	0.23
Sunset Creek	SE 30th	772.6812	10-year	236.6	49.8	54.12	51.89	4.32	0.001111	2.15	114.96	45.55	0.21	3.03	0.21
Sunset Creek	SE 30th	772.6812	25-year	297.45	49.8	54.59	52.11	4.79	0.001118	2.35	132.29	46.91	0.21	3.44	0.24
Sunset Creek	SE 30th	772.6812	100-year	413.2	49.8	55.36	52.47	5.56	0.001144	2.68	160.78	49.34	0.22	4.13	0.29
Sunset Creek	SE 30th	742.021	1.01-year	100.55	49.76	52.02	51.21	2.26	0.003175	2.11	47.73	33.85	0.31	1.33	0.26
Sunset Creek	SE 30th	742.021	2-year	151.35	49.76	52.92	51.43	3.16	0.001521	1.91	79.37	41.36	0.23	2.05	0.19
Sunset Creek	SE 30th	742.021	10-year	236.6	49.76	54.09	51.73	4.33	0.000907	1.94	122	51.48	0.19	3.11	0.18
Sunset Creek	SE 30th	742.021	25-year	297.45	49.76	54.56	51.93	4.8	0.000926	2.14	139.1	53.01	0.19	3.55	0.21
Sunset Creek	SE 30th	742.021	100-year	413.2	49.76	55.33	52.27	5.57	0.000967	2.47	167.2	53.01	0.2	4.27	0.26
Sunset Creek	SE 30th	704.0906		Bridge											
Sunset Creek	SE 30th	637.1669	1.01-year	100.55	49	51.91	50.27	2.91	0.00085	1.45	70.14	47.21	0.17	2.09	0.11
Sunset Creek	SE 30th	637.1669	2-year	151.35	49	52.51	50.53	3.51	0.000907	1.72	88.88	47.46	0.18	2.59	0.15
Sunset Creek	SE 30th	637.1669	10-year	236.6	49	53.11	50.86	4.11	0.001183	2.21	108.38	50.77	0.21	3.11	0.23
Sunset Creek	SE 30th	637.1669	25-year	297.45	49	53.45	51.05	4.45	0.001363	2.53	120.73	55.09	0.23	3.42	0.29
Sunset Creek	SE 30th	637.1669	100-year	413.2	49	53.98	51.41	4.98	0.001657	3.04	141.58	55.09	0.26	3.9	0.4
Sunset Creek	SE 30th	616.5581	1.01-year	100.55	48.88	51.91	49.89	3.03	0.000324	1.03	110.9	63.72	0.11	2.53	0.05
Sunset Creek	SE 30th	616.5581	2-year	151.35	48.88	52.51	50.12	3.63	0.00037	1.24	138.28	68.1	0.12	3.03	0.07
Sunset Creek	SE 30th	616.5581	10-year	236.6	48.88	53.13	50.44	4.25	0.00051	1.6	166.3	68.46	0.14	3.53	0.11
Sunset Creek	SE 30th	616.5581	25-year	297.45	48.88	53.47	50.61	4.59	0.0006	1.83	182.43	71.56	0.16	3.83	0.14
Sunset Creek	SE 30th	616.5581	100-year	413.2	48.88	54.01	50.91	5.13	0.000755	2.23	209.89	73.22	0.18	4.33	0.2
Sunset Creek	SE 30th	596.5916	1.01-year	100.55	48.52	51.89	49.66	3.37	0.000468	1.23	86.52	39.78	0.13	2.65	0.08
Sunset Creek	SE 30th	596.5916	2-year	151.35	48.52	52.49	49.91	3.97	0.000582	1.52	105.29	41.8	0.14	3.12	0.11
Sunset Creek	SE 30th	596.5916	10-year	236.6	48.52	53.09	50.27	4.57	0.000845	2.02	124.4	43.07	0.18	3.62	0.19
Sunset Creek	SE 30th	596.5916	25-year	297.45	48.52	53.41	50.49	4.89	0.001027	2.34	135.37	44.36	0.2	3.91	0.25
Sunset Creek	SE 30th	596.5916	100-year	413.2	48.52	53.93	50.89	5.41	0.001351	2.89	153.62	46.4	0.23	4.37	0.37
Sunset Creek	SE 30th	572.9708	1.01-year	100.55	47.8	51.78	50.11	3.98	0.007565	2.48	40.55	21.96	0.31	1.85	0.87
Sunset Creek	SE 30th	572.9708	2-year	151.35	47.8	52.36	50.59	4.56	0.007021	2.83	57.43	34.92	0.31	2.37	1.04
Sunset Creek	SE 30th	572.9708	10-year	236.6	47.8	52.92	51.28	5.12	0.007936	3.43	77.72	37.49	0.34	2.89	1.43
Sunset Creek	SE 30th	572.9708	25-year	297.45	47.8	53.22	51.64	5.42	0.008632	3.8	89.31	38.6	0.36	3.17	1.71
Sunset Creek	SE 30th	572.9708	100-year	413.2	47.8	53.7	52.3	5.9	0.009748	4.41	107.88	38.6	0.39	3.61	2.2
Sunset Creek	SE 30th	554.7107	1.01-year	100.55	47.62	51.53	49.85	3.91	0.008694	3.52	29.6	16.89	0.36	2.05	1.11
Sunset Creek	SE 30th	554.7107	2-year	151.35	47.62	52.03	50.4	4.41	0.010838	4.35	44.1	52.71	0.41	2.39	1.61
Sunset Creek	SE 30th	554.7107	10-year	236.6	47.62	52.64	51.17	5.02	0.010099	4.68	77.48	55.47	0.41	2.81	1.77
Sunset Creek	SE 30th	554.7107	25-year	297.45	47.62	52.99	52.36	5.37	0.009703	4.83	96.72	56.99	0.4	3.04	1.84
Sunset Creek	SE 30th	554.7107	100-year	413.2	47.62	53.53	52.75	5.91	0.009122	5.06	131.7	116.88	0.4	3.41	1.94
Sunset Creek	SE 30th	543.1325	1.01-year	100.55	47.65	51.51	49.72	3.86	0.003282	2.92	35.07	49.3	0.3	2.2	0.45
Sunset Creek	SE 30th	543.1325	2-year	151.35	47.65	52.04	50.19	4.39	0.003632	3.37	63.66	55.12	0.32	2.55	0.58
Sunset Creek	SE 30th	543.1325	10-year	236.6	47.65	52.63	50.87	4.98	0.003922	3.9	97.98	117.31	0.35	3	0.73
Sunset Creek	SE 30th	543.1325	25-year	297.45	47.65	52.96	51.29	5.31	0.004001	4.15	120.15	117.31	0.35	3.25	0.81
Sunset Creek	SE 30th	543.1325	100-year	413.2	47.65	53.49	52.3	5.84	0.00408	4.53	155.86	117.31	0.36	3.65	0.93
Sunset Creek	SE 30th	529.8341	1.01-year	100.55	47.8	51.46	49.72	3.66	0.003873	2.94	34.83	19.16	0.31	2.16	0.52
Sunset Creek	SE 30th	529.8341	2-year	151.35	47.8	51.99	50.2	4.19	0.004248	3.38	59.44	104.48	0.33	2.5	0.66
Sunset Creek	SE 30th	529.8341	10-year	236.6	47.8	52.58	50.88	4.78	0.004265	3.79	93.68	110.74	0.34	2.96	0.79
Sunset Creek	SE 30th	529.8341	25-year	297.45	47.8	52.91	51.3	5.11	0.00435	4.04	114.06	114.19	0.35	3.22	0.87
Sunset Creek	SE 30th	529.8341	100-year	413.2	47.8	53.44	52.33	5.64	0.00447	4.44	149.2	119.72	0.36	3.62	1.01
Sunset Creek	SE 30th	420.6496	1.01-year	100.55	47.11	51.29	48.76	4.18	0.0013	1.96	52.8	25.33	0.19	2.57	0.21
Sunset Creek	SE 30th	420.6496	2-year	151.35	47.11	51.75	49.16	4.64	0.001807	2.47	75.24	54.33	0.23	2.87	0.32
Sunset Creek	SE 30th	420.6496	10-year	236.6	47.11	52.28	49.73	5.17	0.002317	3.07	109.78	118.2	0.26	3.29	0.48
Sunset Creek	SE 30th	420.6496	25-year	297.45	47.11	52.58	50.1	5.47	0.002576	3.38	130.07	118.2	0.28	3.53	0.57
Sunset Creek	SE 30th	420.6496	100-year	413.2	47.11	53.07	50.75	5.96	0.002913	3.86	163.44	118.2	0.31	3.92	0.71
Sunset Creek	SE 30th	48.9477	1.01-year	100.55	47.18	50.46	49.5	3.28	0.004085	2.58	56.19	131.31	0.34	1.67	0.43
Sunset Creek	SE 30th	48.9477	2-year	151.35	47.18	50.74	49.88	3.56	0.004403	2.94	78.45	131.31	0.36	1.92	0.53
Sunset Creek	SE 30th	48.9477	10-year	236.6	47.18	51.16	50.55	3.98	0.004202	3.24	112.41	131.31	0.36	2.31	0.61
Sunset Creek	SE 30th	48.9477	25-year	297.45	47.18	51.39	50.7	4.21	0.004248	3.46	131.65	131.31	0.37	2.52	0.67
Sunset Creek	SE 30th	48.9477	100-year	413.2	47.18	51.78	50.92	4.6	0.004331	3.82	163.51	131.31	0.38	2.88	0.78
Richards Creek	Historical	1507.208	1.01-year	15.05	57.05	58.62	57.65	1.57	0.002703	0.91	16.56	17.45	0.16	0.89	0.15
Richards Creek	Historical	1507.208	2-year	22.65	57.05	58.81	57.8	1.76	0.003796	1.13	20.06	19	0.19	0.98	0.23
Richards Creek	Historical	1507.208	10-year	35.4	57.05	59.02	58	1.97	0.005499	1.47	24.22	22.91	0.24	1.12	0.39
Richards Creek	Historical	1507.208	25-year	44.55	57.05	59.13	58.13	2.08	0.006525	1.69	27.09	26.94	0.26	1.21	0.49
Richards Creek	Historical	1507.208	100-year	61.8	57.05	59.27	58.31	2.22	0.00875	2.09	31.13	30.61	0.31	1.34	0.73
Richards Creek	Historical	1481.097	1.01-year	15.05	57.41	58.45	58.08	1.04	0.012687	1.84	10.58	30.74	0.37	0.74	0.58
Richards Creek	Historical	1481.097	2-year	22.65	57.41	58.65	58.32	1.24	0.009489	1.77	20.33	70.02	0.32	0.88	0.52
Richards Creek	Historical	1481.097	10-year	35.4	57.41	58.87	58.51	1.46	0.006409	1.61	40.06	108.82	0.27	1.05	0.42
Richards Creek	Historical	1481.097	25-year	44.55	57.41	59	58.61	1.59	0.004818	1.51	56.33	131.14	0.24	1.18	0.36
Richards Creek	Historical	1481.097	100-year	61.8	57.41	59.14	58.72	1.73	0.004481	1.57	76.03	145.39	0.24	1.32	0.37

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Max Chl Dpth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Hydr Radius C (ft)	Shear Chan (lb/sq ft)
Richards Creek	Historical	1291.987	1.01-year	15.05	55.48	56.38	56.05	0.9	0.009455	1.94	7.75	12.07	0.43	0.63	0.37
Richards Creek	Historical	1291.987	2-year	22.65	55.48	56.5	56.19	1.02	0.012864	2.44	9.29	12.84	0.5	0.71	0.57
Richards Creek	Historical	1291.987	10-year	35.4	55.48	56.57	56.38	1.09	0.024577	3.49	10.15	13.24	0.7	0.75	1.15
Richards Creek	Historical	1291.987	25-year	44.55	55.48	56.5	56.5	1.02	0.050988	4.83	9.21	12.8	1	0.7	2.24
Richards Creek	Historical	1291.987	100-year	61.8	55.48	56.68	56.68	1.2	0.049454	5.28	11.71	13.74	1.01	0.83	2.56
Richards Creek	Historical	999.2128	1.01-year	15.05	51.78	52.33	52.21	0.55	0.021643	2.41	6.26	14.62	0.65	0.42	0.57
Richards Creek	Historical	999.2128	2-year	22.65	51.78	52.53	52.32	0.75	0.014271	2.42	9.35	15.49	0.55	0.59	0.53
Richards Creek	Historical	999.2128	10-year	35.4	51.78	52.91	52.47	1.13	0.007803	2.29	15.44	17.09	0.42	0.88	0.43
Richards Creek	Historical	999.2128	25-year	44.55	51.78	53.76	52.56	1.98	0.00159	1.41	31.52	20.71	0.2	1.46	0.15
Richards Creek	Historical	999.2128	100-year	61.8	51.78	56.21	52.72	4.43	0.000142	0.66	100.91	107.95	0.06	3.03	0.03
Richards Creek	Historical	968.151	1.01-year	15.05	51.3	52.1	51.71	0.8	0.00443	1.44	10.46	15.61	0.31	0.66	0.18
Richards Creek	Historical	968.151	2-year	22.65	51.3	52.38	51.82	1.08	0.003527	1.53	14.82	16.66	0.29	0.87	0.19
Richards Creek	Historical	968.151	10-year	35.4	51.3	52.81	51.97	1.51	0.002585	1.58	22.37	18.33	0.25	1.18	0.19
Richards Creek	Historical	968.151	25-year	44.55	51.3	53.73	52.06	2.43	0.000733	1.09	41.02	21.87	0.14	1.78	0.08
Richards Creek	Historical	968.151	100-year	61.8	51.3	56.21	52.22	4.91	0.000098	0.59	104.01	211.68	0.05	3.38	0.02
Richards Creek	Historical	913.9713		Culvert											
Richards Creek	Historical	875.7664	1.01-year	15.05	49.6	50.58	49.88	0.98	0.00081	0.71	21.08	26.28	0.14	0.79	0.04
Richards Creek	Historical	875.7664	2-year	22.65	49.6	50.86	49.97	1.26	0.000732	0.78	28.95	29.02	0.14	0.98	0.04
Richards Creek	Historical	875.7664	10-year	35.4	49.6	51.29	50.09	1.69	0.000626	0.84	42.23	33.05	0.13	1.25	0.05
Richards Creek	Historical	875.7664	25-year	44.55	49.6	51.54	50.17	1.94	0.000605	0.88	50.7	35.35	0.13	1.4	0.05
Richards Creek	Historical	875.7664	100-year	61.8	49.6	51.95	50.29	2.35	0.000572	0.94	66.07	39.19	0.13	1.64	0.06
Richards Creek	Historical	843.4692	1.01-year	15.05	49.48	50.56	49.76	1.08	0.000568	0.63	23.9	27.54	0.12	0.85	0.03
Richards Creek	Historical	843.4692	2-year	22.65	49.48	50.84	49.85	1.36	0.000547	0.7	32.19	30.37	0.12	1.04	0.04
Richards Creek	Historical	843.4692	10-year	35.4	49.48	51.27	49.97	1.79	0.000493	0.77	46.14	34.42	0.12	1.31	0.04
Richards Creek	Historical	843.4692	25-year	44.55	49.48	51.52	50.05	2.04	0.000486	0.81	54.96	36.68	0.12	1.46	0.04
Richards Creek	Historical	843.4692	100-year	61.8	49.48	51.93	50.17	2.45	0.000471	0.87	70.89	55.77	0.12	1.7	0.05
Richards Creek	Historical	240.4131	1.01-year	15.05	45.9	50.56	46.6	4.66	0.000001	0.11	371.26	206.5	0.01	3.59	0
Richards Creek	Historical	240.4131	2-year	22.65	45.9	50.84	46.73	4.94	0.000001	0.14	431.96	217.66	0.01	3.84	0
Richards Creek	Historical	240.4131	10-year	35.4	45.9	51.27	46.92	5.37	0.000002	0.19	529.07	234.43	0.02	4.22	0
Richards Creek	Historical	240.4131	25-year	44.55	45.9	51.52	47.05	5.62	0.000003	0.21	587.99	238.56	0.02	4.44	0
Richards Creek	Historical	240.4131	100-year	61.8	45.9	51.93	47.25	6.03	0.000003	0.25	686.53	238.56	0.02	4.81	0
Richards Creek	Lower	85.48712	1.01-year	120.25	47.08	50.47	49.54	3.39	0.002211	2.56	102.83	256.31	0.32	1.77	0.24
Richards Creek	Lower	85.48712	2-year	181	47.08	50.75	50.28	3.67	0.002319	2.87	146.45	256.31	0.34	2.03	0.29
Richards Creek	Lower	85.48712	10-year	297	47.08	51.17	50.56	4.09	0.002454	3.31	211.53	256.31	0.36	2.41	0.37
Richards Creek	Lower	85.48712	25-year	376	47.08	51.41	50.7	4.33	0.002514	3.55	248.93	256.31	0.37	2.63	0.41
Richards Creek	Lower	85.48712	100-year	525	47.08	51.81	50.93	4.73	0.002587	3.92	311.09	256.31	0.38	2.99	0.48
Richards Creek	Lower	26.62222	1.01-year	120.25	47	50.29	49.45	3.29	0.003002	2.88	87.32	256.31	0.37	1.68	0.32
Richards Creek	Lower	26.62222	2-year	181	47	50.57	50.2	3.57	0.003	3.16	131.03	256.31	0.38	1.94	0.36
Richards Creek	Lower	26.62222	10-year	297	47	50.99	50.48	3.99	0.003001	3.57	196.15	256.31	0.39	2.32	0.43
Richards Creek	Lower	26.62222	25-year	376	47	51.23	50.62	4.23	0.003004	3.79	233.5	256.31	0.4	2.54	0.48
Richards Creek	Lower	26.62222	100-year	525	47	51.63	50.85	4.63	0.003001	4.14	295.65	256.31	0.41	2.9	0.54

SUNSET CREEK FLOW GAGE (STATION 1) AND RICHARDS CREEK FLOW GAGE (STATION 2) HYDROGRAPHS

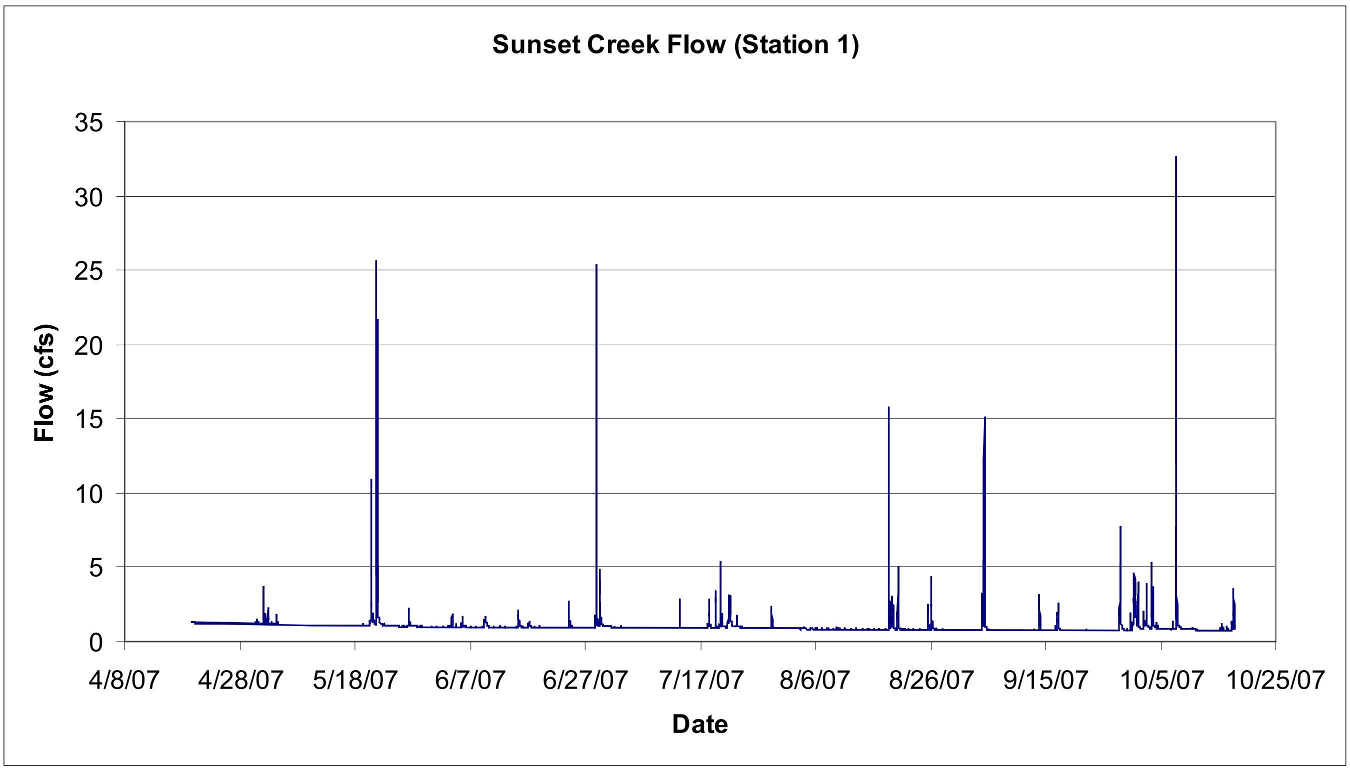

Figure D-27. Hydrograph for Sunset Creek flow gage at Station 1.

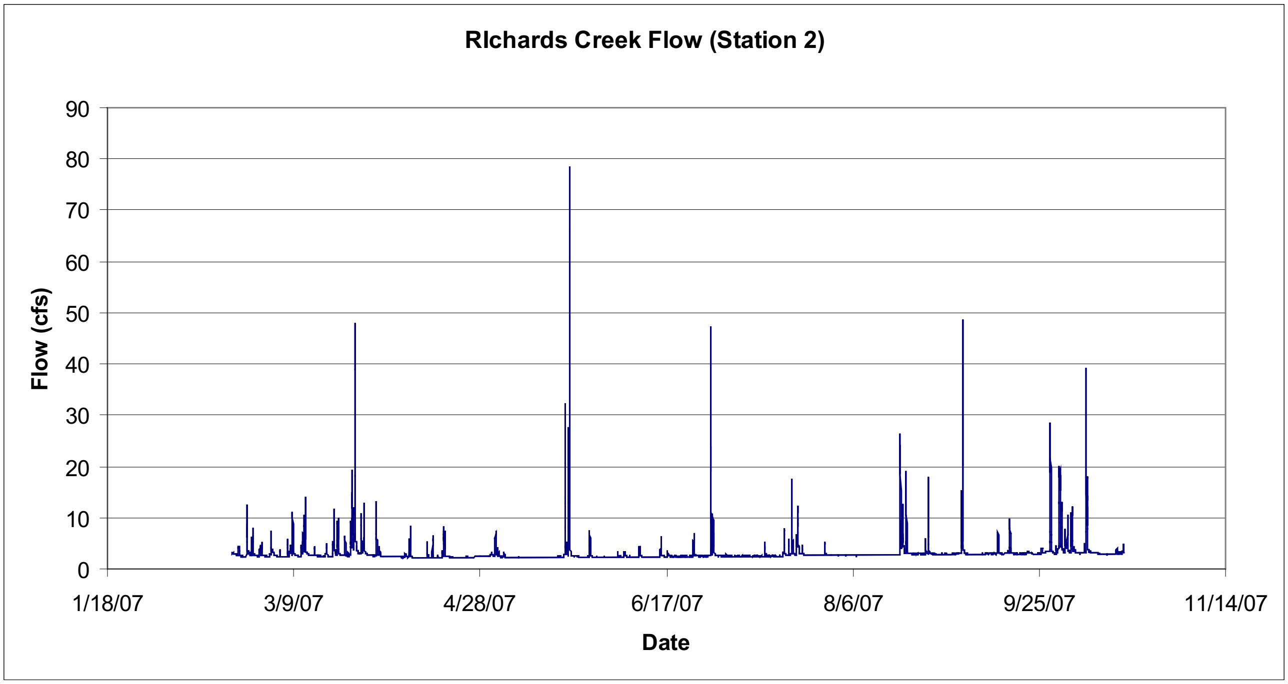

Figure D-28. Hydrograph for Richards Creek flow gage at Station 2.

APPENDIX E

Sediment Transport Modeling Inputs

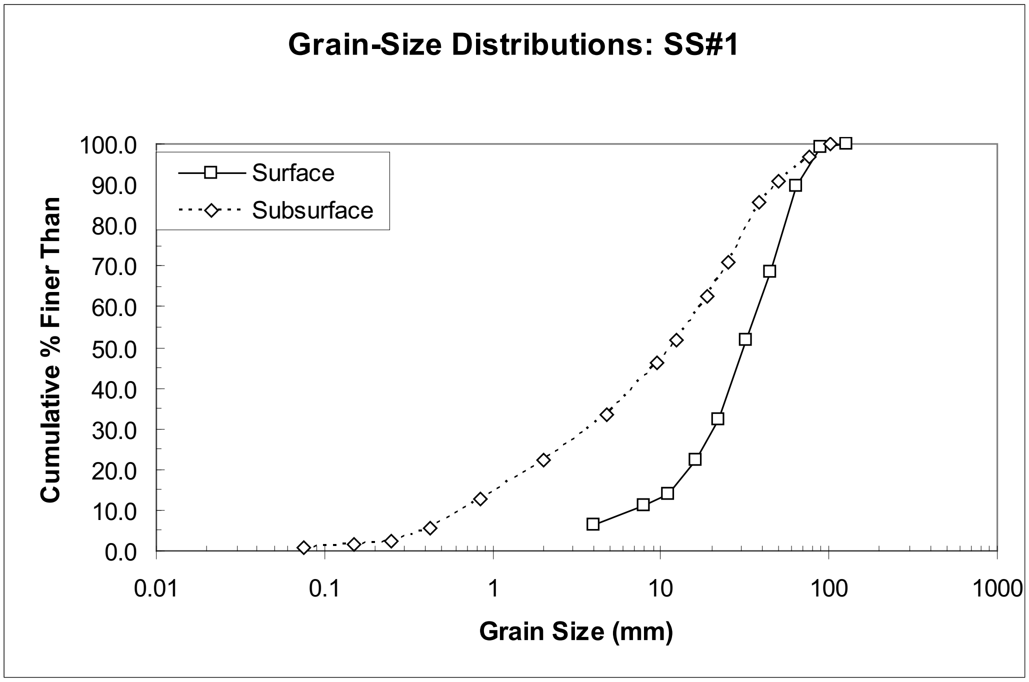

Figure E-1. Surface and subsurface grain-size distributions at sediment sample location SS#1.

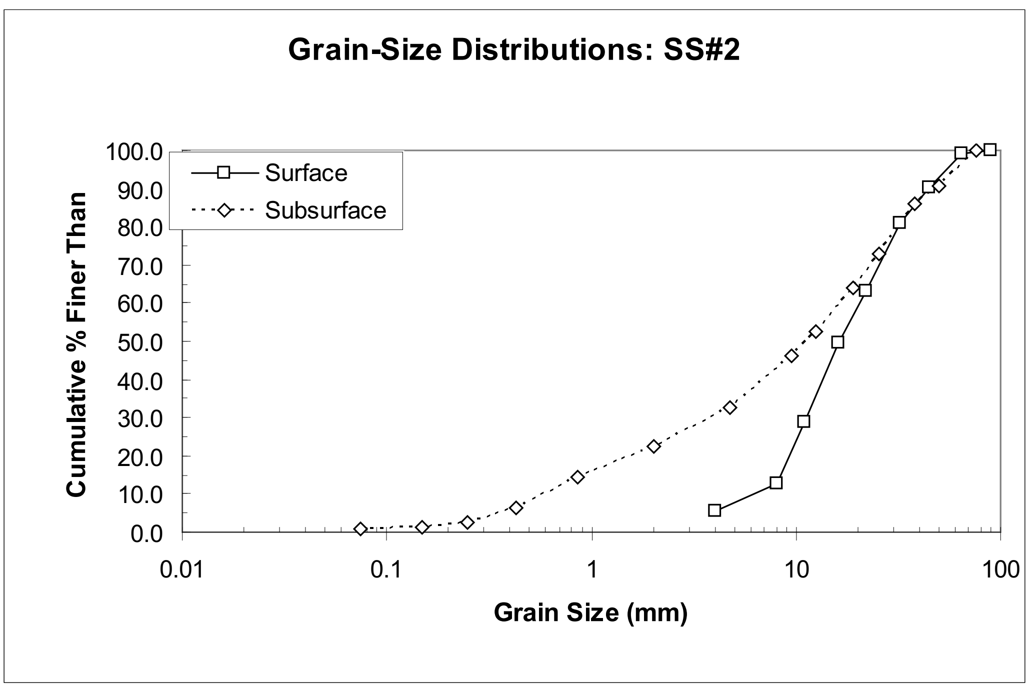

Figure E-2. Surface and subsurface grain-size distribution sat sediment sample location SS#2.

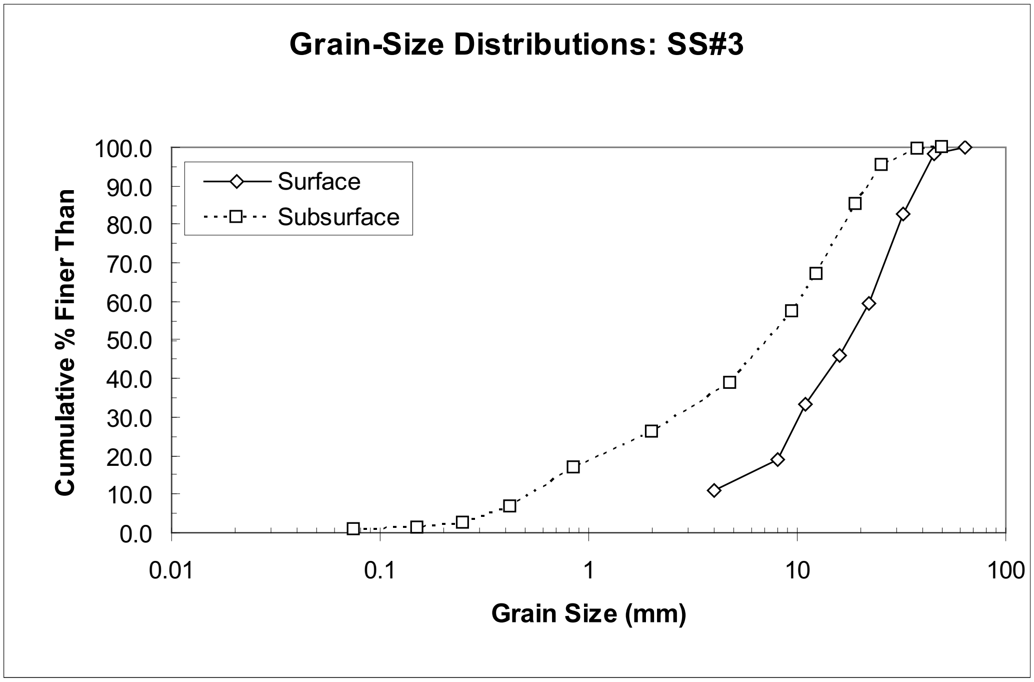

Figure E-3. Surface and subsurface grain-size distributions at sediment sample location SS#3.

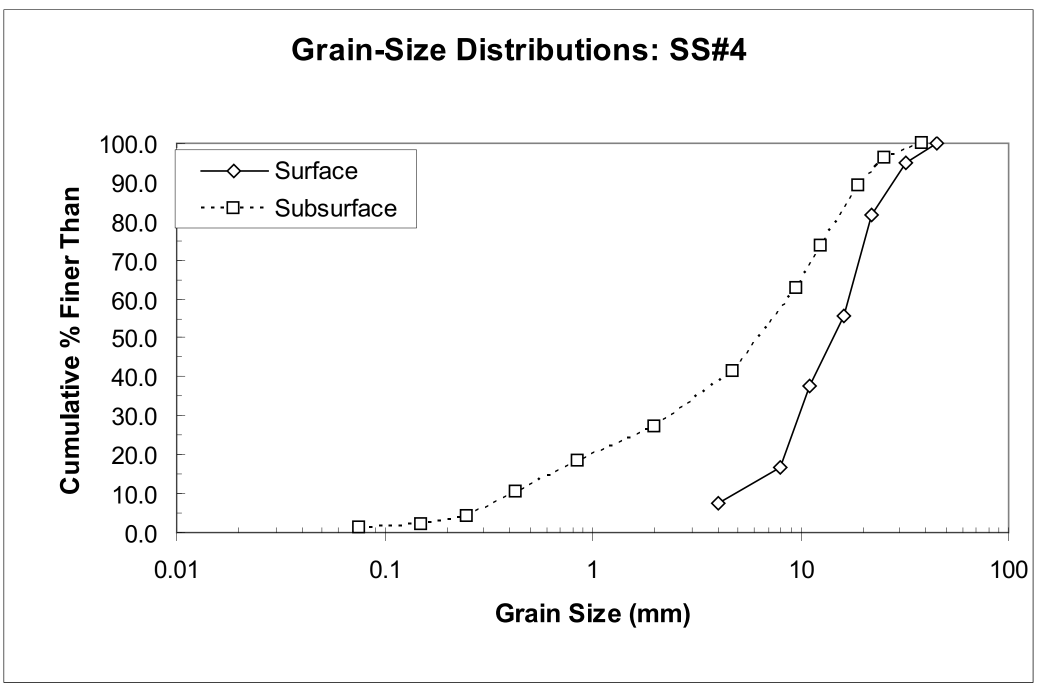

Figure E-4. Surface and subsurface grain-size distributions at sediment sample location SS#4.

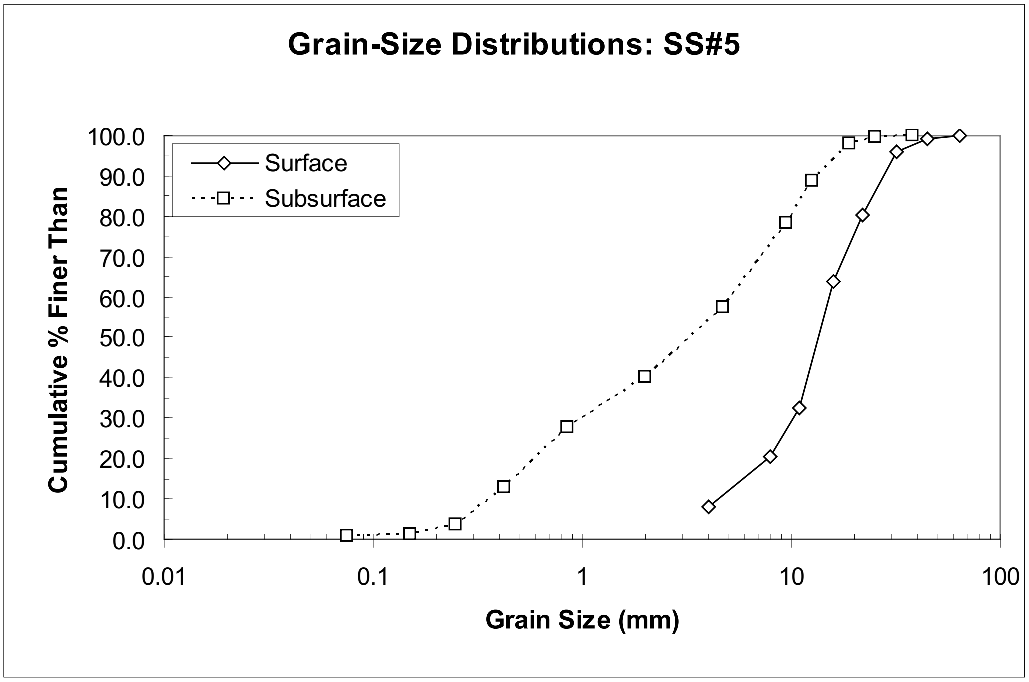

Figure E-5. Surface and subsurface grain-size distributions at sediment sample location SS#5.

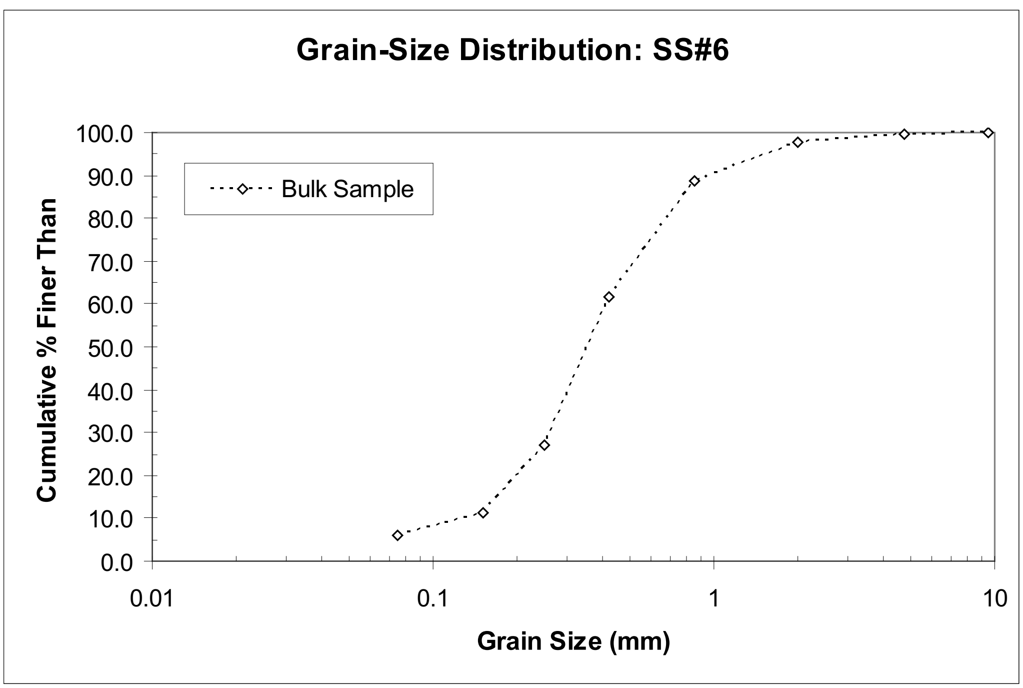

Figure E-6. Surface grain-size distribution at sediment sample location SS#6.

Table E-1. Input parameters for bedload transport calculations at Station 2527 under the existing conditions.

Friction slope from a model	0.00784	SURFACE GRAIN SIZE DISTRIBUTION		
		Size (mm)	% Finer	
Bankfull width	N/A	2	0	
		4	6.5	
Min. water discharge	1.49 cms	8	11.1	
Max. water discharge	3.57 cms	11	13.9	
		16	22.2	
Left floodplain boundary	2.89 m	22	32.4	
Left floodplain Manning's n	0.06	32	51.9	
Right floodplain boundary	5.41 m	45	68.5	
Right floodplain Manning's n	0.06	64	89.8	
		90	99.1	
CROSS SECTION		128	100	
Lateral distance (m)	Elevation (m)			
0	21.39112412	STATISTICS OF THE ABOVE GRAIN SIZE DISTRIBUTION:		
1.106437454	21.36978786	Geometric mean (mm)		26.04
1.630699829	21.36064375	Geometric standard deviation		2.4
1.99341624	21.23262619	D10 (mm)		6.78
2.898683248	20.9125823	D16 (mm)		12.09
3.331504511	20.33345525	D25 (mm)		17.46
3.547915143	20.32735918	D50 (mm)		30.85
3.922823702	20.36698366	D65 (mm)		41.88
4.218483297	20.40051207	D75 (mm)		50.11
5.148134601	20.43404048	D84 (mm)		58.15
5.410265789	20.82723726	D90 (mm)		64.47
8.02548159	21.11984882			
8.656425262	21.18995367			

Table E-2. Input parameters for bedload transport calculations at Station 2527 under Phase I conditions.

Friction slope from a model	0.00109	SURFACE GRAIN SIZE DISTRIBUTION		
		Size (mm)	% Finer	
Bankfull width	N/A	2	0	
		4	6.5	
Min. water discharge	1.49 cms	8	11.1	
Max. water discharge	3.57 cms	11	13.9	
		16	22.2	
Left floodplain boundary	2.17 m	22	32.4	
Left floodplain Manning's n	0.06	32	51.9	
Right floodplain boundary	6.35 m	45	68.5	
Right floodplain Manning's n	0.06	64	89.8	
		90	99.1	
CROSS SECTION		128	100	
Lateral distance (m)	Elevation (m)			
0	21.39112412	STATISTICS OF THE ABOVE GRAIN SIZE DISTRIBUTION:		
1.106437454	21.36978786	Geometric mean (mm)		26.04
1.630699829	21.36064375	Geometric standard deviation		2.4
2.173250427	20.9125823	D10 (mm)		6.78
3.163862473	19.5562058	D16 (mm)		12.09
4.687881005	19.5562058	D25 (mm)		17.46
4.91038771	19.86100951	D50 (mm)		30.85
5.36759327	19.86100951	D65 (mm)		41.88
6.358205316	20.9125823	D75 (mm)		50.11
8.02548159	21.11984882	D84 (mm)		58.15
8.656425262	21.18995367	D90 (mm)		64.47

Table E-3. Input parameters for bedload transport calculations at Station 2527 under Phase II conditions.

Friction slope from a model	0.00476	SURFACE GRAIN SIZE DISTRIBUTION		
		Size (mm)	% Finer	
Bankfull width	N/A	2	0	
		4	6.5	
Min. water discharge	1.49 cms	8	11.1	
Max. water discharge	3.57 cms	11	13.9	
		16	22.2	
Left floodplain boundary	2.17 m	22	32.4	
Left floodplain Manning's n	0.06	32	51.9	
Right floodplain boundary	6.35 m	45	68.5	
Right floodplain Manning's n	0.06	64	89.8	
		90	99.1	
CROSS SECTION		128	100	
Lateral distance (m)	Elevation (m)			
0	21.39112412	STATISTICS OF THE ABOVE GRAIN SIZE DISTRIBUTION:		
1.106437454	21.36978786	Geometric mean (mm)		26.04
1.630699829	21.36064375	Geometric standard deviation		2.4
2.173250427	20.9125823	D10 (mm)		6.78
3.163862473	19.5562058	D16 (mm)		12.09
4.687881005	19.5562058	D25 (mm)		17.46
4.91038771	19.86100951	D50 (mm)		30.85
5.36759327	19.86100951	D65 (mm)		41.88
6.358205316	20.9125823	D75 (mm)		50.11
8.02548159	21.11984882	D84 (mm)		58.15
8.656425262	21.18995367	D90 (mm)		64.47

Table E-4. Input parameters for bedload transport calculations at Station 2429 under existing and Phase I conditions.

Friction slope from a model	0.006992	SURFACE GRAIN SIZE DISTRIBUTION		
		Size (mm)	% Finer	
Bankfull width	N/A	2	0	
		4	5.41	
Min. water discharge	1.49 cms	8	12.61	
Max. water discharge	3.57 cms	11	28.83	
		16	49.55	
Left floodplain boundary	2.6 m	22	63.06	
Left floodplain Manning's n	0.06	32	81.08	
Right floodplain boundary	6.8 m	45	90.09	
Right floodplain Manning's n	0.06	64	99.1	
		90	100	
CROSS SECTION				
Lateral distance (m)	Elevation (m)	STATISTICS OF THE ABOVE GRAIN SIZE DISTRIBUTION:		
0	22.86027798	Geometric mean (mm)		16.32
0.003048037	20.97659108	Geometric standard deviation		2.12
2.603023653	20.87600585	D10 (mm)		6.22
2.86515484	20.24506218	D16 (mm)		8.55
3.386369178	20.23591807	D25 (mm)		10.2
3.657644477	20.22982199	D50 (mm)		16.17
4.380029261	20.13228481	D65 (mm)		22.9
4.943916118	20.21762985	D75 (mm)		28.2
5.529139234	20.312119	D84 (mm)		35.74
5.562667642	20.31821507	D90 (mm)		44.85
6.196659351	20.24811022			
6.842843209	20.57425018			
9.104486711	20.86990978			
9.107534748	22.86027798			

Table E-5. Input parameters for bedload transport calculations at Station 2429 under Phase II conditions.

Friction slope from a model	0.008311	SURFACE GRAIN SIZE DISTRIBUTION		
		Size (mm)	% Finer	
Bankfull width	N/A	2	0	
		4	5.41	
Min. water discharge	1.49 cms	8	12.61	
Max. water discharge	3.57 cms	11	28.83	
		16	49.55	
Left floodplain boundary	2.6 m	22	63.06	
Left floodplain Manning's n	0.06	32	81.08	
Right floodplain boundary	6.8 m	45	90.09	
Right floodplain Manning's n	0.06	64	99.1	
		90	100	
CROSS SECTION				
Lateral distance (m)	Elevation (m)	STATISTICS OF THE ABOVE GRAIN SIZE DISTRIBUTION:		
0	22.86027798	Geometric mean (mm)		16.32
0.003048037	20.97659108	Geometric standard deviation		2.12
2.603023653	20.87600585	D10 (mm)		6.22
3.732321385	19.26969032	D16 (mm)		8.55
5.256339917	19.26969032	D25 (mm)		10.2
5.684915265	19.87929773	D50 (mm)		16.17
6.294522677	19.87929773	D65 (mm)		22.9
6.553813094	20.24811022	D75 (mm)		28.2
6.842843209	20.57425018	D84 (mm)		35.74
9.104486711	20.86990978	D90 (mm)		44.85
9.107534748	22.86027798			

Table E-6. Input parameters for bedload transport calculations at Station 2205 under existing and Phase I conditions.

Friction slope from a model	0.009445	SURFACE GRAIN SIZE DISTRIBUTION		
		Size (mm)	% Finer	
Bankfull width	N/A	2	0	
		4	10.81	
Min. water discharge	1.49 cms	8	18.92	
Max. water discharge	3.57 cms	11	33.33	
		16	45.95	
Left floodplain boundary	0. m	22	59.46	
Left floodplain Manning's n	0.06	32	82.88	
Right floodplain boundary	3.35 m	45	98.2	
Right floodplain Manning's n	0.097	64	100	
CROSS SECTION		STATISTICS OF THE ABOVE GRAIN SIZE DISTRIBUTION:		
Lateral distance (m)	Elevation (m)	Geometric mean (mm)		14.8
0	21.33625945	Geometric standard deviation		2.25
0.003048037	19.62021458	D10 (mm)		3.8
0.637039746	19.36113143	D16 (mm)		6.23
1.32894416	19.26054621	D25 (mm)		9.15
1.783101683	19.28188247	D50 (mm)		17.6
2.036088759	19.29407462	D65 (mm)		24.04
2.48110217	19.3916118	D75 (mm)		28.21
3.352840771	19.58363814	D84 (mm)		32.81
7.062301878	19.62326262	D90 (mm)		37.49
7.574372104	19.69641551			
8.817971227	19.8762497			
9.939648866	19.93111436			

Table E-7. Input parameters for bedload transport calculations at Station 2205 under Phase II conditions.

Friction slope from a model	0.00827	SURFACE GRAIN SIZE DISTRIBUTION		
		Size (mm)	% Finer	
Bankfull width	N/A	2	0	
		4	10.81	
Min. water discharge	1.49 cms	8	18.92	
Max. water discharge	3.57 cms	11	33.33	
		16	45.95	
Left floodplain boundary	0.92 m	22	59.46	
Left floodplain Manning's n	0.097	32	82.88	
Right floodplain boundary	7.06 m	45	98.2	
Right floodplain Manning's n	0.097	64	100	
CROSS SECTION		STATISTICS OF THE ABOVE GRAIN SIZE DISTRIBUTION:		
Lateral distance (m)	Elevation (m)	Geometric mean (mm)		14.8
0	21.33625945	Geometric standard deviation		2.25
0.003048037	19.64764692	D10 (mm)		3.8
0.917459156	19.64764692	D16 (mm)		6.23
1.728237015	19.24225799	D25 (mm)		9.15
2.337844428	19.24225799	D50 (mm)		17.6
3.557059254	18.63265057	D65 (mm)		24.04
5.081077786	18.63265057	D75 (mm)		28.21
7.062301878	19.62326262	D84 (mm)		32.81
7.574372104	19.69641551	D90 (mm)		37.49
8.507071446	19.83052914			

Table E-8. Input parameters for bedload transport calculations at Station 2527 under Phase I conditions using grain-size distributions truncated above 32 mm.

Friction slope from a model	0.00109	SURFACE GRAIN SIZE DISTRIBUTION		
		Size (mm)	% Finer	
Bankfull width	N/A	2	0	
		4	12.5	
Min. water discharge	1.49 cms	8	21.4	
Max. water discharge	3.57 cms	11	26.8	
		16	42.9	
Left floodplain boundary	2.17 m	22	62.5	
Left floodplain Manning's n	0.06	32	100	
Right floodplain boundary	6.35 m	45	100	
Right floodplain Manning's n	0.06	64	100	
		90	100	
CROSS SECTION		128	100	
Lateral distance (m)	Elevation (m)			
0	21.39112412	STATISTICS OF THE ABOVE GRAIN SIZE DISTRIBUTION:		
1.106437454	21.36978786	Geometric mean (mm)		13.81
1.630699829	21.36064375	Geometric standard deviation		2.13
2.173250427	20.9125823	D10 (mm)		3.48
3.163862473	19.5562058	D16 (mm)		5.25
4.687881005	19.5562058	D25 (mm)		9.89
4.91038771	19.86100951	D50 (mm)		17.96
5.36759327	19.86100951	D65 (mm)		22.56
6.358205316	20.9125823	D75 (mm)		24.93
8.02548159	21.11984882	D84 (mm)		27.27
8.656425262	21.18995367	D90 (mm)		28.96

Table E-9. Input parameters for bedload transport calculations at Station 2527 under Phase II conditions using grain-size distributions truncated above 32 mm.

Friction slope from a model	0.00476	SURFACE GRAIN SIZE DISTRIBUTION		
		Size (mm)	% Finer	
Bankfull width	N/A	2	0	
		4	12.5	
Min. water discharge	1.49 cms	8	21.4	
Max. water discharge	3.57 cms	11	26.8	
		16	42.9	
Left floodplain boundary	2.17 m	22	62.5	
Left floodplain Manning's n	0.06	32	100	
Right floodplain boundary	6.35 m	45	100	
Right floodplain Manning's n	0.06	64	100	
		90	100	
CROSS SECTION		128	100	
Lateral distance (m)	Elevation (m)			
0	21.39112412	STATISTICS OF THE ABOVE GRAIN SIZE DISTRIBUTION:		
1.106437454	21.36978786	Geometric mean (mm)		13.81
1.630699829	21.36064375	Geometric standard deviation		2.13
2.173250427	20.9125823	D10 (mm)		3.48
3.163862473	19.5562058	D16 (mm)		5.25
4.687881005	19.5562058	D25 (mm)		9.89
4.91038771	19.86100951	D50 (mm)		17.96
5.36759327	19.86100951	D65 (mm)		22.56
6.358205316	20.9125823	D75 (mm)		24.93
8.02548159	21.11984882	D84 (mm)		27.27
8.656425262	21.18995367	D90 (mm)		28.96

Table E-10. Input parameters for bedload transport calculations at Station 2429 under Phase I conditions using grain-size distributions truncated above 32 mm.

Friction slope from a model	0.006992	SURFACE GRAIN SIZE DISTRIBUTION		
		Size (mm)	% Finer	
Bankfull width	N/A	2	0	
		4	6.67	
Min. water discharge	1.49 cms	8	15.56	
Max. water discharge	3.57 cms	11	35.56	
		16	61.11	
Left floodplain boundary	2.6 m	22	77.78	
Left floodplain Manning's n	0.06	32	100	
Right floodplain boundary	6.8 m			
Right floodplain Manning's n	0.06	STATISTICS OF THE ABOVE GRAIN SIZE DISTRIBUTION:		
		Geometric mean (mm)		12.79
CROSS SECTION		Geometric standard deviation		1.84
Lateral distance (m)	Elevation (m)	D10 (mm)		5.19
0	22.86027798	D16 (mm)		8.06
0.003048037	20.97659108	D25 (mm)		9.3
2.603023653	20.87600585	D50 (mm)		13.59
2.86515484	20.24506218	D65 (mm)		17.23
3.386369178	20.23591807	D75 (mm)		20.86
3.657644477	20.22982199	D84 (mm)		24.43
4.380029261	20.13228481	D90 (mm)		27.03
4.943916118	20.21762985			
5.529139234	20.312119			
5.562667642	20.31821507			
6.196659351	20.24811022			
6.842843209	20.57425018			
9.104486711	20.86990978			
9.107534748	22.86027798			

Table E-11. Input parameters for bedload transport calculations at Station 2429 under Phase II conditions using grain-size distributions truncated above 32 mm.

Friction slope from a model	0.008311	SURFACE GRAIN SIZE DISTRIBUTION		
		Size (mm)	% Finer	
Bankfull width	N/A	2	0	
		4	6.67	
Min. water discharge	1.49 cms	8	15.56	
Max. water discharge	3.57 cms	11	35.56	
		16	61.11	
Left floodplain boundary	2.6 m	22	77.78	
Left floodplain Manning's n	0.06	32	100	
Right floodplain boundary	6.8 m			
Right floodplain Manning's n	0.06	STATISTICS OF THE ABOVE GRAIN SIZE DISTRIBUTION:		
		Geometric mean (mm)		12.79
CROSS SECTION		Geometric standard deviation		1.84
Lateral distance (m)	Elevation (m)	D10 (mm)		5.19
0	22.86027798	D16 (mm)		8.06
0.003048037	20.97659108	D25 (mm)		9.3
2.603023653	20.87600585	D50 (mm)		13.59
3.732321385	19.26969032	D65 (mm)		17.23
5.256339917	19.26969032	D75 (mm)		20.86
5.684915265	19.87929773	D84 (mm)		24.43
6.294522677	19.87929773	D90 (mm)		27.03
6.553813094	20.24811022			
6.842843209	20.57425018			
9.104486711	20.86990978			
9.107534748	22.86027798			

Table E-12. Input parameters for bedload transport calculations at Station 2205 under Phase I conditions using grain-size distributions truncated above 32 mm.

Friction slope from a model	0.009445	SURFACE GRAIN SIZE DISTRIBUTION		
		Size (mm)	% Finer	
Bankfull width	N/A	2	0	
		4	13.04	
Min. water discharge	1.49 cms	8	22.83	
Max. water discharge	3.57 cms	11	40.22	
		16	55.43	
Left floodplain boundary	0. m	22	71.74	
Left floodplain Manning's n	0.06	32	100	
Right floodplain boundary	3.35 m			
Right floodplain Manning's n	0.097	STATISTICS OF THE ABOVE GRAIN SIZE DISTRIBUTION:		
		Geometric mean (mm)		12.09
CROSS SECTION		Geometric standard deviation		2.1
Lateral distance (m)	Elevation (m)	D10 (mm)		3.4
0	21.33625945	D16 (mm)		4.93
0.003048037	19.62021458	D25 (mm)		8.32
0.637039746	19.36113143	D50 (mm)		14
1.32894416	19.26054621	D65 (mm)		19.29
1.783101683	19.28188247	D75 (mm)		22.97
2.036088759	19.29407462	D84 (mm)		25.88
2.48110217	19.3916118	D90 (mm)		28.03
3.352840771	19.58363814			
7.062301878	19.62326262			
7.574372104	19.69641551			
8.817971227	19.8762497			
9.939648866	19.93111436			

Table E-13. Input parameters for bedload transport calculations at Station 2205 under Phase II conditions using grain-size distributions truncated above 32 mm.

Friction slope from a model	0.00827	SURFACE GRAIN SIZE DISTRIBUTION		
		Size (mm)	% Finer	
Bankfull width	N/A	2	0	
		4	13.04	
Min. water discharge	1.49 cms	8	22.83	
Max. water discharge	3.57 cms	11	40.22	
		16	55.43	
Left floodplain boundary	0.92 m	22	71.74	
Left floodplain Manning's n	0.097	32	100	
Right floodplain boundary	7.06 m			
Right floodplain Manning's n	0.097	STATISTICS OF THE ABOVE GRAIN SIZE DISTRIBUTION:		
		Geometric mean (mm)		12.09
CROSS SECTION		Geometric standard deviation		2.1
Lateral distance (m)	Elevation (m)	D10 (mm)		3.4
0	21.33625945	D16 (mm)		4.93
0.003048037	19.64764692	D25 (mm)		8.32
0.917459156	19.64764692	D50 (mm)		14
1.728237015	19.24225799	D65 (mm)		19.29
2.337844428	19.24225799	D75 (mm)		22.97
3.557059254	18.63265057	D84 (mm)		25.88
5.081077786	18.63265057	D90 (mm)		28.03
7.062301878	19.62326262			
7.574372104	19.69641551			
8.507071446	19.83052914			

City of Bellevue
Development Services Department
Land Use Staff Report

Proposal Name:	City of Bellevue Utilities Department SE 30th Street/Sunset Creek Flood Improvement Project
Proposal Address:	Sunset Creek - vicinity of 13200 SE 30th Street
Proposal Description:	Application for a Critical Areas Land Use permit to replace an existing twin barrel 42-inch diameter culvert on Sunset Creek at SE 30th Street with an integrated fish-passable culvert and sediment capture structure. Installation of the new structure will require modifications of the stream channel upstream and downstream of SE 30th. The purpose of the project is flood control and sediment management.
File Number:	**08-128529 LO**
Applicant:	Brian Ward, City of Bellevue Utilities Department
Decisions Included:	Critical Areas Land Use Permit (Process II. LUC 20.30P)
Planner:	**Heidi M. Bedwell**, Planner
State Environmental Policy Act Threshold Determination:	**Determination of Non-Significance**

Michael A. Paine for
Carol V. Helland, Environmental Coordinator
Development Services Department

Director's Decision: **Approval with Conditions**

Michael A. Paine for
Carol V. Helland, Land Use Director
Development Services Department

Application Date:	July 30, 2008
Notice of Application Publication Date:	September 11, 2008
Decision Publication Date:	March 12, 2009
Project/SEPA Appeal Deadline:	March 26, 2009

For information on how to appeal a proposal, visit Development Services Center at City Hall or call (425) 452-6800. Comments on State Environmental Policy Act (SEPA) Determinations can be made with or without appealing the proposal within the noted comment period for a SEPA Determination. Appeal of the Decision must be received in the City's Clerk's Office by 5 PM on the date noted for appeal of the decision.

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I. Proposal Description

The applicant requests a Critical Areas Land Use Permit approval to replace an existing twin barrel 42-inch diameter culvert on Sunset Creek at SE 30th Street with an integrated fish-passable culvert and sediment capture structure. Installation of the new structure will require modifications of the stream channel upstream and downstream of SE 30th. The purpose of the project is flood control and sediment management. The existing twin culverts are not currently passable to fish at all flows. Extensive sediment deposition in Sunset Creek downstream of these culverts presents a low flow barrier to fish passage, and sediment deposition upstream of SE 30th Street has created conditions that are a likely barrier to passage during high flow conditions. The proposed project would improve fish passage conditions in Sunset Creek at the SE 30th Street culvert and address barrier conditions in the channel both upstream and downstream of the structure.

The replacement of the culvert, and associated restoration of the stream channel and restoration of the riparian corridor is allowed as a flood control measure with a Critical Areas Land Use Permit accompanied by a Critical Areas Report per Land Use Code (LUC) 20.25H.080.B.2 for modification of stream channel.

II. Site Description, Zoning, Land Use and Critical Areas

A. Site Description

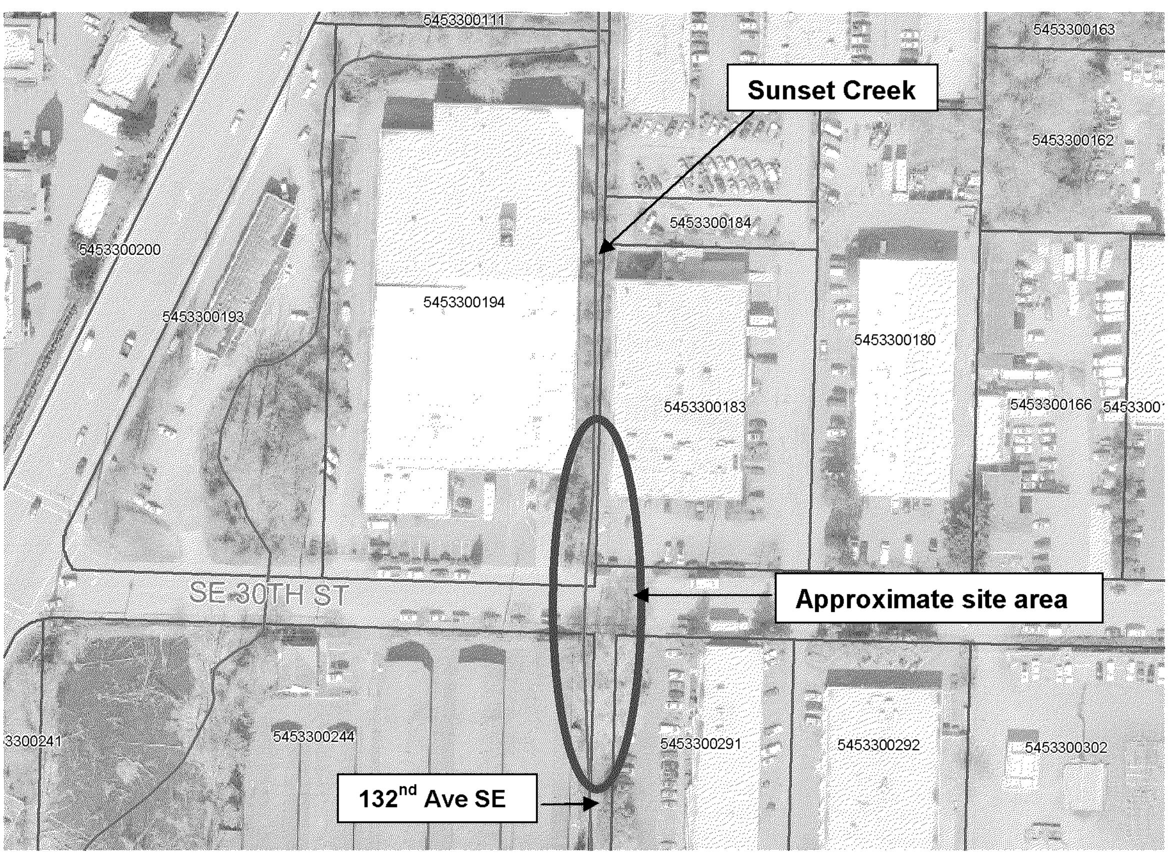
The project site is on a portion of Sunset Creek, east of Richards Road. The project improvements are proposed to occur within existing city street right-of-way and adjacent privately-owned parcels. The culvert replacement site is located within the right-of-way of SE 30th Street along the same alignment as the existing twin 42-inch diameter culverts.

Historic development of the area prior to institution of critical areas protections has encroached upon the stream buffer. Buildings, roadways, and paved parking lots limit the existing and potential riparian zone to an average width of 10 to 30 feet. Upstream channel modifications are to occur primarily within an existing city right-of-way for 132nd Avenue SE, which was never constructed in this location.

Downstream of SE 30th-Sunset Creek

Upstream of SE 30th- Sunset Creek

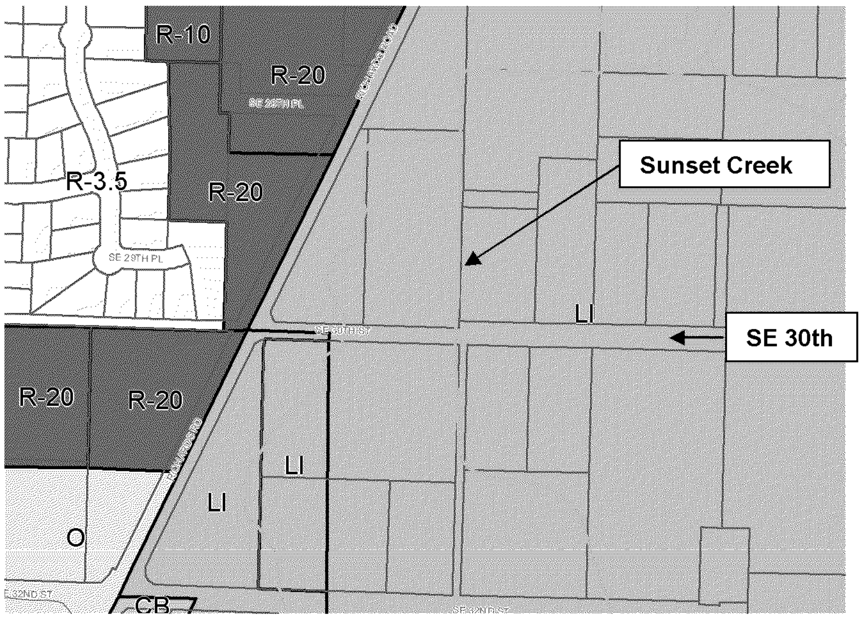
Some channel modification, site access and revegetation activities associated with upstream channel modifications will occur on private parcels (tax parcel numbers 5453300244 and 5453300291). Downstream channel modifications are proposed on private parcels (tax parcel numbers 5453300194 and 5453300183).



B. Zoning and Uses

The proposed activities would be conducted on properties zoned Light-Industrial (LI). The general dimensional standards in LUC 20.20.010 do not apply, because there is no structural development proposed. The existing uses on the affected properties are permitted and there is no proposed change in use of the properties.

The project site and surrounding properties are designated light-industrial in the Comprehensive Plan and are developed with light industrial and warehouse uses.



C. Critical Areas Functions and Values

1. Streams and Riparian Areas

Riparian vegetation along stream banks mitigates the impacts of urbanization and support healthy stream conditions. Riparian vegetation affects water temperature by providing shade to reduce solar exposure and regulate high ambient air temperatures, slowing or preventing increases in water temperature.

Upland and wetland riparian areas retain sediments, nutrients, pesticides, pathogens, and other pollutants that may be present in runoff, protecting water quality in streams. The roots of riparian plants also hold soil and prevent erosion and sedimentation that may affect spawning success or other behaviors, such as feeding.

Both upland and wetland riparian areas reduce the effects of flood flows. Riparian areas and wetlands reduce and desynchronize peak crests and flow rates of floods. Upland and wetland areas can infiltrate flood flows, which in turn, are released to the stream as base flow.

Stream riparian areas, or buffers, can be a significant factor in determining the quality of wildlife habitat. For example, buffers comprised of native vegetation with multi-canopy structure, snags, and down logs provide habitat for the greatest range of wildlife species. Vegetated riparian areas also provide a source of large woody debris that helps create and maintain diverse in-stream habitat, as well as create woody debris jams that store sediments and moderate flood velocities.

Sparsely vegetated or vegetated buffers with non-native species may not perform the needed functions of stream buffers. In cases where the buffer is not well vegetated, it is necessary to either increase the buffer width or require that the standard buffer width be restored or revegetated. Until the newly planted buffer is established the near term goals for buffer functions may not be attained.

Riparian areas often have shallow groundwater tables, as well as areas where groundwater and surface waters interact. Groundwater flows out of riparian wetlands, seeps, and springs to support stream baseflows. Surface water that flows in to riparian areas during floods or as direct precipitation infiltrates into groundwater in riparian areas and is stored for later discharge to the stream.

2. Floodplains

The value of floodplains can be described in terms of both the hydrologic and ecological functions that they provide. Flooding occurs when either runoff exceeds the capacity of rivers and streams to convey water within their banks, or when engineered stormwater systems become overwhelmed. Studies have linked urbanization with increased peak discharge and channel degradation (Dunne and Leopold 1978; Booth and Jackson 1997; Konrad 2000). Floodplains diminish the effects of urbanization by temporarily storing water and mediating flow to downstream reaches. The capacity of a floodplain to buffer upstream fluctuations in discharge may vary according to valley confinement, gradient, local relief, and flow resistance provided by vegetation. Development within the floodplain can dramatically affect the storage capacity of a floodplain, impact the hydrologic regime of a basin and present a risk to public health and safety and to property and infrastructure.

III. Consistency with Land Use Code Requirements

A. Zoning District Dimensional Requirements

The subject area is zoned Light-Industrial (LI). The general dimensional standards in LUC 20.20.010 do not apply, because there are no structural development proposed which would be subject to these standards.

B. Critical Areas Requirements LUC 20.25H

1. Analysis of Technical Feasibility for New or Expanded Allowed Uses

a. New or expanded facilities and systems are allowed within the critical area or critical area buffer only where no technically feasible alternative with less impact on the critical area or critical area buffer exists. A determination of technically feasible alternatives will consider:
   i. The location of existing infrastructure;
   ii. The function or objective of the proposed new or expanded facility or system;
   iii. Demonstration that no alternative location or configuration outside of the critical area or critical area buffer achieves the stated function or objective, including construction of new or expanded facilities or systems outside of the critical area;
   iv. Whether the cost of avoiding disturbance is substantially disproportionate as compared to the environmental impact of proposed disturbance; and
   v. The ability of both permanent and temporary disturbance to be mitigated.

b. If the applicant demonstrates that no technically feasible alternative with less impact on the critical area or critical area buffer exists, then the applicant shall comply with the following:

i. Location and design shall result in the least impacts on the critical area or critical area buffer;
ii. Disturbance of the critical area and critical area buffer, including disturbance of vegetation and soils, shall be minimized;
iii. Disturbance shall not occur in habitat used for salmonid rearing or spawning or by any species of local importance unless no other technically feasible location exists;
iv. Any crossing over of a wetland or stream shall be designed to minimize critical area and critical area buffer coverage and critical area and critical area buffer disturbance, for example by use of bridge, boring, or open cut and perpendicular crossings, and shall be the minimum width necessary to accommodate the intended function or objective; provided, that the Director may require that the facility be designed to accommodate additional facilities where the likelihood of additional facilities exists, and one consolidated corridor would result in fewer impacts to the critical area or critical area buffer than multiple intrusions into the critical area or critical area buffer;
v. All work shall be consistent with applicable City of Bellevue codes and standards;
vi. The facility or system shall not have a significant adverse impact on overall aquatic area flow peaks, duration or volume or flood storage capacity, or hydroperiod;
vii. Associated parking and other support functions, including, for example, mechanical equipment and maintenance sheds, must be located outside critical area or critical area buffer except where no feasible alternative exists; and
viii. Areas of new permanent disturbance and all areas of temporary disturbance shall be mitigated and/or restored pursuant to a mitigation and restoration plan meeting the requirements of LUC 20.25H.210.

Response: The Richards Creek, Sunset Creek, and East Creek channel network in the vicinity of SE 30th Street and Kamber Road has been directly impacted by channel realignment, channel confinement, and increased rates of sediment production associated with land development both local to the project area and in the upper watershed. These impacts include recurrent flooding and sedimentation problems, channel instability, and degraded habitat conditions. The proposed project includes the replacement of an existing twin barrel 42-inch diameter culvert on Sunset Creek at SE 30th Street with an integrated fish-passable culvert and sediment capture structure. This project is part one of a four-phased Flood Control and Sedimentation Plan developed by the City to address the impacts to this stream system. Phases I and II are funded and Phase II is anticipated to be constructed in 2010. Phases III and IV are dependent upon additional CIP funding.

Installation of the new structure will require modification of the stream channel upstream and downstream of SE 30th Street. These modifications will include eight grade control structures upstream and two grade control structures downstream of the culvert, riprap removal and replacement with bioengineered bank protection structures, and stream and riparian habitat enhancement. Channel and riparian modifications will take place over a segment of Sunset Creek extending from approximately 110 feet upstream to approximately 60 feet downstream of SE 30th Street.

The culvert replacement project is designed to address chronic flooding of Sunset Creek at SE 30th Street and adjacent businesses, and provide the ability to adaptively manage habitat conditions and flood conveyance capacity. Based on the engineering done in support of this project and contained in the Critical Areas Report Attachment 2, the integrated sediment trap will capture the majority of sediments transported to this reach of Sunset Creek in most years. This will allow for maintenance dredging to be conducted within the enclosed structure rather than the active channel. Sediment removal will be managed to optimize sediment delivery rates to the channel segment downstream of the structure, maintaining flood conveyance capacity and desirable habitat conditions for fish by providing a fish passable culvert.

The sediment storage capacity of the sediment retention (sedimentation) structure portion of the replacement culvert is designed to accommodate approximately 50 cubic yards of sediment. This volume was determined primarily through a consideration of estimated historical, existing, and potential future sediment delivery and transport rates, combined with practical sediment removal frequency for City of Bellevue maintenance crews. Additional secondary considerations included site constraints, cost implications and environmental impact associated with operations and maintenance activities. Current maintenance practice to remove sediments in the vicinity of the SE 30th culvert involve dredging materials directly from the stream channel on an up to yearly basis. Compared to the current maintenance practice, the proposed culvert maintenance will allow sediment to be removed within the culvert structure and will not involve modification to the stream channel. This will result is fewer environmental impacts to the critical areas.

The Critical Areas Report discusses in detail the rate of sediment delivery and reasons for the amount of sediment in the stream system. Sediment delivery rates are highly variable and episodic by nature. To accommodate for annual variability in sediment delivery, the capacity of the sedimentation structure is designed to accommodate delivery rates up to two times the estimated current rate. Given this design volume, sediment removal activities are forecast to be required every two years on average. The report additionally defines protocols for structure maintenance based on actual deposition rates and channel. So long as these protocols for maintenance and monitoring are followed, the facility shall not have a significant impact on critical area function and should provide flood protection and habitat improvement in the long term as compared to existing conditions.

3. Performance Standards for Public Flood Protection Measures LUC 20.25H.055.C.3.c

New public flood protection measures and expansion of existing ones may be permitted only in accordance with a design prepared by a qualified professional.

Response: A Critical Areas Report consistent with LUC 20.25H.230 has been prepared by Herrera Environmental Consultants (See Attachment 2). A discussion of how the critical areas report satisfies the critical areas report decision criteria can be found below.

4. **Performance Standards for New or Expanded Bridges and Culverts.** New culverts shall be designed in accordance with the Washington State Department of Fish and Wildlife "Design of Road Culverts for Fish Passage" now or as hereafter amended. Culvert expansions shall be considered new culverts and be required to be designed in accordance with "Design of Road Culverts for Fish Passage" now or as hereafter amended when the expansion is associated with a project increasing vehicular capacity and (i) there are fish present downstream; (ii) there is potential fish habitat upstream; and (iii) the benefits of so designing the culvert are substantial when compared to expanding the culvert based on its then-existing design.

Response: Per the Critical Areas Report (Attachment 2) and the JARPA documentation, the proposal is designed in accordance with WDFW culvert design guidance (WDFW 2003), using the stream simulation method. The culvert replacement is intended to address flood control and sediment management issues at the existing road crossing. It will not change the traffic capacity of the existing roadway or otherwise facilitate new development however the design will provide improved fish passage over the existing culvert design.

5. **Consistency Critical Areas Performance Standards**

The performance standards for the modification of a stream channel described in LUC 20.25H.080.B require the preparation of a critical areas report for a public flood control project that proposes to modify the stream channel, as allowed under LUC 20.25H.055. A critical areas report has been prepared by Herrera Environmental Consultants (See Attachment 2). A discussion of how the critical areas report satisfies the critical areas report decision criteria can be found below.

6. **Consistency with Critical Areas Report LUC 20.25.230.**

The applicant supplied a complete critical areas report prepared by Herrera Environmental Consultants, a qualified professional. The report met the minimum requirements in LUC 20.25H.250 as determined by the Director. The critical areas report contained items discussed below.

The critical areas report contained an accurate depiction of the critical areas on the site and those properties immediately adjacent to the site in a graphical format on the site plans. The critical areas report also includes a discussion of probable habitat and water quality impacts resulting from the proposed project.

The report was supplemented by materials provided to State and Federal permitting agencies including a Joint Aquatic Resources Permit Application and Biological Evaluation.

IV. Public Notice and Comment

Application Date:	July 30, 2008
Public Notice (500 feet):	September 11, 2008
Minimum Comment Period:	September 25, 2008

The Notice of Application for this project was published in the City of Bellevue weekly permit bulletin on September 11, 2008, which was advertised in Seattle Times on the same day. The weekly permit bulletin was mailed to property owners within 500 feet of the project site.

One comment letter was received regarding this project from Karen Walter with the Muckleshoot Indian Tribe Fisheries Division. See Attachment 5 for the full comment letter and applicant response. The following are a summary of the issues raised:

Comment *The proposed in-culvert sediment trap has the potential to starve downstream areas of Sunset Creek, Richards Creek and East Creek of spawning gravel necessary for successful spawning. The project should monitor downstream spawning areas to determine if there is a change in spawning gravel area and particle size distribution. Methods suggested.*

Response The objective of the proposed sediment trap is to reduce the delivery of sediment to the Sunset Creek channel downstream of SE 30th Street where the rate of sediment delivery has historically far exceeded the sediment transport capacity of the channel. Optimally, the trap would be sized to capture the sediment in excess of the downstream channel's sediment transport capacity, thereby maintaining a flux of gravel through the channel that would not result in net aggradation. Although the capacity of the trap is approximately 50 cubic yards, adaptive management of the trap, including documenting the amount of sediment captured by the trap, may determine that the optimal sediment removal volume is less than the capacity of the sediment trap. For example, if only 30 cubic yards of sediment are captured annually, the trap could be maintained with a storage capacity of 20 cubic yards so that that amount of sediment delivered in excess of this amount would be delivered to the downstream channel.

Currently, the City of Bellevue documents the condition of salmonid spawning in the Richards and Sunset Creek channels during the spawning season, generally from August to October. During this period City staff conduct surveys of Richards Creek from its confluence with Kelsey Creek to the project site every other week documenting spawning redds and counting fish carcasses. The frequency of surveys is adjusted to once per week if observations warrant the change. Salmon surveys are also conducted through the Salmon Watcher program, a program where volunteers go to designated locations each week to look for salmon. Richards and Sunset Creeks are part of that program.

These surveys will be complemented by the proposed channel monitoring protocol which will document changes in both channel geometry and substrate condition. The protocol for documenting substrate conditions will be guided by the protocols within the recommended document (TFW Monitoring Methods Manual for

Spawning Gravel Composition Surveys, TFW-AM9-99-006, 1999).

The protocol for documenting substrate conditions will include gathering bulk samples from areas representative of potential spawning habitat, such as riffle crests or gravel bar features at the proposed monitoring cross-sections. The samples will be gathered using a McNeil sampler. The information gathered will be suitable for:

- Evaluating the characteristics and composition of gravel within the sampling extent

- Estimating the percentage of fine sediment less than 0.85 mm in order to evaluate the potential impact of fine sediment on survival to emergence

- Comparing the composition of gravel from different locations within the sampling area and from other watersheds

- Monitoring trends in gravel composition over time.

At present there are very limited to no spawning areas located between the Richards Creek flow split and Kamber Road, therefore the proposed extent of the channel monitoring protocol is expected to capture the extent of the channel area containing potential spawning habitat that may be directly affected by an immediate reduction in bedload delivery.

Comment *Concerns regarding the monitoring plan and adaptive management strategy- lacks a numeric standard for the proposed gravel , the actual 'desirable habitat conditions to be maintained' for this project and the adaptive management protocols should be specifically identified, the monitoring plan should include standards regarding both adult and juvenile fish passage to ensure that the new culvert is passing all fish species and all life history stages.*

Response
See discussion in Section VII and conditions in Section IX requiring the Protocols for Channel Monitoring and Replacement Culvert Sedimentation Structure Maintenance to be prepared prior to the approval of the Clearing and Grading permit.

Comment *Phase I as currently proposed provides very little instream habitat diversity for salmonids. The proposed boulders and wood is such that the any pool habitat is likely to be minimal due to the type and orientation of these materials such that they will be resistant to scour necessary to create pool habitat. The design is for streambed and bank stabilization than instream habitat [sic]. The project should be modified by adding wood to additional upstream areas that is allowed to retain sediment and form pools with cover in a more natural manner than what is proposed.*

Response The project objective is for flood and sediment control. Instream habitat for salmonids is not the overall objective with the exception of fish passage at the culvert.

Comment *Removal of 8 trees that are 10 inches in diameter or greater. All of these trees should be used in the project to support the Phase I design or to create habitat for salmonids as recommended above. Otherwise, the project will result in* *an adverse impact to future wood recruitment (temporal loss) that could be avoided.*

Response Of the 8 trees that may be removed during utility relocation and channel modification activities, 3 are conifers and 5 are deciduous. Due to the stability requirements of the proposed channel modifications, and the greater decay rates of deciduous trees relative to coniferous trees, only the 3 Douglas firs are potentially suitable for incorporation into the proposed channel modifications. These 3 trees will be incorporated into the project designs to the extent possible. Opportunities for placing the remaining deciduous trees at other locations in the channel network will be evaluated. The proposed design includes planting 107 native trees during Phase I including; 7 black cottonwood, 29 red alder, 23 Douglas fir, 42 Pacific willow, and 6 Western red cedar. The long-term benefits of these trees are expected to include improved riparian habitat and wood recruitment for Sunset Creek that far exceeds the functions of the 8 trees to be removed.

Comment *The removal of these trees may adversely affect water temperature. An analysis or discussion about the potential loss of shade due to removal of these trees or shrubs that may be providing shade is lacking. A shade analysis should be conducted, and if there is a potential increase in water temperature, then additional tree planting should be required.*

Response A temporary increase in water temperatures was identified as a possible effect of the proposed tree removal. Page 2 of the BA Addendum states: *"Current conditions for water temperatures in Sunset Creek are rated as **at risk**. The proposed action [tree removal] will temporarily degrade water temperatures by reducing available shade. However, these effects will be offset by the deeper and narrower channel profile produced by the planned channel modifications. This will reduce the surface area exposed to insolation, which will mitigate the temporary reduction in shade. As the planned site revegetation matures, shading of the stream channel will increase relative to the current environmental baseline. As a result, the proposed action will **improve** water temperature conditions over the long-term."*
The proposed planting plan incorporates four distinct plant communities based on the available light and proximity to the channel at different locations in the project area. In addition to the 107 trees that will be planted during Phase I (detailed above), the project design calls for removal of invasive species within the project area and additional planting of 256 shrubs, and 196 herbs during Phase I. This is an extensive planting plan relative to the size of the project.

<u>Phase I and Phase II concerns</u>
Comment *Per the documents that we reviewed, the Phase I project is not independent of the Phase II project and should be evaluated for its potential impacts to salmonids and their habitats concurrently. Phase II is needed so that the 30th Street SE [sic] culvert can pass the 100 year flood event with 1 foot of freeboard and meet Bellevue's engineering standards and likely those standards of FEMA and other agencies. The Phase II project is also needed to meet the project's purpose "to address chronic flooding of SE 30th Street and surrounding private property". As noted in the Biological Assessment (BA, page 7), the Phase II project primary purpose is to address the flooding of properties surrounding the project area and to "optimize the flood conveyance capacity of Sunset Creek from the downstream project extents of Alternative 1 to the confluence of Sunset Creek and Richards Creek through channel modifications and construction of a flood containment berm". Also, Phase II was analyzed for sediment transport with the Phase I improvements and compared against the existing conditions in the*

technical sections of the Flood Control and Sediment Plan for this project. Finally, the Flood Control and Sediment Plan clearly notes that there will continue to be a backwater condition in the new culvert and deposition in the area of the modified channel downstream of SE 30th Street until the high point in the channel downstream is lowered, either by Phase II channel modifications or due to geomorphic response of the channel to reduced sediment delivery.

Response to Comment
The Flood Control and Sediment Management Plan for the Richards Creek, Sunset Creek, and East Creek Confluence Area recommends a range of alternatives to address recurrent flooding and sedimentation problems, channel instability, and degraded habitat conditions. Phase I includes the culvert replacement at SE 30th Street and channel modifications upstream and downstream to provide a stable streambed transition to the culvert inlet and outlet. The specific objectives of Phase I are to address the recurrent flooding at SE 30th Street and the recurrent sedimentation upstream and downstream of the existing culverts that requires annual dredging within the active channel. Satisfaction of these objectives does not require Phase II. Phase II includes approximately 400 feet of channel modifications from the downstream end of Phase I to the confluence of Sunset Creek and Richards Creek. The specific objective of Phase II is to limit the extent of flooding into neighboring properties downstream of SE 30th Street and the Phase I project extents. Channel modifications under both phases include the following project components that will improve the aquatic habitat conditions of Sunset Creek:

- Construction of a two-stage channel
- Biostabilization of stream banks
- The removal of invasive species
- Replanting with native vegetation.

Due to the limited width of the channel corridor and the distinct change in channel slope at SE 30th Street, neither Phase I or Phase II can fully meet the City of Bellevue's engineering standard stating that culverts should pass the 100-year flow with one foot of freeboard.
Under the existing conditions, flows as small as the 1-year recurrence interval event are predicted to flood SE 30th Street. These modeled conditions are supported by observations of at least six flooding events at SE 30th Street since January 1, 2005. The replacement culvert and channel modifications proposed under Phase I will improve the flow conveyance capacity and keep the 100-year flow from flooding SE 30th Street, though the City's freeboard requirement in the culvert cannot be met. Immediately following the construction of Phase I, the replacement culvert is designed to pass the 2-year flow with a free water surface at the upstream culvert inlet (i.e., with freeboard through the culvert length). Following either downstream channel responses to reduced bedload delivery rates, or the construction of Phase II channel modifications, the replacement culvert is designed to pass the 25-year flow with a free water surface at the culvert inlet. Based on extensive hydraulic modeling, sediment transport analyses, and a detailed understanding of the geomorphic processes at the project site, it is anticipated that the downstream geomorphic responses to the Phase I culvert replacement and channel modifications would include the transport of sediments that have accumulated within the channel downstream of the Phase I project extents over the last 30 years. The exact timeframe of this response is difficult to predict, but the resulting hydraulic influences of this response to the downstream

channel would likely mimic those that will result from the channel modifications proposed under Phase II. Therefore, while Phase I could be implemented to reduce the recurrent flooding at SE 30th Street and the recurrent sedimentation upstream and downstream of the existing culverts without implementing Phase II, the benefits of constructing Phase II include limiting the extent of flooding into neighboring properties downstream of the Phase I extents while also extending the length of channel with improved aquatic habitat. Although Phase II would provide some control over the timing and character of channel modifications downstream of the Phase I project extents, it is not a required component of long-term flood control at SE 30th Street and is thus considered independent of Phase I.

Comment *Concern about potential Phase IV improvements.*

Response The City of Bellevue is only pursuing Phase I improvements with this application. Phases II-IV will be evaluated separately and are dependent upon CIP priorities and funding.

V. Summary of Technical Reviews

Clearing and Grading

The Clearing and Grading Division of the Development Services Department has reviewed the proposed site development for compliance with Clearing and Grading codes and standards. The Clearing and Grading staff found no issues with the proposed development.

VI. State Environmental Policy Act (SEPA)

The environmental review indicates no probability of significant adverse environmental impacts occurring as a result of the proposal. The Environmental Checklist submitted with the application adequately discloses expected environmental impacts associated with the project. The City codes and requirements, including the Clear and Grade Code, Utility Code, Land Use Code, Noise Ordinance, Building Code and other construction codes are expected to mitigate potential environmental impacts. Therefore, issuance of a Determination of Non-Significance (DNS) is the appropriate threshold determination under the State Environmental Policy Act (SEPA) requirements.

A. Earth and Water

A grading plan that includes temporary erosion and sedimentation control best management practices is included in the project plans, and addresses all requirements for restoring the site to a condition equal to or better than its existing condition. See Section IX for a related condition of approval.

B. Animals

The project site is part of type F stream and riparian area and is adjacent to larger natural areas that contains quality habitat for birds and mammals. Fisheries resources in Sunset Creek include anadromous and resident species. Sunset Creek is identified by the WDFW as containing priority resident fish presence two aquatic species listed under the Endangered Species Act (i.e., Puget Sound Chinook salmon [*Oncorhynchus tshawytscha*] and Puget Sound steelhead [*O. mykiss*]) In addition, coho salmon (*O. kisutch*) currently listed as a species of concern, may also occur within the action area.

The existing twin culverts at SE 30th Street are not currently passable to fish at all flows. Extensive sediment deposition in Sunset Creek downstream of these culverts presents a low flow barrier to fish passage, and sediment deposition upstream of SE 30th Street has created gradient and velocity conditions that are a likely barrier to passage during high flow conditions. The proposed project would improve fish passage conditions in Sunset Creek at the SE 30th Street culvert and address barrier conditions in the channel both upstream and downstream of the structure. The new culvert would provide for full fish passage for all species and life history stages likely to occur in this system during the flow conditions in which migratory and dispersal behavior is likely to take place. In addition, the grade control structures, culvert configuration, and sediment trap would prevent aggradation at the inlet and outlet of the culvert that currently limits fish passage.

The applicant will implement WSDOT Fish Exclusion Protocols and Standards to ensure fish resources in the project reach are protected. See Section IX for related conditions of approval.

C. Plants

The proposed project will remove approximately 600 square feet of riprap from the stream banks upstream and downstream of the SE 30th Street culvert and install bank protection structures. In addition 6,800 square feet of the stream bank will be replanted with native riparian vegetation appropriate for this site. There no rare or threatened plant species identified in or near the project area. Eight trees will be removed as part of the project because of conflicts with utility relocations. Of these eight trees, only three are Douglas Fir which would be suitable for incorporation into the project. The plan calls for removal of invasive species within the project area and the planting of 107 trees 256 shrubs, and 196 herbs. The proposed restoration plan, when satisfactorily completed and maintained will result in no adverse impact. See Section IX for related conditions of approval.

D. Noise

The site is adjacent to Light Industrial uses. The proposed project will produce short-term noise effects on the surrounding terrestrial environments. Construction noise will be limited by the City's Noise Ordinance (Chapter 9.18 BCC) which regulates construction hours and noise levels. See Section X for a related condition of approval.

VII. Decision Criteria

A. Critical Areas Report Decision Criteria- General Criteria LUC 20.25H.255

The Director may approve, or approve with modifications, the proposed modification where the applicant demonstrates:

1. The modifications and performance standards included in the proposal lead to levels of protection of critical area functions and values at least as protective as application of the regulations and standards of this code;

Finding: The proposed project is not proposing the modification of any of the standards contained in the Land Use Code. The proposed project is expected to improve critical area functions and values in the segments of Sunset Creek. The expected improvements include the following:

- Reduced maintenance dredging frequency in the active channel, reducing habitat disturbance
- Simplified fish exclusion procedures and reduced need for fish capture and relocation during maintenance
- Replacement of 154 lineal feet of riprap bank protection with bioengineered structures and channel modifications and addition of 39 pieces of geomorphically functional large woody debris to the stream channel, resulting in increased hydraulic complexity and habitat diversity.
- Improved water quality.
- Improved fish passage under high and low flow conditions.
- Maintenance of desirable spawning habitat conditions.
- Restoration and enhancement of all areas disturbed by construction.
- Removal of invasive and ornamental riparian vegetation and replacement with site appropriate native species;
- Increased density and coverage of native vegetation, providing improved shade and cover, and increased recruitment of organic material and prey organisms (dense vegetation will also limit human access, reducing harrassment and disturbance of aquatic life).

These habitat improvements will be maintained over the anticipated life of the project, and will be further enhanced by the subsequent phases of the proposed comprehensive flood control and sediment management plan. This project will lead to a increased level of protection of the functions and values of this stream and riparian area.

2. Adequate resources to ensure completion of any required mitigation and monitoring efforts;

Finding: The City of Bellevue Utilities Department is initiating the project and has sufficient resources to complete the required mitigation and monitoring efforts.

3. The modifications and performance standards included in the proposal are not detrimental to the functions and values of critical area and critical area buffers off-site; and

Finding: The proposal does not include a modification of the prescribed buffers on the site. The proposed performance standards are consistent with those in the land use code. The proposed project will be beneficial to the functions and values of the critical area and critical area buffer off-site because it will increase the habitat structure by reducing flooding and sedimentation impacts.

4. The resulting development is compatible with other uses and development in the same land use district.

Finding: The proposal to replace an existing twin barrel 42-inch diameter culvert with an integrated fish-passable culvert and sediment capture structure, modification of the stream channel upstream and downstream of SE 30th and the restoration of the impacted area with native plantings is compatible with the light-industrial uses in the area.

B. Critical Areas Land Use Permit Decision Criteria 20.30P

The proposal, as conditioned below, meets the applicable regulations and decision criteria for a Critical Areas Land Use Permit pursuant to LUC Section 20.30P.

1. The proposal obtains all other permits required by the Land Use Code;

Finding: The proposed project will require a Clearing and Grading Permit from the City of Bellevue. No work on the project will be allowed to commence until the Clearing and Grading permit in addition to permits from other state and federal agencies are issued.

2. The proposal utilizes to the maximum extent possible the best available construction, design and development techniques which result in the least impact on the critical area and critical area buffer;

Finding: The culvert replacement project is designed to address chronic flooding of Sunset Creek at SE 30th Street and adjacent businesses, and provide the ability to adaptively manage habitat conditions and flood conveyance capacity. The integrated sediment trap will capture the majority of sediments transported to this reach of Sunset Creek in most years. This will allow for maintenance dredging to be conducted within the enclosed structure rather than the active channel. Sediment removal will be managed to optimize sediment delivery rates to the channel segment downstream of the structure, maintaining flood conveyance capacity and desirable habitat conditions. The applicant has provided a draft protocol for Channel Monitoring and Replacement Culvert Sedimentation Structure and shall provide a detailed plan with reporting to the Development Services Department on an annual basis for a minimum of 10 years. Construction will only occur during the allowed work windows as established by the Washington Department of Fish and Wildlife. The proposal utilizes the best available construction, design and development techniques which will result in the least impact to critical area functions.

3. The proposal incorporates the performance standards of Part 20.25H to the maximum extent applicable, and ;

Finding: As discussed above in Section II, the proposal does incorporate the applicable performance standards, which will be implemented and enforced as conditions of approval the underlying Clearing and Grading Permit.

4. The proposal will be served by adequate public facilities including street, fire protection, and utilities; and;

Finding: The property is currently served by adequate public facilities. The proposal does not change the need for, or ability to serve the property.

5. The proposal includes a mitigation or restoration plan consistent with the requirements of LUC Section 20.25H.210; and

Finding: The installation of the culvert does not require the preparation of a mitigation plan. However, the proposal includes a restoration plan consistent with LUC 20.25H.210 for the restoration of disturbed areas within and adjacent to the stream channel.

With a condition that the restoration plan meet the standards for plant spacing and sizing found in Critical Areas Handbook and include performance standards and monitoring schedules for fish passage and plant establishment for a period of five years this criteria can be met.

6. The proposal complies with other applicable requirements of this code.

Finding: As discussed in Section IV & V of this report, the proposal complies with all other applicable requirements of the Land Use Code.

VIII. Conclusion and Decision

After conducting the various administrative reviews associated with this proposal, including Land Use Code consistency, SEPA, City Code and Standard compliance reviews, the Director of Planning and Community Development does hereby **approve with conditions** the proposal replace an existing twin barrel 42-inch diameter culvert on Sunset Creek at SE 30th Street with an integrated fish-passable culvert and sediment capture structure and associated modifications of the stream channel upstream and downstream of SE 30th for the purpose of flood control and sediment management.

Note- Expiration of Approval: In accordance with LUC 20.30P.150 a Critical Areas Land Use Permit automatically expires and is void if the applicant fails to file for a Clearing and Grading Permit or other necessary development permits within one year of the effective date of the approval.

IX. Conditions of Approval

The applicant shall comply with all applicable Bellevue City Codes and Ordinances including but not limited to:

Applicable Ordinances	Contact Person
Clearing and Grading Code- BCC 23.76	Tom McFarlane, 425-452-5207
Land Use Code- BCC 20.25H	Heidi M. Bedwell , 425-452-4862
Noise Control- BCC 9.18	Heidi M. Bedwell, 425-452-4862

The following conditions are imposed under the Bellevue City Code or SEPA authority referenced:

1. Restoration for Areas of Temporary Disturbance: A detailed restoration plan for all areas of temporary disturbance is required to be submitted for review and approval by the City of Bellevue prior to the issuance of the Clearing and Grading Permit. The plan shall include the documentation of existing site conditions and shall identify the restoration planting plan and include performance standards and monitoring schedules for fish passage and plant establishment for a period of five years. The restoration plan must contain native shrubs and trees and most conform to planting details, densities outlined in the City of Bellevue Critical Area Handbook where suggested densities do not match the standard. No permits shall be issued until the associated restoration plan has been approved by the City. Any modifications to this plan must be submitted for review and approval by the City prior to commencing any work.

Authority: Land Use Code 20.25H.220.H
Reviewer: Heidi M. Bedwell, Land Use Division

2. Rainy Season restrictions: Due to the proximity to Sunset Creek, a type F stream, no clearing and grading activity may occur during the rainy season, which is defined as November 1 through April 30 without written authorization of the Development Services Department. Should approval be granted for work during the rainy season , increased erosion and sedimentation measures, representing the best available technology must be implemented prior to beginning or resuming site work.

Authority: Bellevue City Code 23.76.093.A
Reviewer: Tom McFarlane, Development Services Department

3. Culvert Monitoring and Maintenance Prior to approval of the clearing and grading permit, the applicant shall prepare a detailed protocol for Channel Monitoring and Replacement Culvert Sedimentation Structure Maintenance. The report shall detail surveying protocol of the channel cross sections up stream and downstream of the culvert replacement and streambed sediment surveying for both pebble counts and subsurface bulk sampling and sieve analysis. Surveying and sampling shall be for a period of 5 years annually and semi-annually for the following 10 years. The report shall also detail measures to address sediment delivery rates which are different from predicted outcomes including but not limited to gravel nourishment and sediment removal. Reporting of the survey findings shall be given to the Development Services Department on an annual basis.

Authority: Land Use Code 20.25H.220.H
Reviewer: Heidi M. Bedwell, Land Use Division

4. Noise Control: Noise related to construction is exempt from the provisions of BCC 9.18 between the hours of 7 am to 6 pm Monday through Friday and 9 am to 6 pm on Saturdays, except for Federal holidays and as further defined by the Bellevue City Code. Noise emanating from construction is prohibited on Sundays or legal holidays unless expanded hours of operation are specifically authorized in advance. Requests for construction hour extension must be done in advance with submittal of a construction noise expanded exempt hours permit.

Authority: Bellevue City Code 9.18
Reviewer: Heidi M. Bedwell, Land Use Division

5. Temporary Erosion and Sedimentation Control Plan: Prior to approval of the underlying clearing and grading permit and initiation of any clearing or grading activities, a Temporary Erosion and Sedimentation Control Plan must be approved as part of a Clearing and Grading permit and all clearing limits and the location of temporary erosion and sedimentation control measures shall be field staked for approval by the on-site clearing and grading inspector's approval.

Authority: Bellevue City Code 23.76
Reviewer: Tom McFarlane, Development Services Department

6. Turbidity Monitoring Plan: Prior to approval of the underlying clearing and grading permit and initiation of any clearing and grading activities, a Turbidity Monitoring Plan must be approved as part of the Clearing and Grading Permit.

Authority: Bellevue City Code 23.76
Reviewer: Tom McFarlane, Development Services Department

7. Use of removed trees: Three Douglas fir trees removed as part of the proposed project shall be incorporated into the project designs to the extent possible.

Authority: Land Use Code 20.25H.180.C.2
Reviewer: Heidi M. Bedwell, Land Use Division

8. Applicable State and Federal Permits: Prior to approval of the underlying clearing and grading permit and before work can be allowed to proceed, all applicable state and federal permits must be presented to the Development Services Department.

Authority: Land Use Code 20.25H.180.C.2
Reviewer: Heidi M. Bedwell, Land Use Division

9. Fish protection measures: The applicant shall implement WSDOT Fish Exclusion Protocols and Standards to ensure fish resources in the project reach are protected during construction.

Authority: Land Use Code 20.25H.160
Reviewer: Heidi M. Bedwell, Land Use Division

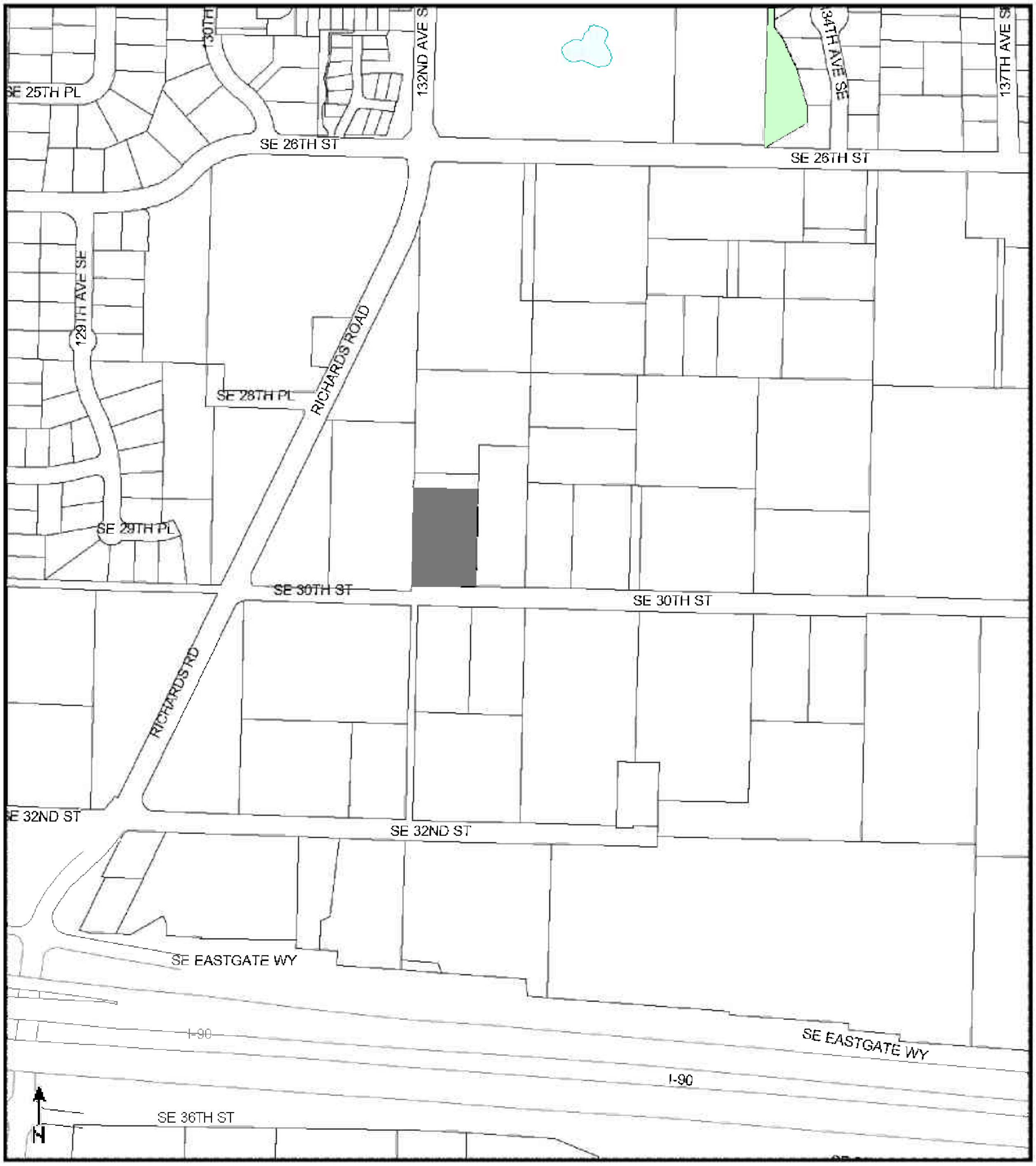
10. In-Water Work Window: Work in the active channel approved by the underlying Clearing and Grading Permit must be completed during an in-water work window of July 1 through August 31 or as allowed per the Washington Department of Fish and Wildlife, HPA conditions.

Authority: Land Use Code 20.25H.160
Reviewer: Heidi M. Bedwell, Land Use Division

Attachments

1. Vicinity Map
2. Critical Areas Report
3. Addendum to the Critical Areas Report
4. Environmental Checklist
5. Public Comment

Attachment 1
Vicinity Map



City of Bellevue
Information Technology
Geographic Information Services
August 27, 2008

Vicinity Map

08-128529 LO COB Sunset Creek Flood Improvement

This map is derived from the Bellevue Geographic Information System and designed for City staff use.
It is not guaranteed accurate.

If you have specific questions regarding this map, contact the department shown.

Site
Park
School

VICINITY MAP

Attachment 2

Critical Areas Report (Includes Development Plans and supplemental material provide to the State and Federal Permitting agencies- JARPA & BE)

HERRERA
ENVIRONMENTAL
CONSULTANTS

June 27, 2008

Heidi Bedwell
City of Bellevue
Department of Planning and Community Development
450 110th Avenue NE
P.O. Box 90012
Bellevue, WA 90009

Subject: SE 30th Street/Sunset Creek Flood Improvement Project – Phase 1: Abbreviated Critical Areas Report

Dear Heidi:

On behalf of Brian Ward of the City of Bellevue Utilities Department, Herrera Environmental Consultants has prepared an abbreviated report intended to satisfy Critical Areas Report requirements for the proposed SE 30th Street/Sunset Creek Flood Improvement Project. Per agreement between you and Brian, this report specifically identifies the components of existing permitting documentation that satisfy the Critical Areas Land Use Permit reporting requirements codified under LUC 20.25H.250.B. Where necessary, the report provides additional supporting information and interpretation to fully comply with these requirements.

The technical and permitting documents referenced in this report include:

- The Joint Aquatic Resources Permitting Application (JARPA) submitted to the Washington Department of Fish and Wildlife
- The Biological Assessment (BA) prepared to satisfy Endangered Species Act Consultation in conjunction with U.S. Army Corps of Engineers permitting requirements

Copies of these documents are included as appendices to the enclosed Abbreviated Critical Areas Report.

Please do not hesitate to contact Chase Barton or me if you have any questions or require additional information.

Sincerely,

Herrera Environmental Consultants, Inc.

Eric Doyle
Fisheries Biologist/Project Scientist

Enclosure: Abbreviated Critical Areas Report

cc: Brian Ward, Utilities

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Suite 1100
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435 Holgerson Road
Sequim
Washington
98382

(360) 683-9109
FAX 683-3671

ABBREVIATED CRITICAL AREAS REPORT

SE 30th Street / Sunset Creek Flood Improvement Project

Prepared for

City of Bellevue
Utilities Department

June 27, 2008

Contents

1 Introduction

The City of Bellevue (the City) proposes to replace existing twin barrel 42-inch diameter culverts on Sunset Creek at SE 30th Street with an integrated fish-passable culvert and sediment capture structure. Installation of the new structure will require modification of the stream channel upstream and downstream of SE 30th Street. These modifications will include eight grade control structures upstream and two grade control structures downstream of the culvert, riprap removal and replacement with bioengineered bank protection structures, and stream and riparian habitat enhancement. Channel and riparian modifications will take place over a segment of Sunset Creek extending from approximately 110 feet upstream to approximately 60 feet downstream of SE 30th Street.

The culvert replacement project (hereafter referred to as the proposed action) is designed to address chronic flooding of Sunset Creek at SE 30th Street and adjacent businesses, and provide the ability to adaptively manage habitat conditions and flood conveyance capacity. The integrated sediment trap will capture the majority of sediments transported to this reach of Sunset Creek in most years. This will allow for maintenance dredging to be conducted within the enclosed structure rather than the active channel. Sediment removal will be managed to optimize sediment delivery rates to the channel segment downstream of the structure, maintaining flood conveyance capacity and desirable habitat conditions.

The proposed project is planned as Phase 1 of a multiple-phase Flood Control and Sediment Management Plan for Richards Creek, Sunset Creek, and East Creek that is currently in development. The intent of this multi-phase effort is to provide a comprehensive solution to ongoing sediment management and flooding challenges in these drainages, and produce a net improvement in habitat conditions. While considered part of this larger effort, Phase 1 has independent utility and is being implemented separately to address immediate needs.

Under Bellevue Land Use Code (LUC) 20.25H.250, project proponents are required to prepare a Critical Areas Report (CAR) when the action they propose might affect the ecological functions and values provided by designated critical areas. The CAR provides the information needed by the City's Department of Planning and Community Development (PCD) to evaluate consistency with these requirements and determine if proposed restoration and mitigation adequately compensate for affected critical area functions and values.

In lieu of preparing a full CAR, PCD staff indicated they will accept an abbreviated CAR supported by the other permitting documents prepared for the proposed action. An abbreviated CAR is acceptable, providing that it clearly identifies the elements of the existing technical and permitting documentation that satisfy CAR requirements detailed in LUC 20.25H.250.B. This report has been prepared in accordance with this agreement. It identifies the pertinent elements of permitting documents that address CAR requirements, and provides additional supporting information where necessary.

The existing technical and permitting documents referenced in this report include:

- The Joint Aquatic Resources Permit Application (JARPA) (Appendix A)
- The Biological Assessment (BA) prepared to satisfy Endangered Species Act Consultation in conjunction with U.S. Army Corps of Engineers permitting requirements (Appendix B)

The general location of the proposed action is shown on Figure 1 of the BA (see BA page 2). The construction limits for the proposed action are shown generally in BA Figure 2 (see BA page 15), and more specifically in the project plans (see BA, Appendix B and/or the JARPA). The extent of anticipated direct and indirect impacts associated with the proposed action are best represented by the aquatic component of the action area, as shown on BA Figure 3 (see BA page 39), and the clearing limits shown in plan sheet C-10 (see BA Appendix B). For the purpose of this report, these combined effect limits are referred to hereafter as the impact area. (The remaining component of the action area outlined in red represents short-term construction noise impacts which are not a CAR reporting requirement.) The majority of the impact area downstream of SE 30th Street represents anticipated gradual and long-term changes in habitat conditions expected to result from adaptive management of sediment delivery rates. The design of the proposed action, construction methods, impact avoidance and minimization measures, best management practices (BMPs), and mitigation and monitoring are described in detail in the BA.

2 Critical Areas Report

Consistent with LUC 20.25H.245, the supporting information upon which this report is based was developed by qualified professionals in the areas of hydrologic and hydraulic modeling, geomorphology, engineering and fisheries biology, using the best available science and guidance. This report relates the pertinent elements in existing documentation to CAR information needs specified in LUC 20.25H.250. For ease of reference, this information is presented following the stepwise listing of CAR reporting requirements provided in LUC 20.25H.250.B.

2.1 Identification and Classification of Critical Areas and Critical Area Buffers

This subsection addresses LUC 20.25H.250.B. subsections 1 and 2. Identified critical areas and critical area buffers within and adjacent to the impact area include the following:

Streams and stream buffers: The proposed action will be constructed in and/or have direct and indirect effects on the lower Sunset Creek and upper Richards Creek stream channels identified in BA Figures 2 and 3 (see BA pages 12 and 37). Under the definitions provided in LUC 20.25H.075.B, subsection 2, both stream systems are classified as Type F (fish bearing) waterbodies. Under LUC 20.25H.075.C, subsection 1.a.ii, streams of this class have a designated buffer width of 50 feet. Historic development of the area prior to institution of critical areas protections has encroached upon the stream buffer. Buildings, roadways, and paved parking lots limit the existing and potential riparian zone to an average width of 10 to 30 feet.

Vegetation and channel conditions within these critical areas are described in the BA (see BA pages 5-8).

Habitats associated with species of local importance: Richards Creek and Sunset Creek are known and/or presumed habitat for Chinook and coho salmon, both of which are identified as species of local importance under LUC 20.25H.150.A. Chinook salmon are currently listed as threatened under the Endangered Species Act (ESA) (64 CFR 14308-14328). The buffers defined for fish bearing streams also apply to this critical area type. Additional detail on habitat use by these species, as well as other species of importance, is provided in Section 2.3.2 of this report.

No amphibian, avian, or mammal species of local importance were observed in the impact area during site surveys. Habitat conditions are generally not suitable for these species due to natural characteristics or the degraded condition of the stream buffer. Large trees that could serve as perch areas for raptors and woodpeckers are a possible exception, but these habitat elements will remain protected. There are no wetlands (LUC 20.25H.095) or geologic hazard areas (LUC

20.25H.120) within the impact area, or on adjacent properties. Neither Richards nor Sunset Creek are designated as shoreline critical areas under LUC 20.25H.115. Critical areas adjacent to the site include the Richards Creek stream channel and associated buffer upstream of the Sunset Creek confluence (existing buffer conditions are similar to those described above for Sunset Creek).

2.2 Regulations and Codes Proposed for Modification

The proposed action is classified as an allowable use under LUC 20.25H.055.B (new or expanded culverts and bridges). Under LUC 20.25H.055.C, subsection 2, this type of use is allowed providing certain performance standards are met. Consistent with the CAR guidance, relevant performance standards are discussed in detail in Section 7 of this report.

2.3 Habitat Assessment Report

This subsection identifies the elements of existing documentation that satisfy Habitat Assessment Report (HAR) requirements specified under LUC 20.25H.165.A.

2.3.1 Vegetation on and Adjacent to the Site

Vegetation conditions in the stream's buffer are described in the BA, under Vegetation and Wetlands (see BA page 5).

2.3.2 Species of Local Importance with Primary Habitat Association

Chinook salmon use of the impact area is described in detail in the BA (see BA page 40). Coho spawning and rearing has been documented in the Richards and Sunset Creek channels up to and immediately upstream of SE 30th Street (Paulsen 2007; WDFW 2004, 2007a, 2007b). Neither species has been documented in the impact area in recent years, as a result of two factors: depressed population abundance; and partial barriers to fish passage created by beaver activity in downstream areas of Richards Creek (Paulsen 2007).

While not currently considered a species of local importance, steelhead trout are listed as threatened under the ESA (72 FR 26722-26735) and are of special concern from a state and federal permitting perspective. This species has been historically documented in the Kelsey Creek system and could potentially occur in the impact area. Potential habitat use is described in the BA (see BA page 42).

The streams and associated stream buffers within the impact area described in the previous subsections comprise the primary habitats utilized by these species of local importance.

2.3.3 Federal, State, or Local Management Recommendations

No specific federal or state level management recommendations have been developed for Sunset Creek and Richards Creek. However, area biologists with WDFW and the Muckleshoot Tribe have both expressed a strong sentiment toward the maintenance and improvement of riparian functions and the protection of spawning habitat provided by Sunset Creek within the impact area (Fisher 2007; Walter 2007). Lead City of Bellevue biologists have expressed similar concerns (Paulsen 2007).

Sediment accumulation and chronic flooding in this area have been ongoing management concerns at the local level for several years. The City has invested considerably in infrastructure to address sediment delivery from upstream source areas (i.e., the high-flow bypass system in upper Sunset Creek), and in comprehensive planning to address these issues (e.g., the Richards Creek Basin Plan [Entranco 1999], and the ongoing comprehensive flooding and sediment management planning effort discussed in Section 1 of this report). The proposed action is consistent with these other city efforts.

2.3.4 Direct and Indirect Impacts

The anticipated direct and indirect impacts of the proposed action are described in detail in the BA (see BA pages 27-34). The discussion includes consideration of the indirect effects of ongoing sediment management activities in the impact area on channel conditions, and the habitat benefits expected to result from the proposed action.

2.3.5 Impact Avoidance, Minimization, and Mitigation Measures

The proposed action incorporates two general categories of impact avoidance and minimization measures:

1. Conceptual planning for the project based on the best available science and appropriate guidance

2. Standard BMPs employed to avoid and minimize short-term, construction related direct effects.

The conceptual planning element is discussed under Applicable Performance Standards (Section 2.6). Construction BMPs and long-term maintenance related measures are discussed in the BA (see BA pages 20-22).

With regard to mitigation requirements, the proposed project is considered to be self-mitigating because it will result in a net-increase in critical area functions and values. Supporting information for this position is provided in Section 2.7.

2.3.6 Ongoing Management Practices for Habitat Protection

The proposed project includes a long-term monitoring and adaptive management plan to ensure that desired habitat conditions in the project impact area are maintained. This component, which is critical to achieving the desired net improvement in critical areas functions and values, is detailed in the BA (see BA pages 22-24).

2.4 Probable Cumulative Impacts

With regard to cumulative impacts, the long-term indirect effects, effects of interrelated and interdependent actions, and project benefits described in the BA (see BA pages 29-34) provide the best measure of long-term anticipated project effects. As noted in the introduction, the proposed action is considered to be Phase 1 of a broader plan to comprehensively address sediment loading, chronic flooding, and habitat conditions in the Sunset Creek/Richards Creek/East Creek confluence area. The intent of the broader plan is to develop a comprehensive solution to sediment accumulation and flooding problems in this area while enhancing aquatic and riparian habitat conditions. The combined cumulative effects of these actions are expected to be beneficial on balance, as they will: 1) reduce the need for routine maintenance dredging of the active channel; 2) decrease the frequency of flooding of adjacent impervious surfaces that contribute pulses of non-point source pollution during storm events, and 3) incorporate extensive channel and riparian habitat enhancements. These combined elements should result in a net improvement in chronic flooding, a reduction in maintenance-related habitat disturbance, and improved habitat conditions.

The proposed action is not expected to lead to additional cumulative effects. It will not increase the traffic capacity of SE 30th Street, nor will it facilitate future development. Therefore, there are no effects associated with land use changes that can be ascribed to the action.

2.5 Critical Areas Functions and Values Protection Assessment

This component of the CAR requires a pre- and post-project assessment of the level of protection afforded to critical area functions and values by the regulations and standards in the LUC. This assessment must include the following components:

- Existing functions and values provided by critical areas and critical area buffers
- Projected future functions and values should the project be permitted
- Projected future functions and values should the project not be permitted.

These assessment elements are addressed in the following sections.

2.5.1 Existing Functions and Values Provided by Affected Critical Areas

Existing conditions in the Sunset Creek/Richards Creek impact area are degraded. The surrounding area was developed for commercial and light industrial uses during the 1960s and 1970s, prior to the establishment of critical areas protections. To accommodate this development, much of the existing channel network was relocated, straightened, and contained within riprap armored channels. Property development was allowed to encroach upon the streams, limiting the effective riparian buffer to less than 20 feet on either side of the stream in most circumstances. The remaining riparian buffer is composed of a sparse mix of ornamental, invasive, and native vegetation.

Before historic hydromodification, stream channels within the project area would have naturally aggraded and shifted location across an alluvial fan, occupying the course of least resistance. Development related hydromodification halted the natural process of channel migration and restricted the natural process of sediment deposition to the established channel corridors. Concurrent development of headwater areas of the drainage proceeded without adequate stormwater detention, resulting in an increased sediment supply rate that has proven difficult to mitigate. Sediment aggradation in the project vicinity currently exceeds transport capacity, resulting in chronic sediment deposition that reduces channel capacity and promotes flooding. As a consequence, the City must dredge the active channel annually to maintain flood conveyance. While considered an allowable use under LUC 20.25H.055.B, this activity nonetheless contributes to chronic disturbance of the channel and channel buffer.

The functions and values provided by the area proposed for modification are mixed. Under natural conditions, this alluvial fan reach likely provided prime spawning habitat for resident and migratory fish, including salmon and steelhead. Even in its current degraded state, the aggraded stream reach immediately downstream of SE 30th Street continues to provide important spawning habitat. However, the inability of the channel to migrate in response to sediment deposition has created an overly wide and shallow channel condition that limits the quality and quantity of useable spawning habitat and presents a low flow passage barrier.

Protecting and enhancing remaining spawning habitat in the Kelsey Creek watershed is considered a central objective of critical areas management by the City. This system is spawning habitat limited (Paulsen 2007), meaning that salmonid productivity in the system is constrained by the amount of available habitat suitable for spawning. Preserving existing spawning habitat and increasing its function will directly benefit species of local interest.

2.5.2 Projected Future Conditions: Proposed Action Permitted

The proposed action is expected to improve critical area functions and values in the segments of Sunset Creek and Richards Creek within the impact area. The expected improvements include the following, by critical area and critical area buffer category:

- Streams and habitats used by species of local interest:

- ☐ Reduced maintenance dredging frequency in the active channel, reducing habitat disturbance
- ☐ Simplified fish exclusion procedures and reduced need for fish capture and relocation during maintenance
- ☐ Replacement of 154 lineal feet of riprap bank protection with bioengineered structures and channel modifications and addition of 39 pieces of geomorphically functional large woody debris to the stream channel, resulting in increased hydraulic complexity and habitat diversity (see BA page 32)
- ☐ Improved water quality (see BA pages 34, 43-53)
- ☐ Improved fish passage under high and low flow conditions (see BA pages 33-34)
- ☐ Maintenance of desirable spawning habitat conditions (see BA pages 43-53).

- ▪ Stream buffers, and buffers for habitats used by species of local interest (see BA, Appendix B, Drawings P1-P3):
  - ☐ Restoration and enhancement of all areas disturbed by construction;
  - ☐ Removal of invasive and ornamental riparian vegetation and replacement with site appropriate native species;
  - ☐ Increased density and coverage of native vegetation, providing improved shade and cover, and increased recruitment of organic material and prey organisms (dense vegetation will also limit human access, reducing harrassment and disturbance of aquatic life).

These habitat improvements will be maintained over the anticipated life of the project, and will be further enhanced by the subsequent phases of the proposed comprehensive flood control and sediment management plan for this portion of the Richards Creek drainage discussed elsewhere in this report.

2.5.3 Projected Future Conditions: Proposed Action Denied

Should the proposed action not go forward, the protections afforded by existing critical areas regulations would be expected to maintain habitat conditions in a degraded state. Routine annual maintenance dredging of the active channel would continue, resulting in episodic habitat disturbance, including fish capture and handling during work area dewatering. Chronic sediment aggradation upstream and downstream of the SE 30th Street culvert would continue to pose high flow and low flow barriers to fish passage. Periodic water quality degradation associated with overland flooding of adjacent impervious surfaces would continue unabated. Riparian vegetation would likely remain in its current degraded state, dominated by sparse ornamental and invasive species.

2.6 Applicable Performance Standards

Pertinent performance standards for culvert replacement are specified under LUC 20.25H.055.C. These standards require demonstration that the proposed action is the most technically feasible and appropriate solution to the problem at hand, and that the solution is designed consistent with applicable best available science and guidance.

The proposed action presents the most technically feasible solution to sediment accumulation and flooding issues that characterize the SE 30th Street crossing of Sunset Creek. As described in the BA summary of hydraulic and geomorphic characteristics (see BA pages 6-8), historic hydromodification of this channel segment has created a condition in which sediment deposition rates exceed transport capacity. This causes chronic aggradation inside the culvert and immediately upstream and downstream that in turn contributes to chronic flooding. The City has invested considerable resources in infrastructure to address sediment delivery from upstream source areas. However, a detailed analysis of current and projected future conditions (currently in preparation) has indicated that sediment delivery rates will exceed transport capacity for the foreseeable future even if additional source control measures are implemented. This will contribute to ongoing sediment deposition in the SE 30th Street vicinity, poor culvert performance, and continued chronic flooding. Annual maintenance dredging required to minimize this flooding will maintain aquatic habitat conditions in a degraded state (LUC 20.25H.055.C, subsection 2.a.v.).

The proposed action will address these issues by increasing the hydraulic capacity of the culvert and adjacent channel and improving sediment management capability. In combination with the improved habitat conditions provided by riparian enhancement and addition of instream wood structures, the ability to adaptively manage sediment delivery rates to the downstream channel will result in improved habitat conditions. The channel will be allowed to gradually erode the existing sediment deposit until a more suitable width/depth ratio is reached. Substrate conditions will be monitored to ensure desirable spawning habitat attributes are maintained. As such, the long-term impacts of the proposed action are anticipated to be beneficial. While short-term construction related impacts will occur, the BMPs and impact avoidance and minimization measures incorporated into the design will limit their duration and extent. The site will be fully restored following project completion and riparian vegetation in stream buffer areas will be enhanced relative to current conditions (LUC 20.25H.055.C, subsections 2.b.i, ii, and viii).

Per the requirements of LUC 20.25H.055.C, subsection 3, the culvert replacement structure and related stream modifications have been designed by qualified professionals consistent with the best available science and the appropriate guidance. As stated in the BA (see BA pages 24-25) the entire design is based on a comprehensive assessment of watershed, reach, and site specific hydrologic, hydraulic, and geomorphic conditions. This approach is consistent with the Integrated Streambank Protection Guidelines prepared by the Washington State Aquatic Habitat Guidelines Program (WSAHGP 2003). As discussed in the JARPA (see JARPA page 10), the culvert replacement structure has been designed in accordance with WDFW culvert design guidance (WDFW 2003), using the stream simulation method. The culvert replacement is strictly intended to address flood control and sediment management issues at the existing road crossing. It will not change the traffic capacity of the existing roadway or otherwise facilitate new development.

2.7 Restoration and Mitigation Requirements

Mitigation and restoration requirements associated with this type of project are defined based on the type of critical area affected. As discussed, the proposed project will result in two categories of functional effects: short-term construction related effects on the stream buffer; and long-term beneficial effects on the stream buffer and stream habitat conditions, including habitats used by species of local importance.

With regard to short-term effects, all areas disturbed during construction of the proposed action will be fully restored and enhanced. The construction plans incorporate measures to protect existing trees, avoid native vegetation, and concentrate disturbance in areas dominated by invasive or ornamental vegetation. All disturbed areas will be replanted with site appropriate native species. Existing invasive and ornamental vegetation will be removed. The site revegetation plan, prepared in accordance with City requirements, is provided in Appendix B of the BA (see Drawings P1-P3).

Per LUC 20.25H.085.A, mitigation is specifically intended to replace loss or degradation of critical area and buffer values and functions caused by a proposed action. Mitigation requirements specific to streams and stream buffers include the following in the stated order of preference:

1. On-site, through replacement of lost critical area buffer

2. On-site, through enhancement of the functions and values of remaining critical area buffer

3. Off-site, through replacement or enhancement, in the same sub-drainage basin

4. Off-site, through replacement or enhancement, out of the sub-drainage basin but in the same drainage basin.

Per LUC 20.25H.085.B, lost values and functions shall be mitigated with a one-to-one ratio.

Based on these requirements, the proposed action is considered to be self-mitigating. No further mitigation should be required because: 1) the project will result in an immediate and long-term net-improvement in critical area values and functions, and 2) the project incorporates long-term monitoring and adaptive management to ensure that desirable conditions are maintained overtime. Because no loss of critical area functions and values will result from the proposed action, no further mitigation measures should be required.

3 References

Entranco. 1999. Richards Creek Basin Plan. Prepared for the City of Bellevue by Entranco, Bellevue, Washington. July 26, 1999.

Fisher, Larry. 2007. Personal communication (field meeting with Eric Doyle, Herrera Environmental Consultants, Inc., Seattle, Washington, regarding proposed SE 30th Street/Sunset Creek Culvert Replacement Project). Regional biologist, Washington Department of Fish and Wildlife. August 20, 2007.

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APPENDIX A

Joint Aquatic Resources Permit Application

AGENCY USE ONLY	**JARPA FORM LAST UPDATED: March 19, 2007**
Agency Reference #:	Date Received:
Circulated by:	(local govt. or agency)
Project Tracking Number:	

Washington State **JOINT AQUATIC RESOURCES PERMIT APPLICATION (JARPA)** Form

Step 1: Get Ready	Step 2: Complete Form		Step 3: Check Work	Step 4: Copy and Send In
Go to www.epermitting.org for **correct form** and **instructions**.	Use **black ink**. Check correct permit boxes.	Use internet **"Help" buttons** to answer questions completely.	Use final review checklist at www.epermitting.org .	See **JARPA Contacts** at www.epermitting.org for correct mailing addresses.

☐ Fish Habitat Enhancement Projects per RCW 77.55.181. You must submit copy of completed JARPA form and Fish Habitat Enhancement JARPA Addition to your Local Government Planning Dep't and WA Dep't of Fish and Wildlife (WDFW) Area Habitat Biologist on same day. Note for Local Governments: You must submit comments to WDFW within 15 working days.

Based on instructions at www.epermitting.org, I am sending copies of this application to the following: *(check all that apply)*

☒ Local Government for Shoreline: ☐ Substantial Development ☐ Conditional Use ☐ Variance ☐ Exemption ☐ Revision
☒ Floodplain Management ☒ Critical Areas Ordinance

☒ Washington Department of Fish and Wildlife for Hydraulic Project Approval (Submit 2 copies to WDFW Region)

☒ Washington Department of Ecology for 401 Water Quality Certification (to Regional Office-Federal Permit Unit)

☐ Washington Department of Natural Resources for Aquatic Resources Use Authorization Notification

☒ Corps of Engineers for: ☒ Section 404 permit ☐ Section 10 permit

☐ Coast Guard for: ☐ General Bridge Act Permit ☐ Private Aids to Navigation (for non-bridge projects)

☐ For Department of Transportation projects only: This project will be designed to meet conditions of the most current Ecology/Department of Transportation Water Quality Implementing Agreement

PROJECT TITLE: SE 30th Street / Sunset Creek Culvert Replacement

PROJECT DESCRIPTION:

The City of Bellevue proposes to replace existing twin 42-inch diameter corrugated metal pipe culverts on Sunset Creek at SE 30th Street with a stream simulation and sedimentation structure, and modify the Sunset Creek channel upstream and downstream to match the culvert replacement structure invert elevations. Proposed channel modifications include removing existing riprap along the channel banks and culvert headwalls, modifying the streambed grade, installing grade control and bank stabilization structures made primarily of boulders and large woody debris, and revegetating disturbed streambanks. The culvert replacement project is designed to reduce ongoing flooding of SE 30th Street and adjacent properties and manage sediment transported in Sunset Creek to eliminate the need for annual dredging in the active channel upstream and downstream of the culvert openings. The replacement culvert project is designed to transmit the 100-year flood without allowing flow to overtop SE 30th Street, store approximately 50 cubic yards of sediment within the culvert structure, and provide improved aquatic habitat and fish passage conditions.

SECTION A - Use for all permits covered by this application. Be sure to ALSO complete Section C (Signature Block) for all permit applications.

help 1. APPLICANT
City of Bellevue Utilities, Brian Ward (Project Manager)

MAILING ADDRESS
450 110th Ave NE, 5th Floor, Bellevue, WA 98004

WORK PHONE	E-MAIL ADDRESS	HOME PHONE	FAX #
425-452-5206	**bward@bellevuewa.gov**	**206-334-1500**	**425-452-5286**

If an agent is acting for the applicant during the permit process, complete #2. Be sure agent signs Section C (Signature Block) for all permit applications

help 2. AUTHORIZED AGENT
Herrera Environmental Consultants, Inc. (Chase Barton, Project Manager)

MAILING ADDRESS
2200 Sixth Avenue, Suite 1100, Seattle, Washington 98121

WORK PHONE	E-MAIL ADDRESS	HOME PHONE	FAX #
206-441-9080	**cbarton@herrerainc.com**	**206-910-4403**	**206-441-9108**

help 3. Relationship of applicant to property: ☒ OWNER ☐ PURCHASER ☐ LESSEE ☐ ______

help 4. Name, address and phone number of property owner(s) if other than applicant:
E.S. Harrington, 13120 SE 30th Street, Bellevue, Washington 98005
Stead Building Partnership, 13200 SE 30th Street, Bellevue, Washington 98005
SLC Investment LLC, 13201 SE 30th Street, Bellevue, Washington 98005
SCC Property Holdings, 13111 SE 30th Street, Bellevue, Washington 98005

help 5. Location (street address, including city, county and zip code, where proposed activity exists or will occur)
SE 30th Street, approximately 500 feet east of Richards Road SE, Bellevue, King County, Washington 98005

help Local government with jurisdiction (city or county) **City of Bellevue**

help Waterbody you are working in		**Sunset Creek**		help Tributary of **Richards Creek**		help WRIA # **8**
help Is this waterbody on the 303(d) List ☐ YES ☒ NO If **YES**, what parameter(s)?				help Shoreline designation	**N/A**	
				help Zoning designation	**Light Industrial**	
¼ Section	Section **9 and 10**	Township **24 North**	Range **5 East**	Government Lot	help DNR stream type if known	**Type F**
help Latitude and Longitude:		**$47^0$35'01"N, $122^0$09'52"W**		Tax Parcel Number	**5453300194, 5453300183, 5453300244, 5458300291**	

help 6. Describe (a) the current use of the property, (b) structures existing on the property, and (c) existing environmental conditions.
Have you completed any portion of the proposed activity on this property? ☐ YES ☒ NO
For any portion of the proposed activity already completed on this property, indicate month and year of completion.

a & b) The project improvements are proposed to occur within existing city street right-of-way and adjacent privately owned parcels. The culvert replacement site is located within the right-of-way of SE 30th Street along the same alignment as the existing twin 42-inch diameter culverts. Upstream channel modifications are to occur primarily within an existing city right-of-way for 132nd Avenue SE, which was never completed in this location. Some channel modification, site access and revegetation activities associated with upstream channel modifications may also occur on private parcels (tax parcel numbers 5453300244, 5453300291). Downstream channel modifications are proposed on private parcels (tax parcel numbers 5453300194 and 5453300183). The taxpayers, property name, property type and present use of the private parcels associated with the proposed project activities are presented in Table 1. Initial discussions have been initiated with private parcel owners by the City of Bellevue, and there is no indication of any opposition to the proposed project activities.

Table 1. Property characteristics for private parcels associated with proposed project activities.

Tax Parcel Number	Taxpayer	Property Name	Property Type	Present Use
5453300244	SCC Property Holdings	Shurgard Mini Storage	Commercial	Mini Warehouse
5453300291	SLC Investment LLC	Printed Circuits Assembly Corp.	Commercial	Industrial Park
5453300194	Emmett S. Harrington	Shurgard Mini Storage	Commercial	Mini Warehouse
5453300183	Stead Building Partnership	Stead Building	Commercial	Warehouse

c) Sunset Creek is located in the Kelsey Creek subarea of WRIA 8. Approximately 400 feet downstream of the proposed culvert replacement location, Sunset Creek joins Richards Creek. Approximately 850 feet downstream of the confluence of Sunset Creek and Richards Creek, Richards Creek is joined by East Creek. From this confluence, Richards Creek flows north towards Kelsey Creek. Upstream of the proposed project site, Sunset Creek originates from a highly developed watershed approximately one square mile in area that lies primarily to the south of Interstate 90 and east of Interstate 405. Single family residential parcels dominate the watershed land use south of Interstate 90 and commercial properties are predominant in the vicinity of the proposed project site. Significant watershed development began prior to 1961. Presently, the effective impervious area of the Sunset Creek watershed is approximately 44 percent. Sheet 1 shows the project vicinity map.

The physical changes made to a watershed during urbanization can significantly alter its hydrologic regime and sediment supply characteristics. In the Sunset Creek watershed, as has occurred in many other watersheds in the Puget Sound area, the addition of impervious surfaces associated with development resulted in increased peak flow magnitudes that in turn caused widespread adjustments in stream channel form, primarily in the form of channel incision and enlargement. Locally, these changes destabilized the toes of steep hillslopes and increased the rate of sediment supply to the channel from bank erosion and landslides. Although streambanks in many parts of the Sunset Creek channel network have been stabilized, bank erosion and slope instability continues in some reaches upstream of Interstate 90.

The Sunset Creek ravine located immediately upstream of Interstate 90 has been the most highly productive sediment supply reach in the Sunset Creek channel network. The City of Bellevue has completed multiple projects to address widespread landsliding within this reach. Channel spanning grade control structures were installed in the mid to late 1980s and a flow bypass, routing peak flow discharges around the most unstable and highly sediment productive portion of the reach, was completed in 1998. Although it is apparent that these projects have reduced the rate that sediment is delivered to the channel and transported downstream, considerable sediment is stored within the active channel network in the upper watershed. This mobile sediment continues to be routed downstream of Interstate 90 where steep and largely confined channel segments route the sediment to the proposed culvert replacement location at SE 30th Street.

Historical and recent channel survey data indicate that the bed elevation of Sunset Creek and Richards creeks has aggraded between three and four and a half feet within 1,000 feet of channel length downstream of SE 30th Street over the last 30 years. It is estimated that an average of approximately 40 cubic yards of gravel (with some sand) have accumulated annually in this reach of Sunset and Richards creeks in that 30-year period. It is likely that peak rates of sediment delivery to the SE 30th Street culverts and the channel network downstream occurred soon after widespread watershed development, and before efforts to reduce sediment production and transport from the upper watershed. However, ongoing sedimentation in the twin culverts beneath SE 30th Street and in the stream channel downstream requires regular dredging activity to maintain culvert openings and provide flow conveyance. Records of recent maintenance dredging completed by the City of Bellevue show that between 10 and 22 cubic yards of sediment have been removed annually between 2004 and 2007 (Table 2). Dredged areas typically aggrade following the first few storm events of the winter. The volume of accumulated and dredged sediment represents a

reasonable estimate of the bedload sediment volume that is delivered annually to Sunset Creek at and below SE 30th Street. The total sediment in transport past SE 30th Street, including suspended sediment in storm flows, is likely an order of magnitude higher.

Table 2. Records of recent maintenance dredging in Sunset Creek at SE 30th Street.

Year of Dredging	Volume of Sediment Removed Downstream of SE 30th Street Culverts (yds^3)	Volume of Sediment Removed Upstream of SE 30th Street Culverts (yds^3)
2004	15-20	–[a]
2005	20	1.5
2006	10	0.75
2007	15-20	–[a]

[a] **Volume of sediment removal upstream of culverts not reported.**

Ongoing aggradation at the proposed culvert replacement location at SE 30th Street, and within the Sunset, Richards, and East Creek channel network downstream, is a result of the site's position on a historical alluvial fan where steep confined channels from the upper watershed transition to less confined, lower gradient channels. Within this context, the proposed culvert replacement location at SE 30th Street coincides with a marked change in gradient. Upstream of SE 30th Street to Interstate 90 the average channel gradient of Sunset Creek exceeds 2.5 percent. Downstream of SE 30th Street the channel gradient decreases to 1.2 percent; with the gradient decreasing to less than 0.9 percent at the confluence with Richards Creek and approximately 0.3 percent north of Kamber Road. The significant decrease in channel gradient at the proposed culvert replacement location and within the channel network further downstream results in similar decreases in sediment transport capacity and drives the ongoing sediment aggradation that exacerbates flooding at SE 30th Street.

Between 1963 and 1970, Sunset Creek was relocated to its present day alignment at SE 30th Street as part of the development in the area. The current conditions of the Sunset Creek channel immediately upstream and downstream of SE 30th Street are largely controlled by the confined, channelized alignment, insufficient flow conveyance of the existing culverts, and high rates of sediment delivery. Downstream of SE 30th Street, abundant deposits of gravel and sand occupy the entire channel width between vertical riprap banks that were constructed when the stream was relocated from its historic location and channelized at the edge of developing properties. The relatively wide, shallow channel presents a fish passage barrier during low flow conditions in this area. Upstream of SE 30th Street, the channel is confined within constructed banks armored with riprap and protected with riprap toes. The substrate of the channel upstream of SE 30th Street is coarse and armored beyond the extent of backwater deposits associated with limited flow conveyance during moderate and high flow events. Both upstream and downstream of SE 30th Street, within the extent of proposed channel modifications associated with the proposed culvert replacement structure, the straight, plane-bed channel pattern provides little hydraulic or habitat complexity. A private habitat improvement project was completed in 2005 in Sunset Creek just upstream of the limits of the proposed channel modifications. That project included addition of large woody debris and modifications to the channel cross-section in an effort to provide a two-stage channel. The proposed upstream channel modifications associated with the culvert replacement project will transition into this previously completed project reach.

Despite the comprehensive channel modifications, limited riparian corridor and high rates of sediment delivery, resident and adfluvial trout (cutthroat) have been observed spawning in Sunset Creek downstream of the proposed culvert replacement location, and evidence of spring spawning was observed in April of this year. Chinook salmon and steelhead are also known to have used the Sunset Creek and Richards Creek systems with distribution of these species extending into Sunset Creek up to and possibly beyond SE 30th Street. These species have not been observed in Sunset Creek in recent years, potentially due to passage barriers imposed by extensive beaver dam complexes in downstream reaches.

help Is the property agricultural land? ☐ YES ☒ NO help Are you a USDA program participant? ☐ YES ☒ NO

help 7a. Describe the proposed work that needs aquatic permits: Complete plans and specifications should be provided for all work waterward of the ordinary high water mark or line, including types of equipment to be used. If applying for a shoreline permit, describe all work within and beyond 200 feet of the ordinary high water mark. If you have provided attached materials to describe your project, you still must summarize the proposed work here. Attach a separate sheet if additional space is needed.

The proposed project includes replacing existing twin 42-inch diameter corrugated metal pipe culverts with a box culvert designed to simulate natural streamflow conditions to the highest degree possible. The proposed box culvert design includes a sedimentation structure. Channel modifications will be necessary upstream and downstream of the replacement structure to create a stable transition of the existing streambed to the replacement culvert inlet and outlet invert elevations. Sheet 1 shows the project vicinity map. The principal work activities associated with the culvert replacement and channel modifications include:

1. **Site preparation**
2. **Preliminary excavation of roadway**
3. **Install temporary flow bypass**
4. **Conduct fish removal**
5. **Dewater construction area**
6. **Remove riprap from culvert inlet and outlet headwalls**
7. **Remove and replace existing culverts**
8. **Remove riprap from channel banks**

9. Channel grading, excavation and sediment removal
10. Install grade control structures and bank protection
11. Revegetate streambanks
12. Reintroduce flow to channel
13. Construct high flow and maintenance bypass culvert.

A detailed description of each of these work activities follows. Sheet 2 presents a schematic drawing of the proposed work area.

1. Site preparation

Site preparation activities include the contractor mobilizing to the project site, developing a staging area, establishing site access routes and traffic control, marking the work and clearing limits, and installing temporary erosion and sediment control (TESC) best management practices (BMPs). Space at the project site is limited and it is anticipated that the contractor will establish staging in the parking lot of a nearby business. The City of Bellevue is currently evaluating staging area alternatives. A staging area of approximately 100 feet by 100 feet is anticipated to be sufficient for the proposed project activities. Access to the project site will be along SE 30th Street.

2. Preliminary excavation of roadway

Preliminary excavation of SE 30th Street will include removal of the road surfacing and sidewalks in the area where the culvert will be replaced and excavation of the trench where the temporary flow bypass will be routed under SE 30th Street. The temporary flow bypass alignment is anticipated to be located immediately to the west of the replacement culvert adjacent to the future alignment of the maintenance bypass pipe. Preliminary excavation may also include temporary relocations or realignments of utilities at the project site.

3. Conduct fish removal

Fish removal will be conducted by isolating the work area, removing as many fish as possible, then gradually dewatering the work area while continuing to remove any fish observed. The work area will be isolated by installing block nets upstream and downstream of all work activities including the intake and discharge location for the temporary flow bypass. If conditions allow, the upstream block net shall be placed first. The downstream block net will then be used as a seine to herd fish from the upstream block net location downstream to the point selected for the downstream block net installation. The site will be then be dewatered slowly enough to allow for continued removal of all fish species to avoid strandings. Fish removal methods during dewatering will likely include dip netting and hand removal. Fish handling will be kept to the minimum necessary to remove fish from the work site. All fish and aquatic life removed from the project site will be released downstream of the downstream block net.

4. Install temporary flow bypass

In conjunction with fish removal activities, Sunset Creek will be diverted into a flow bypass pipe and routed past the work area for the duration of culvert replacement and channel modification work. A coffer dam will be constructed approximately 250 feet upstream of SE 30th Street and stream flow will be routed into a flexible pipe to be secured to the west of the channel. The bypass pipe will be 36 inches in diameter and capable of conveying flows up to 95 cubic feet per second (cfs). This bypass conveyance capacity exceeds the 2-year recurrence interval flow in Sunset Creek (79 cfs). The temporary bypass pipe will be routed beneath SE 30th Street and will extend for a distance of approximately 150 feet downstream of SE 30th Street where flows will be discharged to a temporary energy dissipater. All coffer dam and energy dissipater materials will be completely removed from the site when the flow bypass is removed.

5. Dewater construction area

Following the installation of the temporary flow bypass any water remaining in the active channel or existing culverts will be pumped from the work area in accordance with permit requirements for discharge water quality. Turbidity control BMPs will be implemented as necessary before this pumped water is released to Sunset Creek and/or its riparian corridor. The culvert excavation will be dewatered as necessary based on the groundwater conditions encountered at the time of construction. Groundwater was encountered from 5 to 8 feet below the road surface during geotechnical borings advanced in April 2007.

6. Remove riprap from culvert inlet and outlet headwalls and channel banks

Riprap will be removed from the culvert inlet and outlet headwalls to facilitate further excavation and culvert replacement. Riprap will also be removed from the banks of Sunset Creek within 110 feet upstream and 60 feet downstream of the replacement culvert. Riprap will be removed using an excavator and will be hauled from the site to a licensed disposal or material reuse facility. Quantities and linear extents of riprap removal are presented in Table 3.

Table 3. Riprap removal quantities.

Location	Bank Length (ft)	Bank Area (ft^2)
Upstream		
Left Bank	10	30
Above Culvert	14	42
Downstream		
Left Bank	60	240
Right Bank	60	240
Above Culvert	10	50
Totals	154	602

7. Remove and replace existing culverts

Removal of the existing twin 42-inch diameter corrugated metal pipe culverts and installation of the replacement culvert structure will require additional excavation in the SE 30th Street corridor. Excavation, culvert removal, and replacement will require traffic control, as only one lane of SE 30th Street will typically be closed at any given time. All excavated material will be hauled from the project site to a licensed disposal or material reuse facility, or stockpiled onsite for use as backfill following installation of the replacement culvert structure. The replacement culvert structure will be installed in approximately the same location as the existing culverts. The replacement culvert will be constructed using precast concrete structures. All replacement culvert construction activities will be constructed in the dry to minimize water quality impacts. Construction of the replacement culvert will be coordinated with utility relocation in the SE 30th Street right-of-way. Sheet 3 shows a profile of the existing and replacement culverts. Sheet 5 shows plan and profile views of the replacement culvert design. Sheet 6 presents cross section views of the proposed culvert design in the upper stream simulation section and in the lower sediment trap section.

8. Channel grading, excavation and sediment removal

The Sunset Creek channel will be modified to provide smooth and stable transitions from the existing streambed to the inlet and outlet invert elevations of the replacement culvert. Upstream of the replacement culvert, the finished channel bed will be lowered an average of approximately 1.4 feet, and up to 2.5 feet locally, over a length of 110 feet and an average channel width of 7 feet. The streambed will be overexcavated an additional 2 feet for the placement of streambed material, boulders, and large woody debris. Sheet 3 shows the extents of proposed channel grading upstream of SE 30th Street. Streambed and bank material will be removed from the channel using an excavator. Streambed material from the channel upstream of the replacement culvert may be reused as stable channel bed material after grade control structures are constructed if deemed suitable by the project engineer. Bank materials and any streambed material deemed unsuitable for reuse by the project engineer will be hauled from the site to a licensed disposal or material reuse facility.

Downstream of the replacement culvert, the full width of the channel bed, at an average width of 10 feet, will be lowered up to 2.5 feet for a distance of 60 feet downstream of the replacement culvert. Sheet 3 shows the extents of proposed channel grading downstream of SE 30th Street. As upstream, the streambed will be overexcavated an additional 2 feet for the placement of streambed material, boulders, and large woody debris. Bed material from this part of the channel will be removed with an excavator. A portion of this material may be suitable for use as stable channel bed material if deemed so by the project engineer during construction. Additional streambed material will be removed from the channel between 60 and 100 feet downstream of the replacement culvert. This material will be removed from the center 4 to 5 feet of the channel using a suction dredge without disturbing existing streambanks or riparian vegetation.

Stream channel bank and bed material removal and fill quantities within the ordinary high water line associated with channel modifications during construction are presented in Table 4. Sheet 4 shows a typical cross section of the proposed channel modifications as well as the plan view extents of grade control structures on the upstream side of SE 30th Street. Sheet 7 shows a typical cross section of the proposed channel modifications as well as the plan view extents of grade control structures on the downstream side of SE 30th Street.

Table 4. Sediment removal and fill quantities within the ordinary high water line.

Impact	Upstream of Culvert	Downstream of Culvert
Volume of excavation within existing OHWM (cy) [a]	111	145
Volume of fill within existing OHWM (cy) [b]	58	47
Area of fill within existing OHWM (arce)	0.02	0.02

[a] Includes streambed material and riprap.
[b] Includes streambed material and boulders.

9. Install grade control structures, bank protection, and substrate material

Grade control and bank protection structures will be constructed in order to create a stable transition of the existing streambed to the replacement culvert inlet and outlet invert elevations. Grade control and bank protection structures will be primarily constructed using large woody debris and rounded to subrounded river boulders; large woody debris will be imbedded in the streambed and banks and surcharged with boulders as necessary to resist lateral drag and buoyant forces and provide a high factor of safety for channel stability. One structure, the large woody debris grade control structure downstream of the replacement culvert outlet, will incorporate ecology blocks buried within the streambanks. Here, where the channel corridor is narrow relative to the channel width, the large woody debris will be attached to the ecology blocks buried within the banks and located outside of the OHWM. Typical dimensions for large woody debris are diameters of 18 to 24-inches and lengths of 15 to 25-feet. Typical boulder diameters are 12 to 18-inches.

Eight grade control structures will be installed upstream of the replacement culvert. The average gradient of Sunset Creek upstream of SE 30th Street is 2.5 percent. Within 15 feet of SE 30th Street on the upstream side, however, the existing channel gradient is up to 30 percent. The design grade of the channel for a distance of 110 feet upstream of the replacement culvert is 4 percent, with no sections to exceed 5 percent between grade control structures and no vertical drops in excess of 4 inches to promote fish passage. Sheet 8 shows plan and section design details of the proposed grade control structures upstream of SE 30th Street.

Downstream of the replacement culvert one large woody debris grade control structure and one boulder grade control structure will be constructed. The large woody debris grade control structure will be constructed 20 feet downstream of the replacement culvert and the boulder grade control structure will be located another 20 feet further downstream. Sheet 9 shows plan and section design details of the proposed grade control structures downstream of SE 30th Street.

Two types of streambed material will be placed in areas where the channel is modified upstream and downstream of the replacement culvert. The streambed surface will be composed of a 12-inch thick layer of streambed habitat gravel. Below this layer, a 12-inch thick layer of cobble and gravel sized to resist scour and downstream transport will be used to maintain design channel elevations between grade control structures. These materials will likely be placed by excavator with finish placement requiring hand grading.

10. Revegetate streambanks

All streambanks disturbed during channel modification will be revegetated with an appropriate range of native species. Typical species that may be used to revegetated streambanks are presented in Table 5. Replanting plans will be consistent with planting guidelines presented in the City of Bellevue's Critical Areas Handbook (2007).

Table 5. Typical species that may be used to revegetated Sunset Creek streambanks following channel modification.

Vegetation Type	Common Name	Latin Name
Trees		
	Oregon ash	*Fraxinus latifolia*
	Pacific Willow	*Salix lasiandra*
	Paper birch	*Betula papyifera*
	Red alder	*Alnus rubra*
Shrubs		
	Vine maple	*Acer circinatum*
	Red-osier dogwood	*Cornus sericea*
	Salmonberry	*Rubus spectablis*
	Pacific ninebark	*Physocarpus capitatus*
Groundcover		
	Lady fern	*Athyrium filix-femina*
	Sword fern	*Polystichum munitum*
Emergent		
	Small-fruited bulrush	*Scirpus microcarpus*

11. Reintroduce flow to channel

Following completion of the culvert replacement and channel bed modifications, Sunset Creek flows will be reintroduced to the channel. The timing of reintroduction will be coordinated with construction of the high flow and maintenance bypass culvert and outfall and completion of bank protection in the outfall location at the downstream end of the replacement culvert.

12. Construct maintenance bypass culvert

A 24-inch diameter maintenance bypass culvert will be constructed to the west of the replacement culvert structure. The maintenance bypass culvert will provide a means to bypass streamflows during maintenance of the sedimentation structure. The inlet of the maintenance bypass culvert at the upstream end will be in the wall of the replacement culvert. The outlet of the high flow and maintenance bypass culvert will discharge to an energy dissipation structure composed of large woody debris built into the left bank of the stream channel downstream of the replacement culvert. Both the inlet and outlet of the culvert will be screened to preclude fish passage.

PREPARATION OF DRAWINGS: See sample drawings and guidance for completing the drawings. ***ONE SET OF ORIGINAL OR GOOD QUALITY REPRODUCIBLE DRAWINGS MUST BE ATTACHED.*** NOTE: Applicants are encouraged to submit photographs of the project site, but these DO NOT substitute for drawings. ***THE CORPS OF ENGINEERS AND COAST GUARD REQUIRE DRAWINGS ON 8-1/2 X 11 INCH SHEETS. LARGER DRAWINGS MAY BE REQUIRED BY OTHER AGENCIES.***

help 7b. Describe the purpose of the proposed work and why you want or need to perform it at the site. Please explain any specific needs that have influenced the design.

The purpose of the proposed culvert replacement project is to improve flow conveyance and reduce flooding at SE 30th Street, manage sediment delivery to Sunset Creek north of SE 30th Street, and improve fish passage conditions at the culvert location. Flood control and sediment management alternatives at the project site are limited both by the highly confined channel corridor and the site's location at a natural deposition zone in a watershed that generates and transports considerable sediment from upstream. The proposed culvert replacement project is designed to address immediate, ongoing, and future conditions at the project location as well as complement flooding, sedimentation, and aquatic habitat resource management objectives in channels downstream.

Since January 1, 2006 Sunset Creek has flooded at SE 30th Street at least six times, most recently on December 3, 2007. Flooding at SE 30th Street directly impacts neighboring businesses and restricts neighborhood access. Sediment deposition at the project site reduces the conveyance capacity of the twin culverts beneath SE 30th Street, further exacerbating flooding. Recurring sediment deposition requires regular dredging of the active channel by the city. Deposition of sediment that is transmitted downstream of SE 30th Street contributes to channel aggradation and aggravates flooding in other locations of the Sunset, Richards, and East Creek channel networks. Under existing conditions, the sediment that accumulates upstream, downstream, and within the twin 42-inch diameter culverts at SE 30th Street inhibits fish passage by contributing to pressure flow conditions during flows as low as 10 cfs (equivalent to the 10 percent exceedance flow for January).

Design of the proposed culvert replacement structure incorporates an understanding of the geomorphic, hydraulic, and

ecological conditions at the watershed and project-site scales. Design of the replacement culvert followed a watershed and project reach assessment of geomorphic conditions, including a thorough evaluation of sediment delivery and transport at the project site, and was supported by a detailed hydraulic analysis of the Sunset Creek, Richards Creek, and East Creek system from SE 32nd Street to downstream of Kamber Road (SE 26th Street). The design of the proposed culvert replacement structure and channel modifications considers the natural variability in sediment delivery to the project site and the potential channel responses to changes in sediment transport downstream of SE 30th Street. The proposed culvert replacement structure will be supported by a monitoring and adaptive operations and maintenance plan that will be implemented by the City of Bellevue following project construction. Detailed descriptions of replacement culvert design components and the monitoring and adaptive operations and maintenance plan are provided below.

1. Replacement Culvert and Channel Modification Design

The replacement culvert structure is designed to transmit the 100-year flood flow without allowing flow to overtop SE 30th Street, provide improved aquatic habitat and fish passage conditions compared to exiting conditions, and store approximately 50 cubic yards of sediment in a structure that can be maintained with minimal detrimental impacts to aquatic habitat. Performance criteria for flow conveyance, fish passage, and sediment transport conditions were used to evaluate replacement structure designs.

City of Bellevue design standards require culverts to pass the 100-year flood with an additional foot of freeboard. Due to physical constraints at the project site, including the downstream channel width and road surface elevation, these design criteria could not be met. The proposed geometry of the structure maximizes flow conveyance beneath SE 30th Street given the physical constraints of the downstream channel and the sediment transport and fish passage performance criteria discussed below. The hydraulic opening of the replacement culvert is designed to be 13 feet wide and approximately 4.5 feet high.

Fish passage criteria for the proposed replacement culvert are met by using a combination backwater and stream simulation culvert. The dimensions of the main culvert opening maintain the width of the bank-full channel upstream of the culvert, consistent with design parameters for stream simulation culverts in confined channels (WDFW 2003). The design slope of the stream simulation portion of the culvert is 3 percent, which is 1.2 times the average upstream channel gradient. This satisfies part of the stream simulation culvert design criteria (WDFW 2003). The bed of the stream simulation structure will be composed of a layer of streambed sediment that will likely be in flux over time from the upstream channel towards the sediment structure. Stable boulders will protrude through the design streambed surface to provide hydraulic complexity.

The sedimentation structure was designed to accommodate storage of 50 cubic yards of sediment. This volume was derived based on analysis of sediment delivery to the project site and ongoing dredging that the city has performed in recent years to maintain flow conveyance. Sediment has accumulated in the channel downstream of SE 30th Street at an average rate of approximately 40 cubic yards annually in the past 30 years. The current average annual accumulation rate is likely less than what it was 10 or 20 years ago due to upstream efforts to reduce sediment production and delivery. Still, regular dredging of 10 to 20 cubic yards of sediment is required on an almost annual basis to maintain flow conveyance. The design sediment storage volume is intended to capture the majority of bedload sediment that is delivered to the project site in an average year with additional storage capacity for infrequent storms during which a greater volume of sediment is transported.

The performance of the replacement culvert will be influenced by the streambed elevation of the downstream channel. It is anticipated that some channel bed lowering will naturally occur downstream of SE 30th Street once bedload delivery is reduced by up to 50 cubic yards per year. As a result, the replacement culvert is designed to achieve performance criteria in terms of flow conveyance, sedimentation, and fish passage under not only as-built conditions but anticipated future conditions as well.

Following construction, the replacement culvert will be backwatered by the relatively high channel bed elevation downstream of the project area. If the downstream channel degrades sufficiently to no longer backwater the replacement culvert, the fish passable conditions will be maintained by backwater through the sedimentation structure caused by the large woody debris grade control structure downstream of the culvert outlet and the stream simulation culvert design in the upstream half of the replacement culvert. The channel modifications downstream of the replacement culvert are further designed to accommodate potential channel responses by incorporating a deformable porous boulder weir downstream of the large woody debris grade control structure. Should the downstream channel degrade, the boulder weir will deform somewhat but will maintain fish passage to and past the large woody debris grade control structure and through the replacement culvert structure.

2. Monitoring and Adaptive Operations and Maintenance Plan

Installing a sedimentation structure into Sunset Creek at SE 30th Street will require active monitoring of the channel downstream of SE 30th Street and a commitment to operation and maintenance of the sedimentation structure. The City of Bellevue will lead these activities to ensure proper function of the sedimentation structure and avoid impacts to aquatic habitat downstream of SE 30th Street.

The following monitoring protocols will be implemented to identify the onset of geomorphic changes to the Sunset and Richards Creek channels downstream of SE 30th Street resulting from the altered dynamics of sediment delivery resulting from the sedimentation structure. These protocols are intended to document geomorphic characteristics of the downstream channels and inform the City of Bellevue if modifications to the operations and maintenance schedule or more aggressive actions, such as gravel supplementation, are necessary to maintain substrate conditions that are beneficial for aquatic habitat.

A channel monitoring protocol will be initiated by establishing four to five permanent monitoring locations approximately every 200 to 250 feet beginning 100 feet downstream of the replacement culvert. At each monitoring section:

1. **Channel cross-sectional geometry will be surveyed.**
2. **The composition of streambed sediment will be monitored at established locations downstream of SE 30th Street using**

a combination of surface pebble counts and subsurface bulk sampling and sieve analysis.

Channel surveying and streambed sediment sampling will be performed annually for a period of 5 years and semi-annually for the following 10 years. At that time future monitoring needs can be reevaluated.

Baseline sedimentation structure monitoring protocols will consist of the following:

1. **Scheduled visual inspections of sedimentation structure capacity and additional inspections following significant storm events.**
2. **Documentation of the timing and quantity of all sediment removed from the structure.**
3. **Bulk sieve analysis of sediment removed to document grain size distribution of captured sediment.**

Based on the patterns and rates of sediment delivery to the site and the channel response downstream of SE 30th Street an adaptive policy for determining when sediment removal is necessary can be developed. Current rates of deposition at SE 30th Street indicate that annual to semi-annual sediment removal should be expected in the near future. As sediment production and delivery from the upstream watershed decrease as a result of additional channel stabilization and sediment reduction measures the frequency of sediment removal may decrease. Should sediment production in the upper watershed reduce to a level such that maintenance of the sedimentation structure is no longer necessary, the sedimentation structure is designed to function as a stream simulation culvert without need for modifications.

Removal of sediment from the sedimentation structure will be conducted so as to minimize impacts to aquatic species and downstream water quality. During maintenance activities flow will be diverted through the maintenance bypass pipe by use of an adjustable gate at the upstream end of the sedimentation structure. Sheet 2 shows the alignment of the bypass pipe on the west side of the replacement culvert structure. Once flows are completely routed into the bypass pipe, fish will be excluded from the sedimentation structure using a seine that will then be installed as a downstream block net at the downstream end of the replacement culvert. Dip netting will likely be used to complement the seining fish removal. Once fish have been removed from the sedimentation cell to the downstream block net, sediment will be removed from the structure through use of a suction dredge operated from the street above and disposed of at an appropriate upland location. Upon completion of sediment removal activities, the downstream block net will be removed and the gate at the upstream end of the culvert will be reopened to allow Sunset Creek to once again flow through the replacement culvert structure. Sediment removal will not require heavy equipment operations within the stream channel.

help 7c. Describe the potential impacts to characteristic uses of the water body. These uses may include fish and aquatic life, water quality, water supply, recreation and aesthetics. Identify proposed actions to avoid, minimize, and mitigate detrimental impacts and provide proper protection of fish and aquatic life. Identify which guidance documents you have used. Attach a separate sheet if additional space is needed.

The proposed project involves the replacement of an existing culvert structure with an improved culvert structure combined with an integrated sediment trap. Placement of this structure will require modification of the stream channel bed and bank modifications for grade control purposes.

Primary impacts of concern associated with the proposed project include the following:

- **Construction related impacts on aquatic species and water quality**
- **Culvert management effects on aquatic species and water quality**
- **Effects on stream habitat conditions**
- **Effects on fish passage.**

The proposed project has been planned and designed to avoid, minimize and mitigate these potential impacts to the greatest extent possible, and will result in a net improvement in existing habitat and water quality conditions. Discussion of methods and guidance used to avoid and minimize impacts are described below.

1. Construction related impacts on aquatic species and water quality

The proposed project has the potential to cause construction-related impacts on water quality, principally in the form of increased suspended sediment loading from channel bed and bank disturbance. The project plans include several BMPs and construction monitoring protocols designed to limit sediment loading and water quality impacts to the greatest extent possible. All channel and bank work will be conducted within a dewatered exclusion area, during the mid to late summer months when streamflow should be at its lowest. Groundwater and stormwater pumped from the construction site will be filtered prior to discharge back to surface waters, or delivered to the sanitary sewer system for treatment. Once construction is completed, the exclusion area will be rewatered slowly to limit the suspension of sediments from disturbed areas. Turbidity levels will be monitored in Sunset Creek downstream of SE 30th Street throughout construction to ensure BMP effectiveness.

Dewatering of the exclusion area will require the capture and relocation of fish and other aquatic organisms. These activities will be conducted consistent with current Washington State Department of Transportation protocols for this practice, which are designed to minimize adverse effects.

All machinery operating within the stream channel will utilize hydraulic fluid that is certified as non-toxic to aquatic life. Throughout construction a spill control and prevention plan will be in place to avoid and manage any spills of potentially hazardous materials.

2. Post-construction related effects on aquatic species and water quality

The proposed project design includes a sediment trap integrated into the replacement culvert structure. Several long-term benefits for aquatic life and water quality are anticipated with the replacement culvert. The primary benefit provided by the sediment trap within the culvert structure is that it will allow for the majority of sediment removal activities to take place inside an enclosed structure, versus dredging of the active channel. Second, the trap will provide increased sediment storage capacity, which is expected to decrease the frequency and/or the extent of sediment removal activities. Currently, dredging of the active channel takes place on an annual basis, causing considerable habitat disturbance and related water quality impacts. While some dredging of the active channel may be required in the future, this will be limited to infrequent occasions when large sediment delivery events overwhelm trap capacity.

The proposed replacement culvert structure design incorporates several design features that will simplify fish exclusion and relocation during sediment removal activities. These features will promote the removal of fish from the sediment management area with less disturbance and handling, reducing stress and injury potential. Because the sediment trap within the culvert is designed to be smaller in areal extent than the segment of channel that is currently dredged, the amount of habitat that fish are denied access to during maintenance activities will be reduced.

Finally, the existing twin culverts that convey Sunset Creek across SE 30th Street provide insufficient flood conveyance capacity, contributing to routine flooding of adjacent roadways and parking lots. These floodwaters commonly overwhelm storm drains and flow overland back into the stream system. Because some of those local storm drains do not drain directly back to the stream system, this suggests that current flooding conditions contribute to elevated delivery of stormwater pollutants to Sunset Creek. By reducing the frequency of flooding that overtops the street, the proposed project is likely to result in a slight incremental improvement in local water quality conditions during and following flood events.

3. Effects on habitat conditions

The proposed project will result in improved habitat conditions in the project area. These improvements will occur because of increased habitat complexity provided by bioengineered grade control and bank stabilization structures, reduced frequency of sediment management activities in the active channel, and adaptive management of sediment delivery rates to downstream channels. These three factors that are expected to positively influence habitat are described in more detail below.

The bioengineered grade control and bank stabilization structures are necessary components of channel reconfiguration needed to support the culvert design. The current channel gradient conditions have been imposed by backwater conditions induced by the existing culvert and sediment deposition in the channel downstream of SE 30th Street that occurs because elevated sediment delivery rates in the Sunset Creek watershed are out of equilibrium with sediment transport capacity in the channel. The channel upstream and downstream of SE 30th Street must be returned to a more natural gradient to support fish passage and enhance sediment capture in the replacement culvert structure. The channel profile modification work will involve excavation of accumulated sediment from the channel bed and the installation of grade control structures, removal of riprap, and bank contouring and stabilization. Riprap will be removed from approximately 74 lineal feet of streambank and replaced with bioengineered bank protection structures composed primarily of LWD. The grade control structures will also be constructed using LWD.

The channel modification design is based on a comprehensive assessment of watershed, reach, and site specific hydrologic, hydraulic, and geomorphic conditions, and is consistent with WDFW Integrated Streambank Protection Guidelines. The grade control and bank stabilization structures are specifically designed to mimic the habitat forming processes and functions provided by LWD in natural stream environments, and will significantly increase habitat complexity and improve fish passage in the project reach of Sunset Creek. The proposed project is considered to be self-mitigating for these reasons.

The Sunset Creek channel accumulates more sediment than it can effectively transport in its current hydromodified state. This promotes an overly wide and shallow channel environment with limited habitat complexity. These channel conditions provide poor flow conveyance, contributing to frequent flooding problems on SE 30th Street and adjacent businesses, and also contribute to low flow passage barrier conditions for adult salmonids and potentially for juvenile salmonids.

Sediment management to maintain flood flow conveyance capacity in this reach of Sunset Creek is accomplished by routine annual dredging of the active channel downstream of the SE 30th Street culvert. This requires regular disturbance of the active channel, interfering with the formation of beneficial habitat features. A key advantage of the integrated sediment trap in the replacement culvert structure is that it will allow for the majority of sediment removal activities to be conducted within the structure using equipment parked on the roadway atop the culvert, avoiding streambank and channel disturbance. Dredging of the active channel will only be required in rare circumstances when large sediment delivery events overwhelm sediment trap capacity.

The integrated sediment trap in the replacement culvert structure will allow for more flexible and adaptive management of sediment flux through the lower reach of Sunset Creek downstream of the culvert, which should produce habitat benefits over the long-term. The proposed project incorporates monitoring of bed elevations and substrate conditions in and downstream of the project reach in Sunset Creek, and an adaptive approach for metering sediment delivery rates to promote the formation of beneficial channel conditions. Specifically, controlled sediment delivery downstream of SE 30th Street will allow for the existing sediment plug in the channel between SE 30th Street and the confluence of Sunset Creek with Richards Creek to gradually erode. This in turn will increase flow conveyance capacity, and allow for the formation of a greater diversity of habitat features. The channel will be routinely monitored to ensure that substrate conditions desirable for salmonid spawning are maintained.

Collectively, these project elements should produce improved habitat conditions within the project reach that are beneficial to a range of aquatic species.

4. Effects on fish passage

The proposed project will result in improved conditions for fish passage in the project reach. Currently, fish passage conditions in Sunset Creek are impaired by sediment deposition upstream and downstream of the SE 30th Street twin culverts. The flatter gradient in the channel downstream of the culverts promotes the accumulation of a large plug of sediment that creates a low flow barrier to adult salmonid passage. This sediment plug may also hinder the movement of juvenile salmonids under certain flow conditions. This sediment plug extends beyond the limits of current dredging activities, meaning that this barrier condition will remain permanent without additional intervention. By allowing for greater control of sediment delivery rates to the downstream channel, it is expected that the sediment trap will permit the evolution of channel conditions that are beneficial to fish passage.

The existing twin culverts also limit fish passage upstream of SE 30th Street. The culverts lack sufficient hydraulic capacity to convey flood flows that transport large sediments. This creates a backwater effect upstream of the structure that promotes the accumulation of coarse bedload, increasing the channel gradient abruptly from approximately 2.5 percent to 10 percent approaching the upstream culvert entrance. During high flow conditions, the high flow velocity in the culvert barrels in combination with shallow, high velocity flow conditions in this over-steepened segment may create a partial barrier condition.

The proposed culvert integrates two fish passage components, a backwatered sediment trap at the downstream end, and a streambed simulation component at the upstream end. The streambed simulation segment has been designed in accordance with current WDFW culvert design guidance (WDFW 2003). This segment will mimic natural channel bed conditions at a more natural 2.5 percent channel slope. The backwatered sediment trap component will provide quiescent flow conditions that will allow for unhindered fish passage. The streambed simulation segment will provide for full fish passage for all species and life history stages likely to occur in this system during the flow conditions during which migratory and dispersal behavior is likely to take place.

Collectively, the proposed culvert design and stream channel modifications address high flow and low flow passage barriers, and are expected to provide improved fish passage conditions throughout this reach of Sunset Creek.

help 7d. For in-water construction work, will your project be in compliance with the State of Washington water quality standards for turbidity (WAC 173-201A-410)? ☒ YES ☐ NO

help 8. Will the project be constructed in stages? ☒ YES ☐ NO

Proposed starting date: **Summer of 2009**

Estimated duration of activity: **50 to 70 working days for construction with up to 10 additional days for mobilization and setup of temporary erosion and sediment control measures.**

help 9. Check if any temporary or permanent structures will be placed:

☒ Waterward of the ordinary high water mark or line for fresh or tidal waters AND/OR

☐ Waterward of the mean higher high water for tidal waters?

help 10. Will fill material (rock, fill, bulkhead, or other material) be placed:

☒ Waterward of the ordinary high water mark or line for fresh waters?

If **YES**, VOLUME (cubic yards) **105** / AREA **0.04** (acres)

☐ Waterward of the mean higher high water for tidal waters?

If **YES**, VOLUME (cubic yards) / AREA (acres)

help 11. Will material be placed in wetlands? ☐ YES ☒ NO

If **YES**:

help A. Impacted area in acres:

help B. Has a delineation been completed? **If YES**, please submit with application. ☐ YES ☐ NO

help C. Has a wetland report been prepared? **If YES**, please submit with application ☐ YES ☐ NO

help D. Type and composition of fill material (e.g., sand, etc.)

help E. Material source:

help F. List all soil series (type of soil) located at the project site, and indicate if they are on the county's list of hydric soils. Soils information can be obtained from the natural Resources Conservation Service (NRCS).

help G. WILL PROPOSED ACTIVITY CAUSE FLOODING OR DRAINING OF WETLANDS? ☐ YES ☒ NO

If **YES**, IMPACTED AREA IS ACRES OF DRAINED WETLANDS.

NOTE: If your project will impact greater than 1/10 of an acre of wetland, submit a mitigation plan to the Corps and Ecology for approval along with the JARPA form.

NOTE: A 401 water quality certification may be required from Ecology in addition to an approved mitigation plan if your project wetland impacts are greater than 1/10 acre in size. Please submit the JARPA form and mitigation plan to Ecology for 401 certification review.

help 12. Stormwater Compliance: This project is (or will be) designed to meet ecology's most current stormwater manual, or an Ecology approved local stormwater manual. ☒ YES ☐ NO

If **YES** – Which manual will your project be designed to meet? **2005 Stormwater Management Manual for Western Washington** help If **NO** – For Clean Water Act Section 401 and 404 permits only – Please submit to Ecology for approval, along with this JARPA application, documentation that demonstrates the stormwater runoff from your project or activity will comply with the water quality standards, WAC 173-201(A)

help 13. Will excavation or dredging be required in water or wetlands? [X] YES [ ] NO

If **YES**:

A. Volume: **256** (cubic yards) /area **0.04** (acre)

B. Composition of material to be removed: **Riprap and streambed material**

C. Disposal site for excavated material: **licensed disposal or reuse facility**

D. Method of dredging: **Excavator and suction dredge (sediment to be removed in the dry)**

help 14. Has the State Environmental Policy Act (SEPA) been completed [ ] YES [X] NO

SEPA Lead Agency: **City of Bellevue**

SEPA Decision: DNS, MDNS, EIS, Adoption, Exemption Decision Date (end of comment period)

SUBMIT A **COPY OF YOUR SEPA DECISION LETTER** TO WDFW AS REQUIRED FOR A COMPLETE APPLICATION

help 15. List other Applications, approvals or certifications from other federal, state or local agencies for any structures, construction discharges or other activities described in the application (i.e. preliminary plat approval, health district approval, building permit, SEPA review, federal energy regulatory commission license (FERC), Forest practices application, etc.). Also, indicate whether work has been completed and indicate all existing work on drawings. NOTE: For use with Corps Nationwide Permits, identify whether your project has or will need an NPDES permit for discharging wastewater and/or stormwater.

– Project does not require an NPDES permit.

TYPE OF APPROVAL	ISSUING AGENCY	IDENTIFICATION NO.	DATE OF APPLICATION	DATE APPROVED	COMPLETED?
Hydraulic Project Approval	**Washington Department of Fish and Wildlife**				
Clean Water Act Section 404	**U.S. Army Corps of Engineers**				
Section 401 Water Quality Certification	**Washington State Department of Ecology**				
SEPA review	**City of Bellevue**				
Critical Areas	**City of Bellevue**				

help 16. Has any agency denied approval for the activity you're applying for or for any activity directly related to the activity described herein?

[ ] YES [X] NO

If **YES**, explain:

SECTION B - Use for Shoreline and Corps of Engineers permits only:

help 17a. Total cost of project. This means the fair market value of the project, including materials, labor, machine rentals, etc.

$995,000

help 17b. If a project or any portion of a project receives funding from a federal agency, that agency is responsible for ESA consultation. Please indicate if you will receive federal funds and what federal agency is providing those funds.

FEDERAL FUNDING [ ] YES [X] NO If **YES**, please list the federal agency.

help 18. Local government with jurisdiction: **City of Bellevue**

help 19. Provide names, addresses and telephone numbers of adjoining property owners, lessees, etc. ***Please note:*** *Shoreline Management Compliance may require additional notice – consult your local government.*

NAME	ADDRESS	PHONE NUMBER
E.S. Harrington	**13120 SE 30th Street, Bellevue, WA 98005**	
Stead Building Partnership	**13200 SE 30th Street, Bellevue, WA 98005**	
SLC Investment LLC	**13201 SE 30th Street, Bellevue, WA 98005**	
SCC Property Holdings	**13111 SE 30th Street, Bellevue, WA 98005**	

SECTION C - This section MUST be completed for any permit covered by this application

help 20. Application is hereby made for a permit or permits to authorize the activities described herein. I certify that I am familiar with the information contained in this application, and that to the best of my knowledge and belief, such information is true, complete, and accurate. I further certify that I possess the authority to undertake the proposed activities. I hereby grant to the agencies to which this application is made, the right to enter the above-described location to inspect the proposed, in-progress or completed work. I agree to start work **ONLY** after all necessary permits have been received.

Brian Ward
SIGNATURE OF APPLICANT

DATE 6/26/08

SIGNATURE OF AUTHORIZED AGENT

DATE

I HEREBY DESIGNATE Chase Barton TO ACT AS MY AGENT IN MATTERS RELATED TO THIS APPLICATION FOR PERMIT(S). I UNDERSTAND THAT IF A FEDERAL PERMIT IS ISSUED, I MUST SIGN THE PERMIT.

Brian Ward 6/26/08
SIGNATURE OF APPLICANT DATE

SIGNATURE OF LANDOWNER (EXCEPT PUBLIC ENTITY LANDOWNERS, E.G. DNR)

THIS APPLICATION MUST BE SIGNED BY THE APPLICANT AND THE AGENT, IF AN AUTHORIZED AGENT IS DESIGNATED.

18 U.S.C §1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of the United States knowingly falsifies, conceals, or covers up by any trick, scheme, or device a material fact or makes any false, fictitious, or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false, fictitious, or fraudulent statement or entry, shall be fined not more than $10,000 or imprisoned not more than 5 years or both.

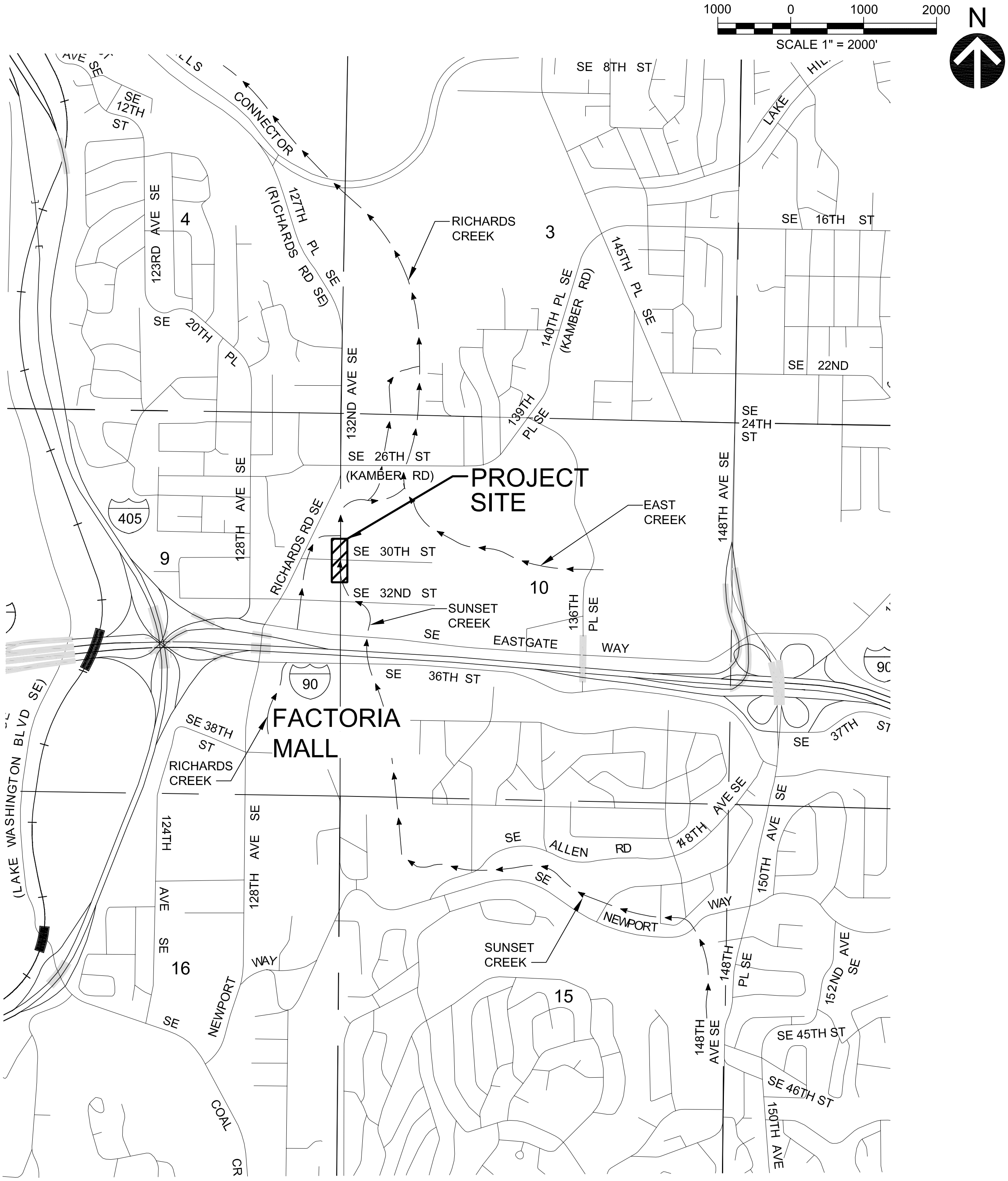
COMPLETED BY LOCAL OFFICIAL

A. Nature of the existing shoreline. (Describe type of shoreline, such as marine, stream, lake, lagoon, marsh, bog, swamp, flood plain, floodway, delta; type of beach, such as accretion, erosion, high bank, low bank, or dike; material such as sand, gravel, mud, clay, rock, riprap; and extent and type of bulkheading, if any)

B. In the event that any of the proposed buildings or structures will exceed a height of thirty-five feet above the average grade level, indicate the approximate location of and number of residential units, existing and potential, that will have an obstructed view:

C. If the application involves a conditional use or variance, set forth in full that portion of the master program which provides that the proposed use may be a conditional use, or, in the case of a variance, from which the variance is being sought:

These Agencies are Equal Opportunity and Affirmative Action employers.
For special accommodation needs, please contact the appropriate agency in the instructions



NOTE:
RICHARDS CREEK IS TRIBUTARY
TO KELSEY CREEK.

PROJECT SITE COORDINATES:
NORTH 1/2, SEC. 10, TWP. 24 N., RGE 5 E., W.M.
LATITUDE: 47°35'01.91"N
LONGITUDE: 122°10'21.95"W

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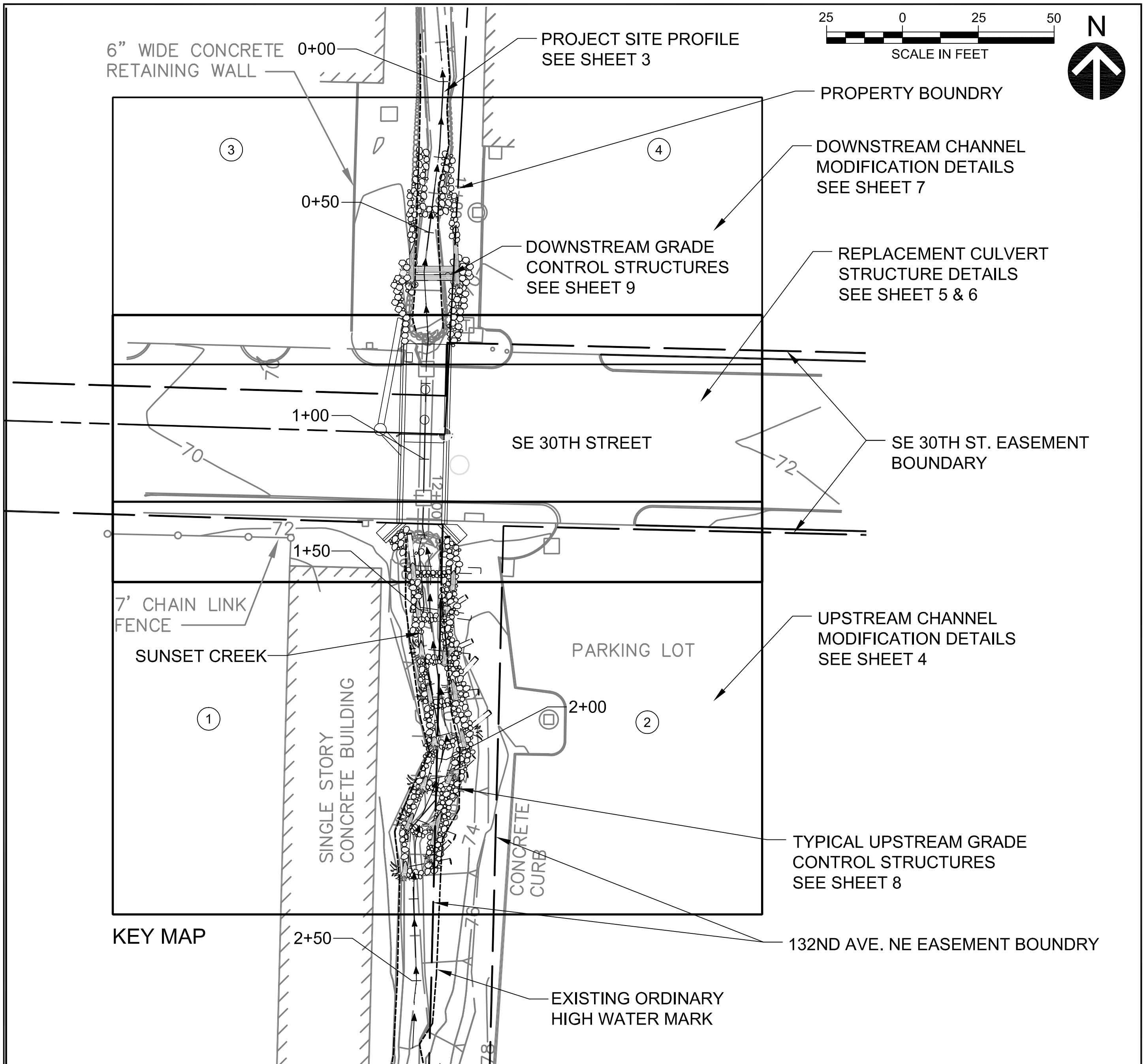
Plot Date: 6/25/2008 3:44 PM Cad User: Wojciech Wieszczecinski

Prepared by: C. BARTON	VICINITY MAP	Applicant: CITY OF BELLEVUE
HERRERA ENVIRONMENTAL CONSULTANTS, 2200 Sixth Avenue, Suite 1100, Seattle, Washington 98121-1820, 206-441-9080, 206-441-9108 FAX, http://www.herrerainc.com	Application for: SE 30th / SUNSET CREEK CULVERT REPLACEMENT	Project Location: BELLEVUE, KING COUNTY, WASHINGTON
	Purpose: FLOW CONVEYANCE	SCALE AS NOTED
Date: JUNE 2008	Waterbody: SUNSET CREEK	SHEET 1 of 9



ADJACENT PROPERTY OWNERS:

1	SHURGARD MINI STORAGE (PARCEL #5453300244)
2	PRINTED CIRCUITS ASSEMBLY CORP. (PARCEL #5453300291)
3	SHURGARD MINI STORAGE (PARCEL #5453300194)
4	STEAD BUILDING (PARCEL #5453300183)

NOTE: BOUNDARIES FOR PROPERTIES ADJACENT TO PROJECT AREA DEFINED BY SE 30TH STREET ROAD RIGHT OF WAY. PROPERTIES 1 AND 2 SEPARATED BY 20' EASEMENT PARALLEL TO STREAM CORRIDOR. PROPERTIES 3 AND 4 SEPARATED BY PROPERTY BOUNDARY.

EXCAVATION AND FILL WITHIN EXISTING ORDINARY HIGH WATER MARK

QTY. OF EXCAVATION (CY)	256
QTY. OF FILL (CY)	104
AREA OF FILL (ACRE)	0.04

NOTE: EXCAVATED MATERIAL INCLUDES RIPRAP, NATIVE SOIL, AND STREAMBED SEDIMENT. TO BE DISPOSED OF AT LICENSED DISPOSAL OR REUSE FACILITY. FILL MATERIAL INCLUDES STREAMBED SEDIMENT AND BOULDERS.

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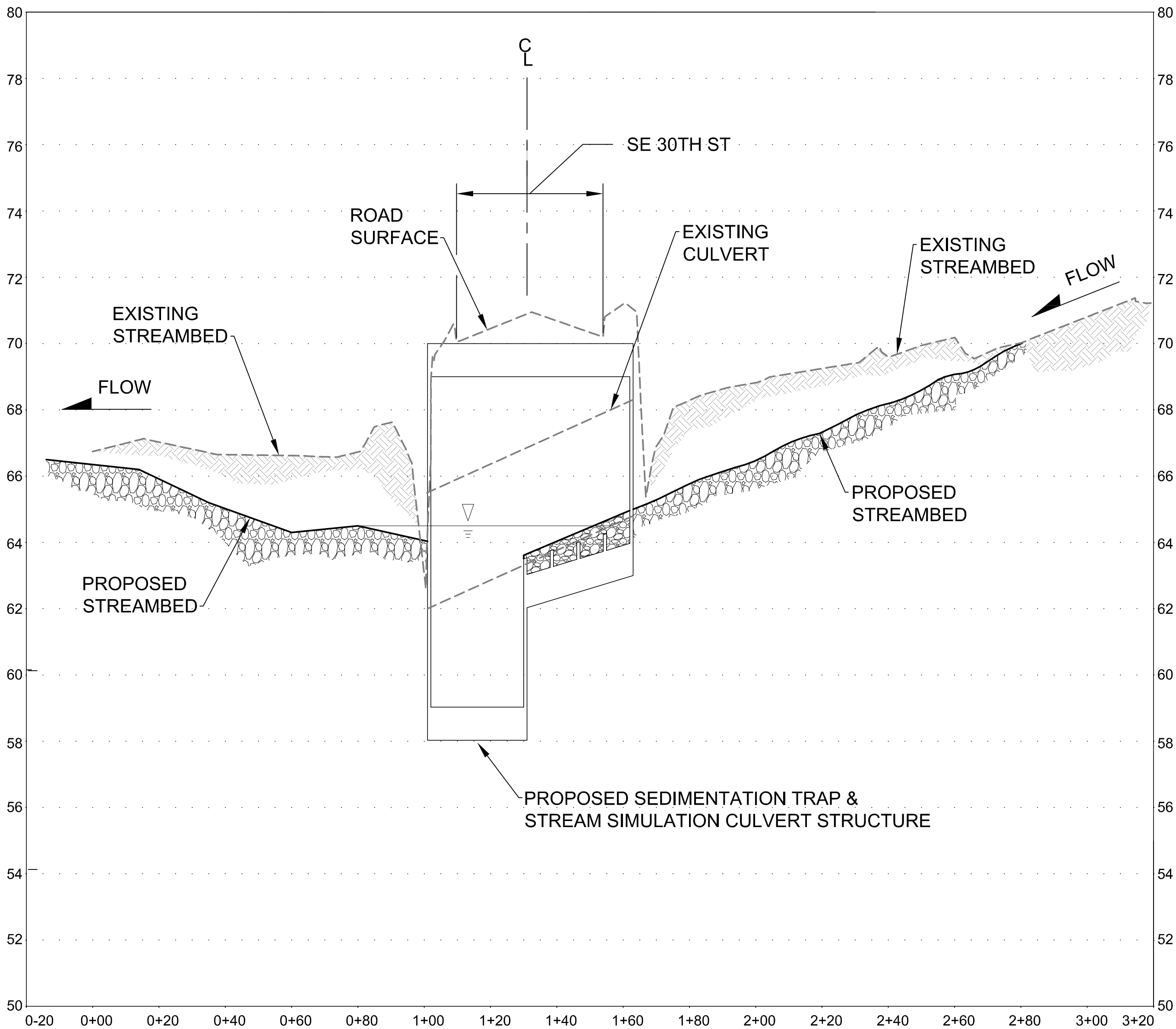
Prepared by: C. BARTON

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
Suite 1100
Seattle, Washington
98121-1820
206-441-9080
206-441-9108 FAX
http://www.herrerainc.com

Date: JUNE 2008

DETAILED SITE SCHEMATIC	Applicant: CITY OF BELLEVUE
Application for: SE 30th / SUNSET CREEK CULVERT REPLACEMENT	Project Location: BELLEVUE, KING COUNTY, WASHINGTON
Purpose: FLOW CONVEYANCE	SCALE AS NOTED
Waterbody: SUNSET CREEK	SHEET 2 of 9

N



PROJECT PROFILE

HORIZ SCALE: 1"=50'
VERT SCALE: 1"=5'

NOTE:
VERTICAL DATUM NAVD 88

Prepared by: C. BARTON	PROJECT PROFILE	Applicant: CITY OF BELLEVUE
HERRERA ENVIRONMENTAL CONSULTANTS 2200 Sixth Avenue Suite 1100 Seattle, Washington 98121-1820 206-441-9080 206-441-9108 FAX http://www.herrerainc.com	Application for: SE 30th / SUNSET CREEK CULVERT REPLACEMENT	Project Location: BELLEVUE, KING COUNTY, WASHINGTON
	Purpose: FLOW CONVEYANCE	SCALE AS NOTED
Date: JUNE 2008	Waterbody: SUNSET CREEK	SHEET 3 of 9

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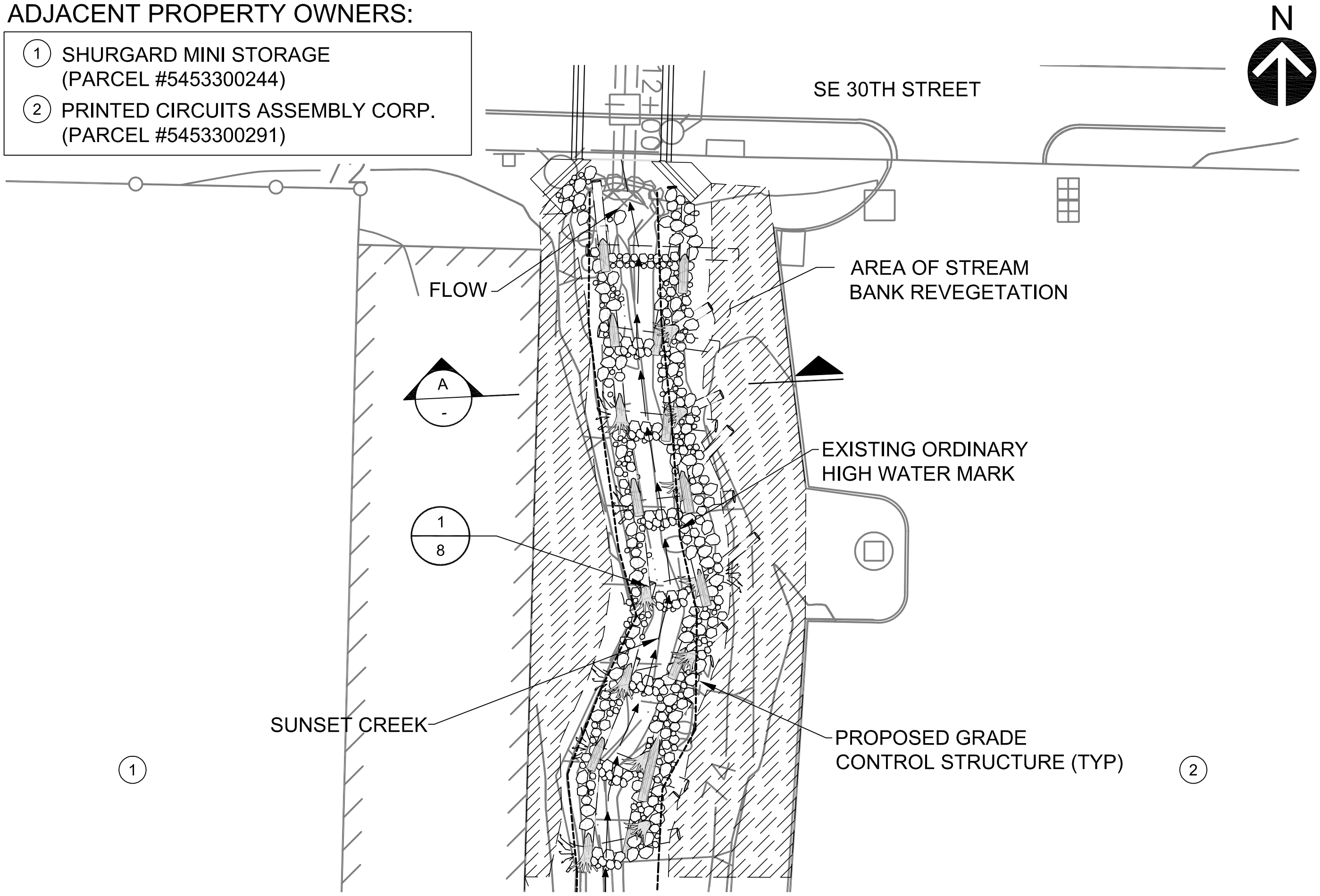
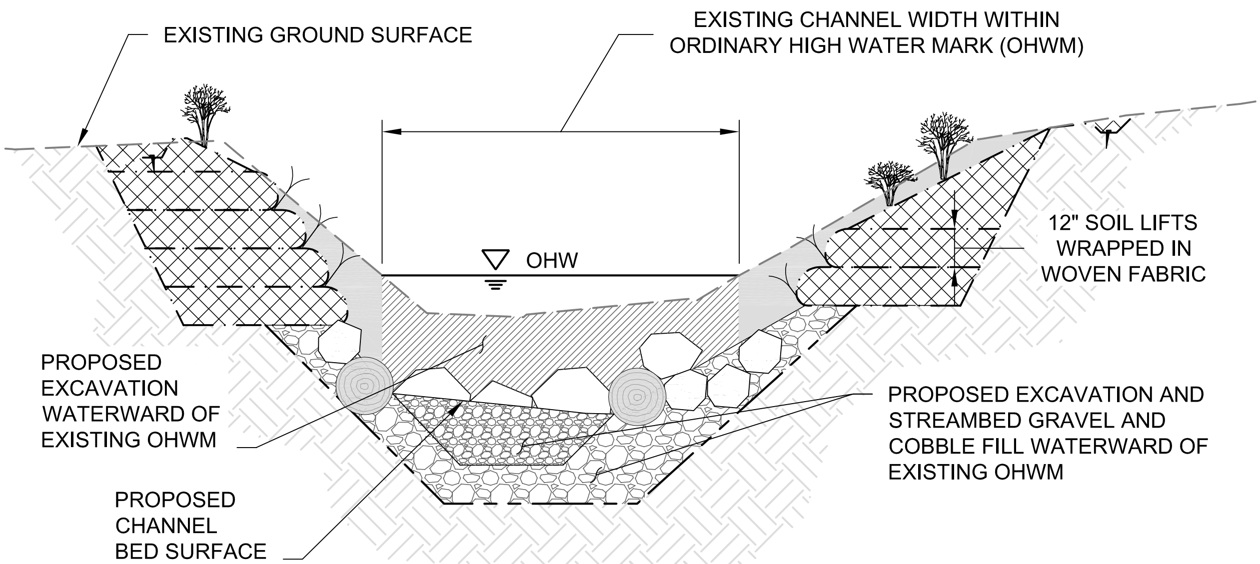
ADJACENT PROPERTY OWNERS:

1. SHURGARD MINI STORAGE (PARCEL #5453300244)
2. PRINTED CIRCUITS ASSEMBLY CORP. (PARCEL #5453300291)



PLAN VIEW - UPSTREAM CHANNEL MODIFICATION (-/2)

SCALE: 1"=30'



SECTION - TYPICAL STREAM CHANNEL SECTION (A/-)

SCALE: 1"=5'

Prepared by: C. BARTON	UPSTREAM CHANNEL MODIFICATION PLAN AND SECTION	Applicant: CITY OF BELLEVUE
HERRERA ENVIRONMENTAL CONSULTANTS 2200 Sixth Avenue Suite 1100 Seattle, Washington 98121-1820 206-441-9080 206-441-9108 FAX http://www.herrerainc.com	Application for: SE 30th / SUNSET CREEK CULVERT REPLACEMENT	Project Location: BELLEVUE, KING COUNTY, WASHINGTON
	Purpose: FLOW CONVEYANCE	SCALE AS NOTED
Date: JUNE 2008	Waterbody: SUNSET CREEK	SHEET 4 of 9

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Jarpa\J-4.dwg
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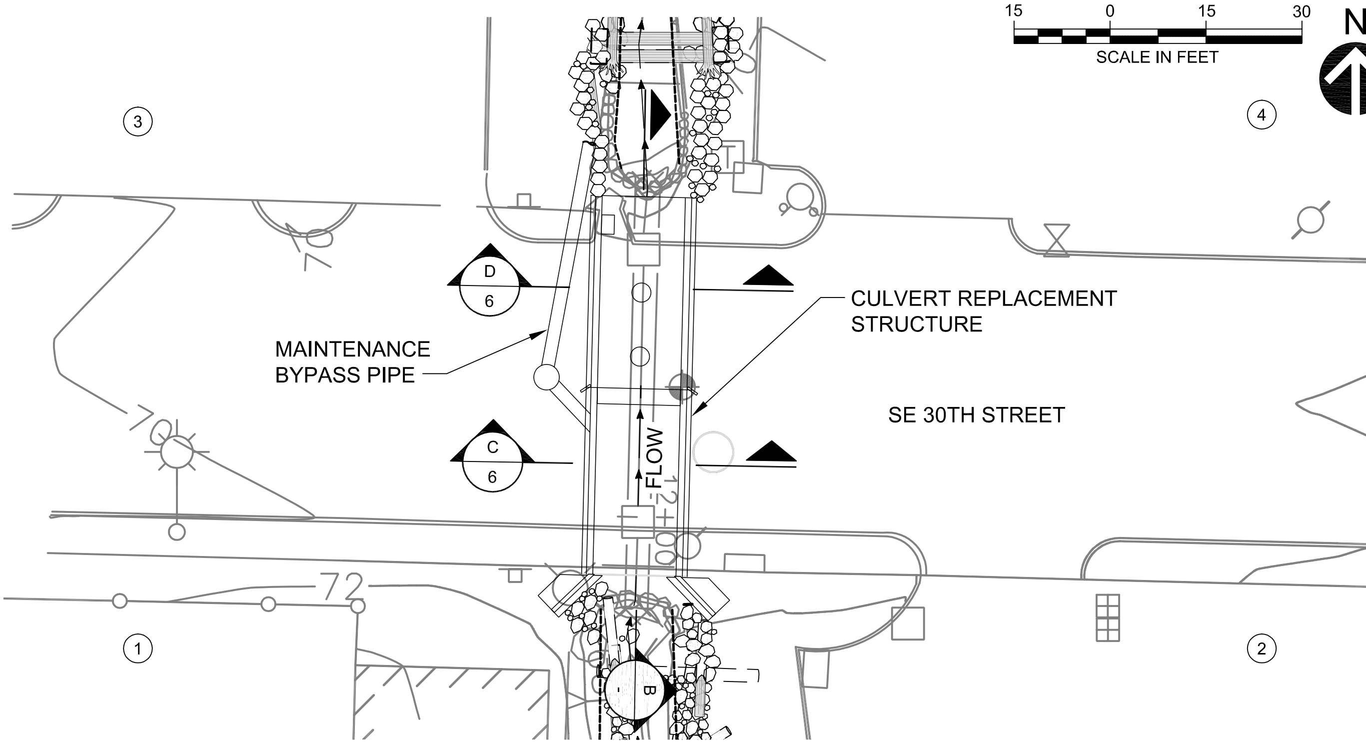
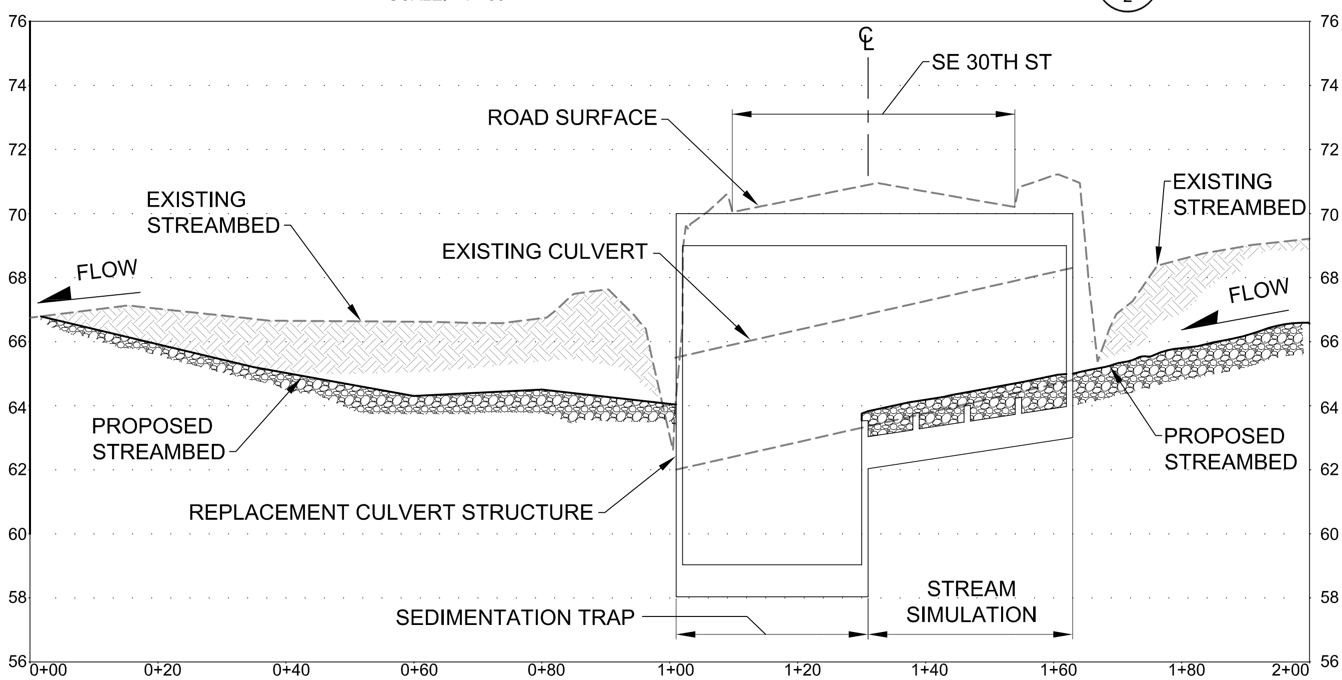


PLAN VIEW - REPLACEMENT CULVERT STRUCTURE (- / 2)

SCALE: 1"=30'



REPLACEMENT CULVERT STRUCTURE PROFILE (B / -)

HORIZ SCALE: 1"=30'
VERT SCALE: 1"=6'

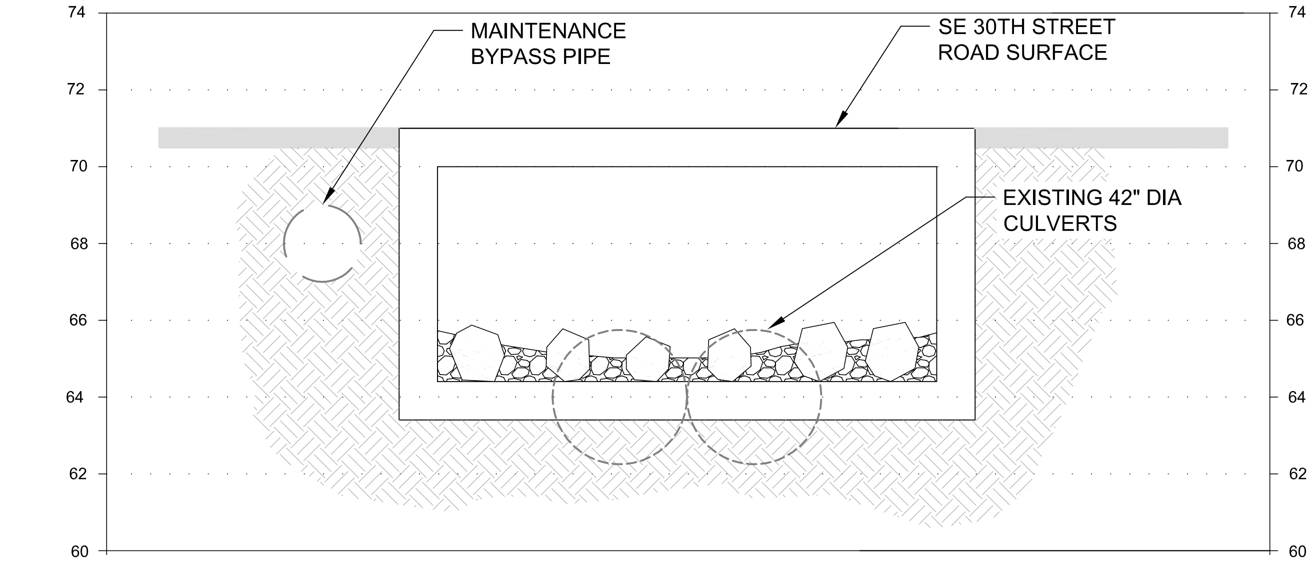
ADJACENT PROPERTY OWNERS:

1. SHURGARD MINI STORAGE (PARCEL #5453300244)
2. PRINTED CIRCUITS ASSEMBLY CORP. (PARCEL #5453300291)
3. SHURGARD MINI STORAGE (PARCEL #5453300194)
4. STEAD BUILDING (PARCEL #5453300183)

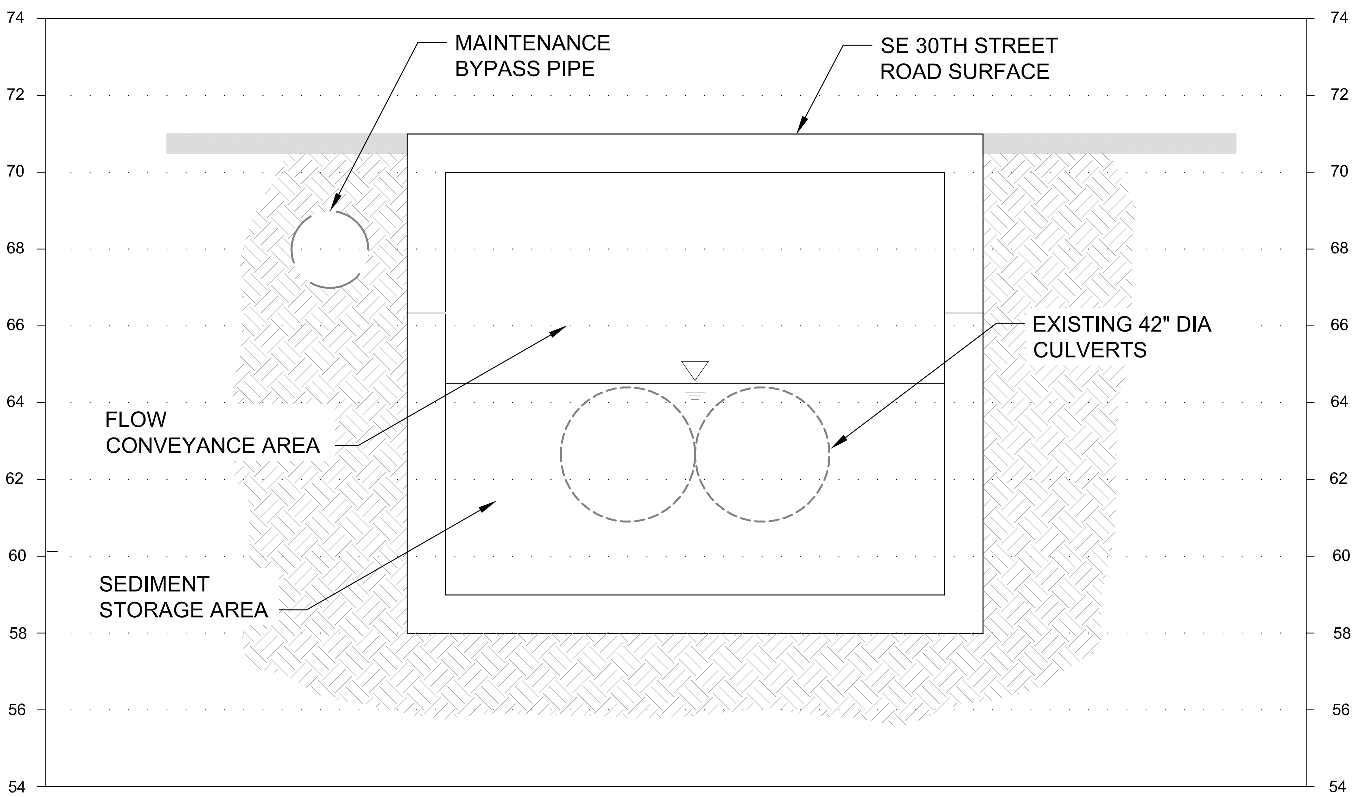
NOTE:
VERTICAL DATUM NAVD 88

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Jarpa\J-5.dwg
Plot Date: 6/25/2008 3:47 PM Cad User: Wojciech Wieszczecinski

Prepared by: C. BARTON	REPLACEMENT CULVERT STRUCTURE PLAN AND PROFILE VIEW	Applicant: CITY OF BELLEVUE
HERRERA ENVIRONMENTAL CONSULTANTS, 2200 Sixth Avenue Suite 1100 Seattle, Washington 98121-1820, 206-441-9080, 206-441-9108 FAX, http://www.herrerainc.com	Application for: SE 30th / SUNSET CREEK CULVERT REPLACEMENT	Project Location: BELLEVUE, KING COUNTY, WASHINGTON
	Purpose: FLOW CONVEYANCE	SCALE AS NOTED
Date: JUNE 2008	Waterbody: SUNSET CREEK	SHEET 5 of 9



STREAM SIMULATION SECTION C/5
SCALE: 1"=5'



SEDIMENT TRAP SECTION D/5
SCALE: 1"=5'

NOTE:
VERTICAL DATUM NAVD 88

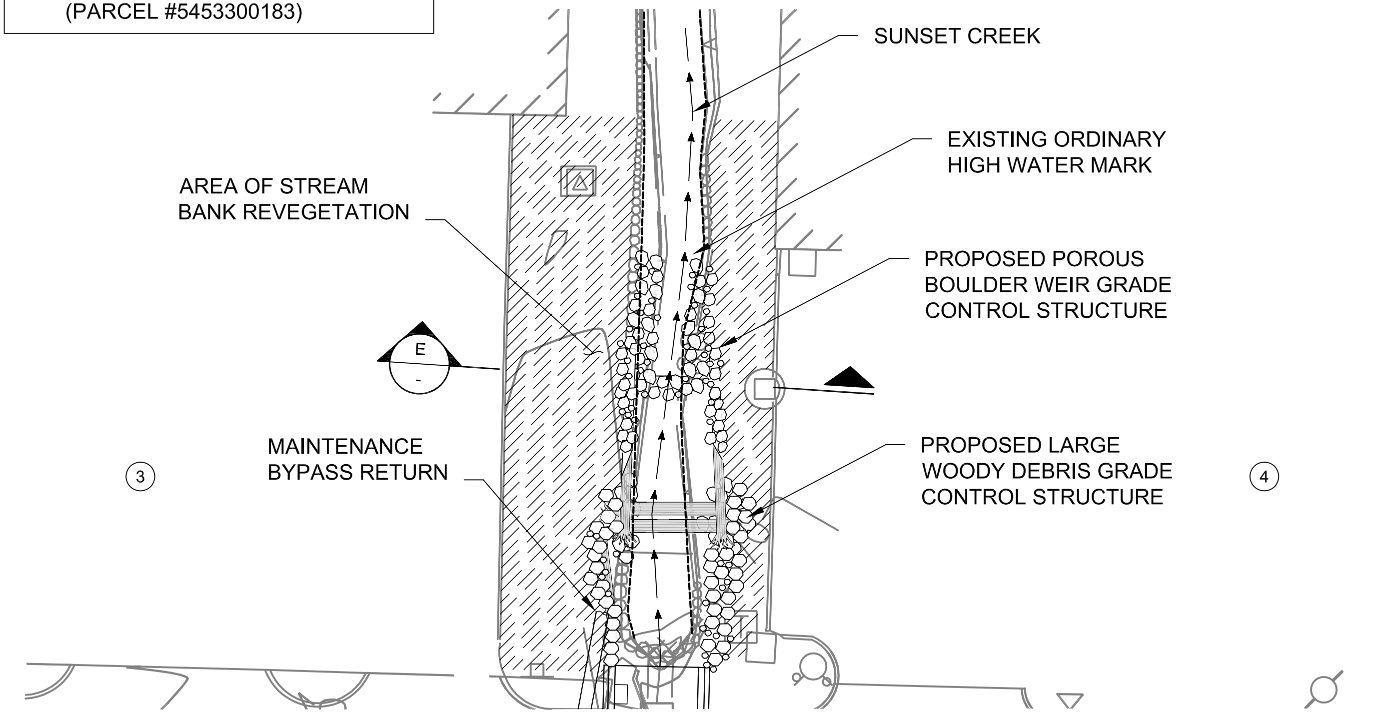
Prepared by: C. BARTON	REPLACEMENT CULVERT STRUCTURE SECTIONS VIEW	Applicant: CITY OF BELLEVUE
HERRERA ENVIRONMENTAL CONSULTANTS 2200 Sixth Avenue Suite 1100 Seattle, Washington 98121-1820 206-441-9080 206-441-9108 FAX http://www.herrerainc.com	Application for: SE 30th / SUNSET CREEK CULVERT REPLACEMENT	Project Location: BELLEVUE, KING COUNTY, WASHINGTON
	Purpose: FLOW CONVEYANCE	SCALE AS NOTED
Date: JUNE 2008	Waterbody: SUNSET CREEK	SHEET 6 of 9

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Jarpa\J-6.dwg
Plot Date: 6/25/2008 3:48 PM Cad User: Wojciech Wieszczecinski

ADJACENT PROPERTY OWNERS:

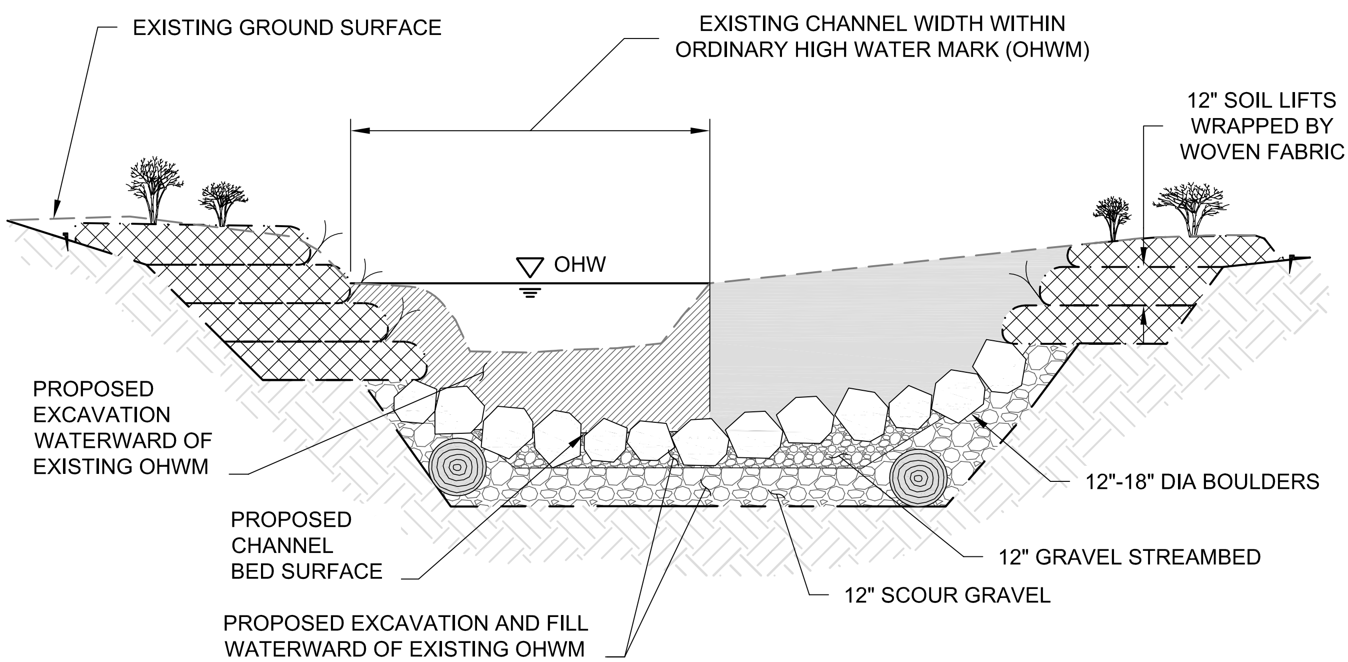
3	SHURGARD MINI STORAGE (PARCEL #5453300194)
4	STEAD BUILDING (PARCEL #5453300183)

N



PLAN VIEW - DOWNSTREAM CHANNEL MODIFICATION
-
2

SCALE: 1"=30'

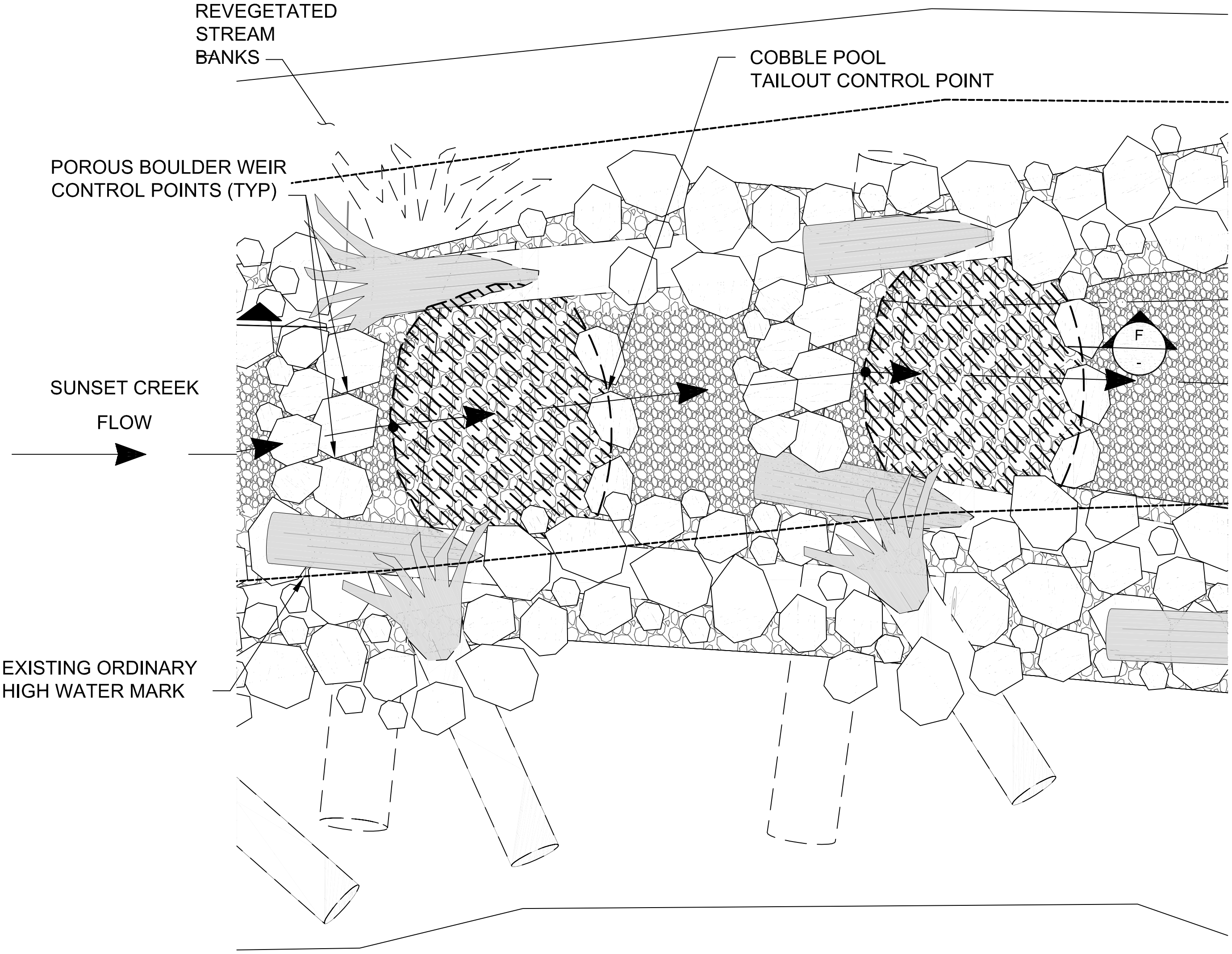


TYPICAL SECTION - DOWNSTREAM CHANNEL MODIFICATION
E
-

SCALE: 1"=5'

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Jarpa\J-7.dwg
Plot Date: 6/25/2008 3:48 PM Cad User: Wojciech Wieszczecinski

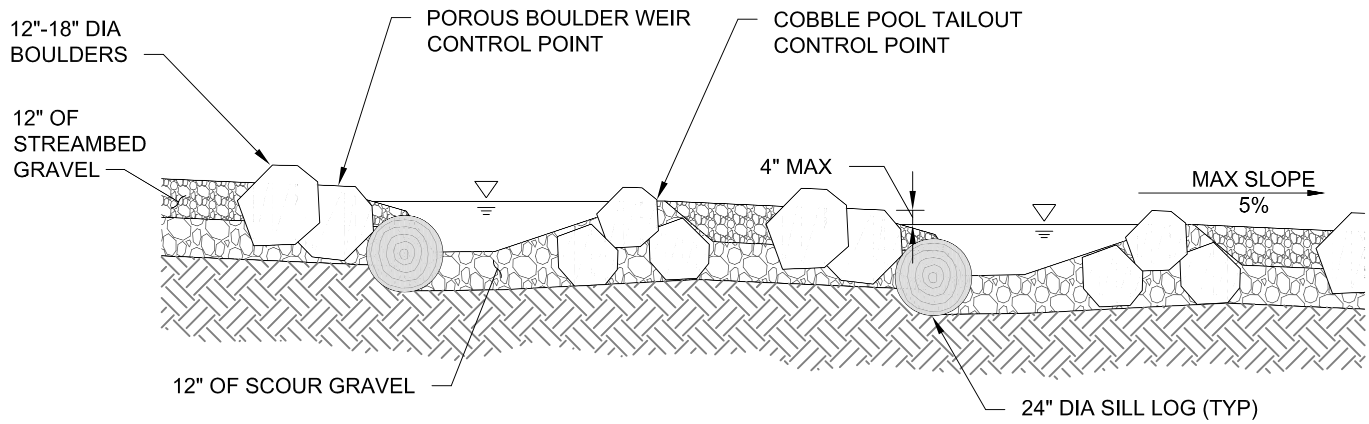
Prepared by: C. BARTON	DOWNSTREAM CHANNEL MODIFICATION PLAN AND SECTION	Applicant: CITY OF BELLEVUE
HERRERA ENVIRONMENTAL CONSULTANTS 2200 Sixth Avenue Suite 1100 Seattle, Washington 98121-1820 206-441-9080 206-441-9108 FAX http://www.herrerainc.com	Application for: SE 30th / SUNSET CREEK CULVERT REPLACEMENT	Project Location: BELLEVUE, KING COUNTY, WASHINGTON
	Purpose: FLOW CONVEYANCE	SCALE AS NOTED
Date: JUNE 2008	Waterbody: SUNSET CREEK	SHEET 7 of 9



PLAN - TYPICAL UPSTREAM GRADE CONTROL

SCALE: 1"=5'

1
-



SECTION - TYPICAL UPSTREAM GRADE CONTROL

SCALE: 1"=5'

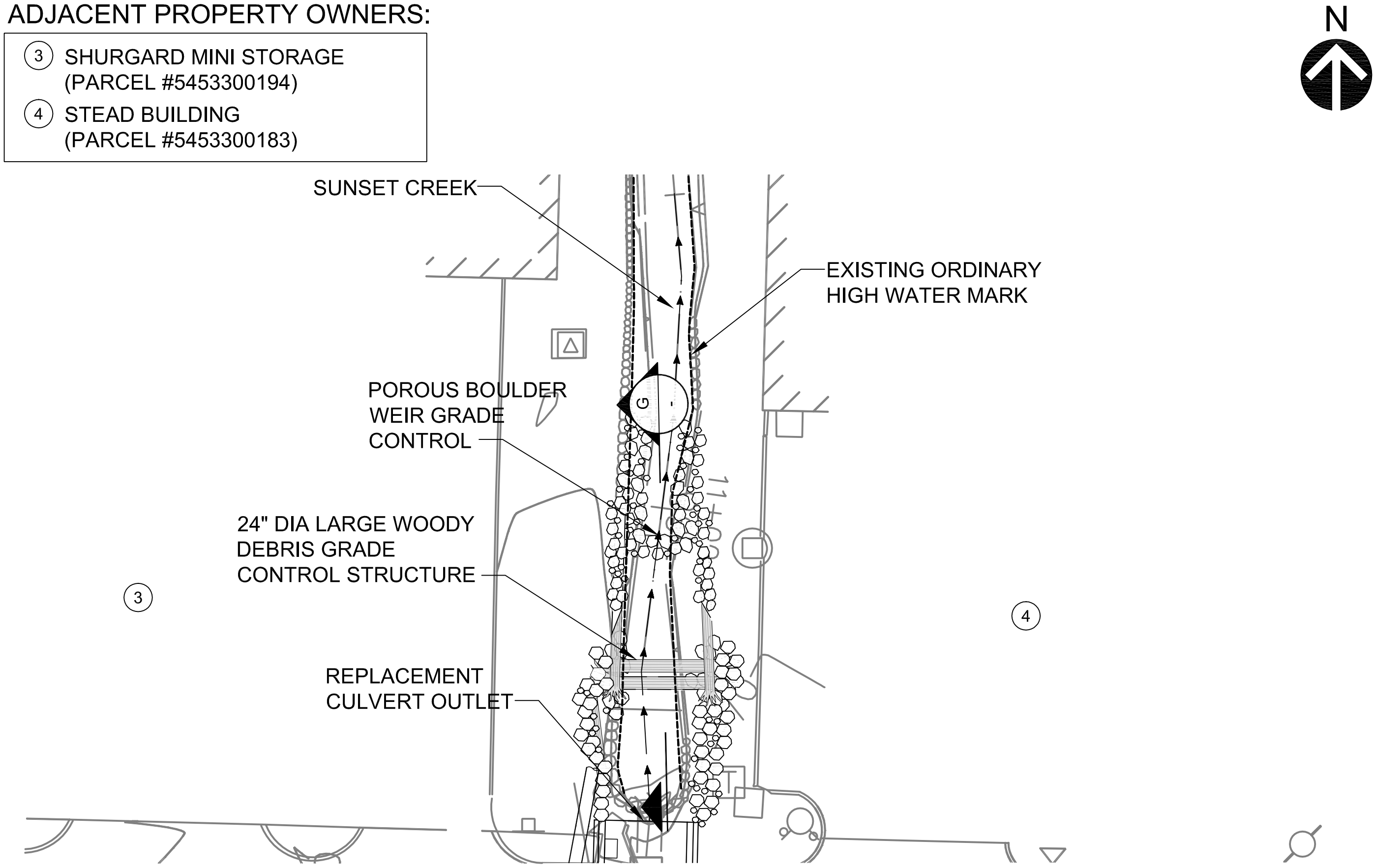
F
-

Path: O:\projY2006\06-03501-001\CAD\Dwgs\Jarpa\J-8.dwg
Plot Date: 6/25/2008 3:49 PM Cad User: Wojciech Wieszczecinski

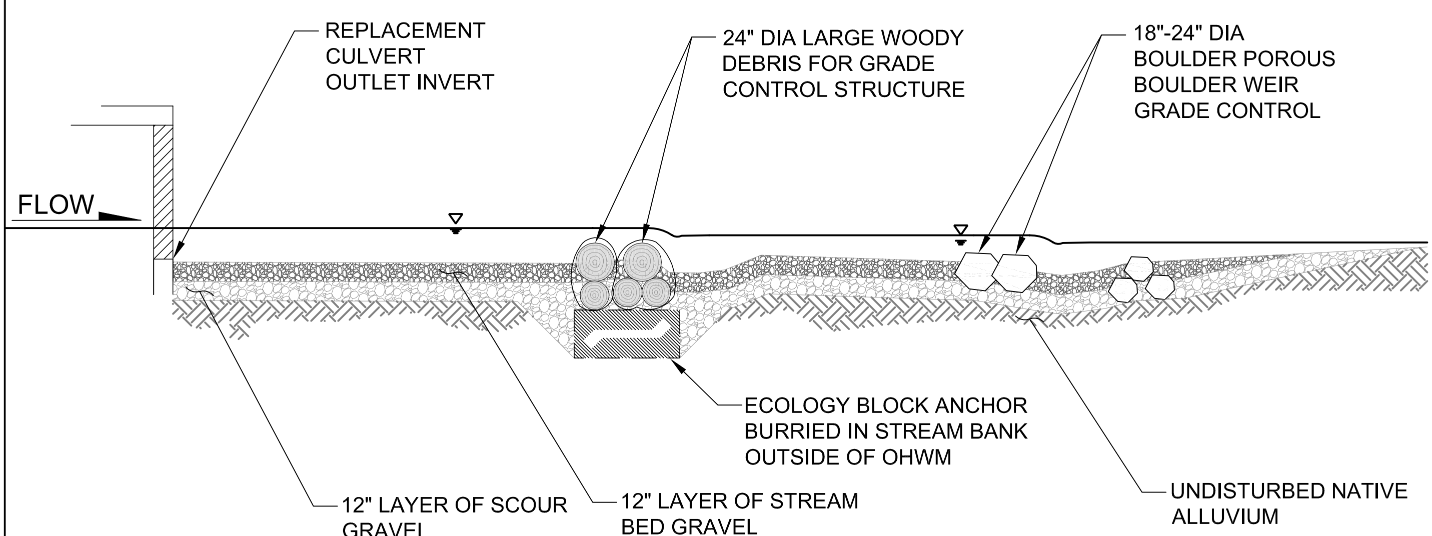
Prepared by: C. BARTON	UPSTREAM GRADE CONTROL DETAILS PLAN AND SECTION	Applicant: CITY OF BELLEVUE
HERRERA ENVIRONMENTAL CONSULTANTS 2200 Sixth Avenue Suite 1100 Seattle, Washington 98121-1820 206-441-9080 206-441-9108 FAX http://www.herrerainc.com	Application for: SE 30th / SUNSET CREEK CULVERT REPLACEMENT	Project Location: BELLEVUE, KING COUNTY, WASHINGTON
	Purpose: FLOW CONVEYANCE	SCALE AS NOTED
Date: JUNE 2008	Waterbody: SUNSET CREEK	SHEET 8 of 9

ADJACENT PROPERTY OWNERS:

3 SHURGARD MINI STORAGE (PARCEL #5453300194)
4 STEAD BUILDING (PARCEL #5453300183)



PLAN - DOWNSTREAM GRADE CONTROL STRUCTURES
- / 2
SCALE: 1"=30'



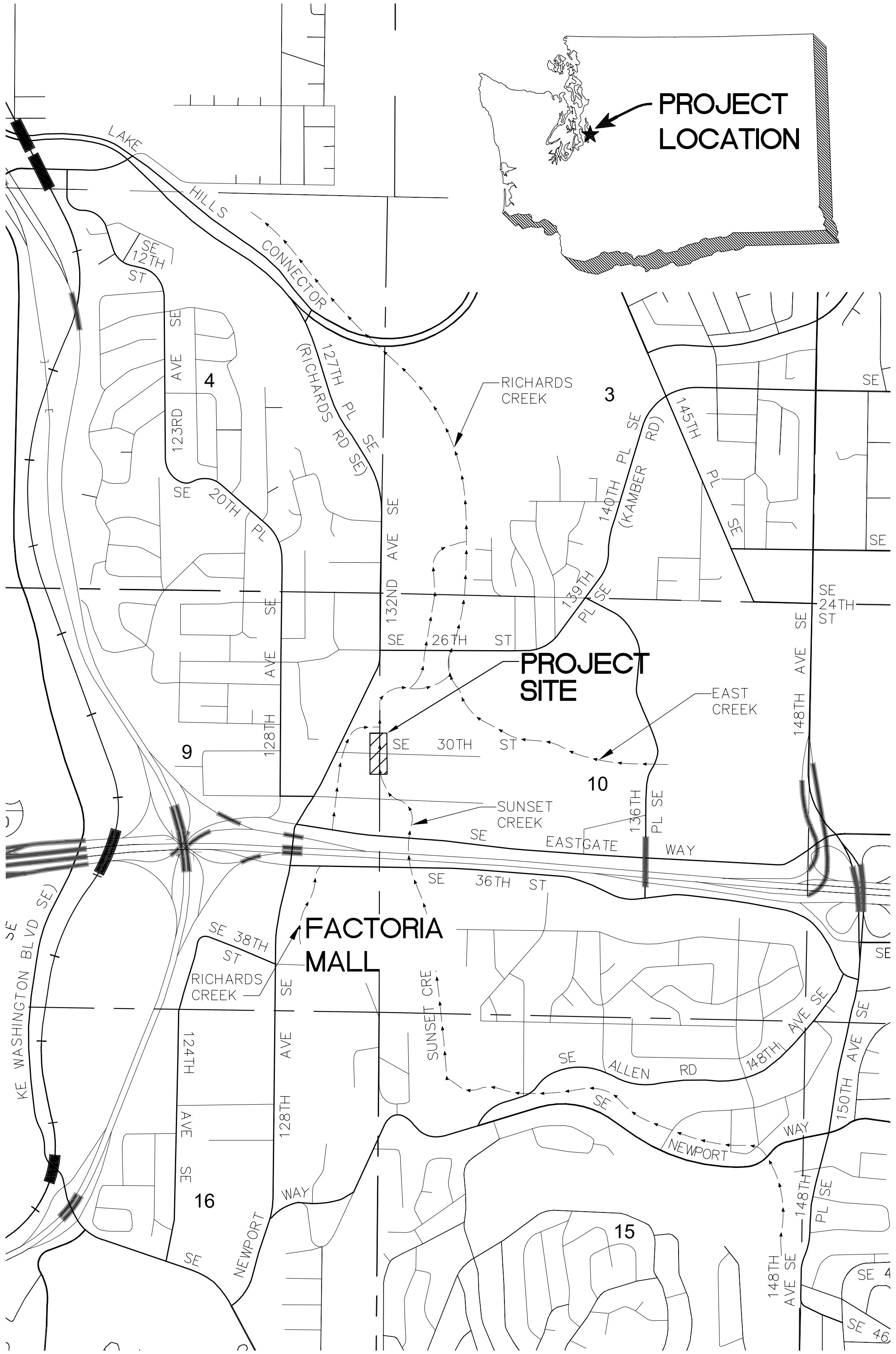
PROFILE - DOWNSTREAM GRADE CONTROL STRUCTURES
G / -
SCALE: 1"=10'

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Jarpa\J-9.dwg
Plot Date: 6/26/2008 7:15 AM Cad User: Wojciech Wieszczecinski

Prepared by: C. BARTON	DOWNSTREAM CHANNEL MODIFICATION PLAN AND PROFILE	Applicant: CITY OF BELLEVUE
HERRERA ENVIRONMENTAL CONSULTANTS, 2200 Sixth Avenue Suite 1100 Seattle, Washington 98121-1820, 206-441-9080, 206-441-9108 FAX, http://www.herrerainc.com	Application for: SE 30th / SUNSET CREEK CULVERT REPLACEMENT	Project Location: BELLEVUE, KING COUNTY, WASHINGTON
	Purpose: FLOW CONVEYANCE	SCALE AS NOTED
Date: JUNE 2008	Waterbody: SUNSET CREEK	SHEET 9 of 9

CITY OF BELLEVUE
SE 30TH STREET/SUNSET CREEK
CULVERT REPLACEMENT PROJECT

BELLEVUE, WASHINGTON



VICINITY MAP
SCALE: 1"=1000'

SHEET INDEX		
SHT NO.	DWG NO.	SHEET DESCRIPTION
1	G-1	TITLE SHEET, INDEX, AND VICINITY MAP
2	G-2	GENERAL NOTES
3	G-3	ABBREVIATIONS AND LEGEND
4	G-4	SITE PLAN
5	C-1	ROADWAY CORRIDOR DEMOLITION PLAN
6	C-2	ROADWAY PHASING PLAN AND NOTES
7	C-3	UTILITIES PLAN
8	C-4	UTILITIES DETAILS
9	C-5	ROADWAY PLAN AND SECTION
10	C-6	ROADWAY PLAN AND SECTION
11	C-7	CULVERT REPLACEMENT PLAN AND NOTES
12	C-8	CULVERT REPLACEMENT PROFILE AND NOTES
13	C-9	CULVERT REPLACEMENT DETAILS
14	C-10	STREAM CORRIDOR SITE PREPARATION PLAN
15	C-11	UPPER STREAM CHANNEL MODIFICATIONS PLAN AND PROFILE
16	C-12	LOWER STREAM CHANNEL MODIFICATIONS PLAN AND PROFILE
17	C-13	STREAM CHANNEL MODIFICATIONS DETAILS
18	ESC-1	TEMPORARY EROSION AND SEDIMENT CONTROL PLAN
19	ESC-2	TESC DETAILS
20	WM-1	FLOW DIVERSION AND FISH EXCLUSION DETAILS
21	P-1	PLANTING PLAN
22	P-2	PLANTING DETAILS
23	P-3	PLANT MATERIAL LIST

1 / C-3 — DETAIL REFERENCE NUMBER; DRAWING ON WHICH DETAIL IS SHOWN

DETAIL
SCALE: NTS
1 / C-1 — DETAIL REFERENCE NUMBER; DRAWING FROM WHICH DETAIL WAS TAKEN

A / C-4 — SECTION REFERENCE LETTER; DRAWING ON WHICH SECTION IS SHOWN

SECTION
SCALE: NTS
A / C-2 — SECTION REFERENCE LETTER; DRAWING FROM WHICH SECTION WAS TAKEN

"–" INDICATES THAT THE DETAIL/SECTION IS SHOWN ON THE SAME SHEET

"TYP" INDICATES THAT THE DETAIL/SECTION IS UNIFORMLY TYPICAL THROUGHOUT PROJECT EXCEPT WHERE OTHERWISE NOTED

"VAR" SPECIFIES THAT DETAIL/SECTION WAS TAKEN FROM SEVERAL DRAWINGS

NOTE AND DETAIL/SECTION REFERENCING

811 Know what's below. Call before you dig.

60% DESIGN - NOT FOR CONSTRUCTION

MARK EWBANK STATE OF WASHINGTON 29434 CIVIL ENGINEER PROFESSIONAL ENGINEER

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase I\G-1.dwg
Plot Date: 6/11/2008 11:50 AM
Cad User: Wojciech Wieszczecinski

NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
Suite 1100
Seattle, Washington
98121-1820
206-441-9080
206-441-9108 FAX
http://www.herrerainc.com

SE 30TH STREET / SUNSET CREEK
CULVERT REPLACEMENT PROJECT

Approved By
DESIGN MANAGER — DATE
PROJECT MANAGER — DATE

C. BARTON	05/2008
DESIGNED BY	DATE
W. WIESZCZECINSKI	06/2008
DRAWN BY	DATE
M. EWBANK	06/2008
CHECKED BY	DATE

CITY OF BELLEVUE WASHINGTON
City of Bellevue
UTILITIES

TITLE SHEET, INDEX, AND VICINITY MAP

DRAWING G-1
SHT 1 OF 23

GENERAL NOTES:

1. MATERIAL SHALL NOT BE STORED OUTSIDE OF IDENTIFIED STAGING AREAS, UNLESS APPROVED BY OWNER OR ENGINEER.
2. ALL EQUIPMENT SHALL USE ONLY BIODEGRADABLE HYDRAULIC FLUIDS.
3. CONTRACTOR SHALL LIMIT MACHINERY MOVEMENT TO PROJECT LIMITS DEFINED ON SITE PLAN OR IDENTIFIED AS ACCEPTABLE BY ENGINEER.
4. CLEARING LIMITS FOR TEMPORARY ACCESS ROAD AND PROPOSED STRUCTURES SHALL BE LIMITED TO THE AREA REQUIRED FOR SAFE EQUIPMENT OPERATION. CLEARING LIMITS SHALL BE STAKED BY CONTRACTOR AND APPROVED BY ENGINEER AT LEAST 3 DAYS PRIOR TO CLEARING ACTIVITIES. CLEARING LIMITS SHALL BE STAKED TO MINIMIZE THE AREA OF DISTURBANCE.
5. SEE SPECIFICATIONS FOR LOG TYPE (SPECIES), DIAMETER AND LENGTH. EXCAVATIONS SHALL BE INSPECTED BY ENGINEER PRIOR TO PLACEMENT OF ANY WOOD.
6. LOG PLACEMENTS SHALL BE INSPECTED BY ENGINEER PRIOR TO BACKFILLING.
7. CONTRACTOR SHALL PROVIDE 24 HOURS ADVANCE NOTICE TO THE ENGINEER PRIOR TO ANY REQUIRED INSPECTION. CONTRACTOR SHALL SUBMIT A CONSTRUCTION SEQUENCE PLAN FOR APPROVAL AT LEAST 5 DAYS PRIOR TO SITE WORK.
8. APPROVED CONSTRUCTION SEQUENCE PLAN SHALL NOT BE ALTERED UNLESS APPROVED BY ENGINEER.
9. EQUIPMENT USED FOR THIS PROJECT SHALL BE FREE OF EXTERNAL PETROLEUM-BASED PRODUCTS WHILE WORKING AROUND THE STREAM. ACCUMULATION OF SOILS OR DEBRIS SHALL BE REMOVED FROM THE DRIVE MECHANISMS (WHEELS, TRACKS, TIRES, ETC.) AND UNDERCARRIAGE OF EQUIPMENT PRIOR TO ITS WORKING WITHIN THE CHANNEL.
10. EQUIPMENT SHALL BE CHECKED DAILY FOR LEAKS, AND ANY NECESSARY REPAIRS SHALL BE COMPLETED PRIOR TO COMMENCING WORK ACTIVITIES.
11. THE CONTRACTOR IS RESPONSIBLE TO ENSURE THAT NO PETROLEUM PRODUCTS, HYDRAULIC FLUID, SEDIMENTS, SEDIMENT-LADEN WATER, CHEMICALS, OR ANY OTHER TOXIC OR DELETERIOUS MATERIALS ARE ALLOWED TO ENTER OR LEACH INTO THE STREAM.
12. IF AT ANY TIME, AS A RESULT OF PROJECT ACTIVITIES, FISH ARE OBSERVED IN DISTRESS, A FISH KILL OCCURS, OR WATER QUALITY PROBLEMS DEVELOP (INCLUDING EQUIPMENT LEAKS OR SPILLS), OPERATIONS SHALL CEASE AND THE ENGINEER SHALL BE NOTIFIED IMMEDIATELY. WASHINGTON DEPARTMENT OF FISH AND WILDLIFE AND WASHINGTON DEPARTMENT OF ECOLOGY SHALL BE CONTACTED IMMEDIATELY BY THE ENGINEER OR BY HIS/HER DESIGNEE. WORK SHALL NOT RESUME UNTIL FURTHER APPROVAL BY OWNER'S REPRESENTATIVE.
13. EROSION CONTROL METHODS SHALL BE USED TO PREVENT SILT-LADEN WATER FROM ENTERING THE CREEK. INITIAL EROSION CONTROL MEASURES ARE SHOWN ON DRAWINGS ESC-1 AND ESC-2. THE CONTRACTOR SHALL SUBMIT A TEMPORARY EROSION AND SEDIMENT CONTROL PLAN SHOWING ADDITIONAL SITE SPECIFIC EROSION AND SEDIMENT CONTROL TECHNIQUES AND METHODS.
14. IF HIGH FLOW CONDITIONS THAT MAY CAUSE SILTATION OR EROSION ARE ENCOUNTERED DURING CONSTRUCTION, WORK SHALL STOP UNTIL THE FLOW SUBSIDES.
15. CONTRACTOR IS RESPONSIBLE FOR CALLING "ONE CALL" FOR UTILITY LOCATES PRIOR TO CONSTRUCTION. 1(800)424-5555 OR 811
16. THE EXISTING FEATURES AS SHOWN ON THE EXISTING CONDITIONS PLAN WERE PROVIDED BY THE CITY OF BELLEVUE AND FROM SUPPLEMENTAL FIELD WORK PERFORMED BY APS.

LOG NOTES:

1. DECKED LOGS SHALL BE ACCESSIBLE FOR INSPECTION.
2. LOG TYPE IDENTIFICATION SHALL BE PAINTED ON ALL LOGS IN A PLACE VISIBLE FOR INSPECTION PRIOR TO PLACEMENT WITH LEAD-FREE, BLAZE-ORANGE SURVEY MARKING PAINT.

UTILITIES AND AGENCIES

CITY OF BELLEVUE

BRIAN WARD – PROJECT MANAGER

450 110TH AVENUE NE
BELLEVUE, WA 98004
(425) 452-5206
(425) 452-7856

EMAIL: BWARD@BELLEVUEWA.GOV

KING COUNTY DEPARTMENT OF NATURAL RESOURCES, WTD

ERIC DAVISON

201 S. JACKSON ST, MAIL STOP KSC-NR-0508
SEATTLE, WA 98104-3855

(206) 684-1707
FAX: (206) 684-1710
ERIC.DAVISON@KINGCOUNTY.GOV

BELLEVUE WATER DISTRICT #1

KIPP FOCKLER – OPERATING & WATER MAINTENANCE
(425) 452-2923

GREG KNIGHT
(425) 452-4493

BELLEVUE FIRE DEPARTMENT

NON-EMERGENCY GENERAL
(425) 452-6892

FIRE PREVENTION PLAN REVIEW DESK
(425) 452-4122

BELLEVUE POLICE DEPARTMENT

(425) 452-6917

CITY OF BELLEVUE – TRANSPORTATION DEPARTMENT

JON REGALIA

450 110TH AVENUE NE
BELLEVUE, WA 98004
(425) 452-4599

EMAIL: JREGALIA@BELLEVUEWA.GOV

CITY OF BELLEVUE – PERMIT CENTER

TRAVIS RIPLEY
(425) 452-6042

PUGET SOUND ENERGY (PSE CONSTRUCTION)

JEANNE COLEMAN – MUNICIPAL CONSTRUCTION PLANNER

P.O. BOX 97034
MAIL STOP: EST-11W
BELLEVUE, WA 98009-9734

(425) 462-3488
EMAIL: JEANNE.COLEMAN@PSE.COM

COMCAST (FORMERLY AT&T BROADBAND)

JILL LOOK

1525 75TH ST. SW, SUITE 200
EVERETT, WA 98203

(425) 263-5346
FAX: (425) 263-5352
MOBILE: (206) 396-6032
EMAIL: JILL_LOOK@CABLE.COMCAST.COM

QWEST (US WEST COMMUNICATIONS)

DAN RESSLER

1550 NEWPORT WAY NW, ROOM #2
ISSAQUAH, WA 98027

(206) 345-3809
EMAIL: JOSEPH.RESSLER@QWEST.COM

ONE CALL

UTILITY LOCATION
(800) 424-5555 OR 811

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase I\G-2.dwg
Plot Date: 6/11/2008 11:51 AM Cad User: Wojciech Wieszczecinski

MARK EWBANK STATE OF WASHINGTON 29434 CIVIL ENGINEER PROFESSIONAL ENGINEER

ONE INCH — AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

60% DESIGN - NOT FOR CONSTRUCTION

NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
Suite 1100
Seattle, Washington
98121-1820
206-441-9080
206-441-9108 FAX
http://www.herrerainc.com

SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER DATE
PROJECT MANAGER DATE

C. BARTON	05/2008
DESIGNED BY	DATE
W. WIESZCZECINSKI	06/2008
DRAWN BY	DATE
M. EWBANK	06/2008
CHECKED BY	DATE

City of Bellevue UTILITIES

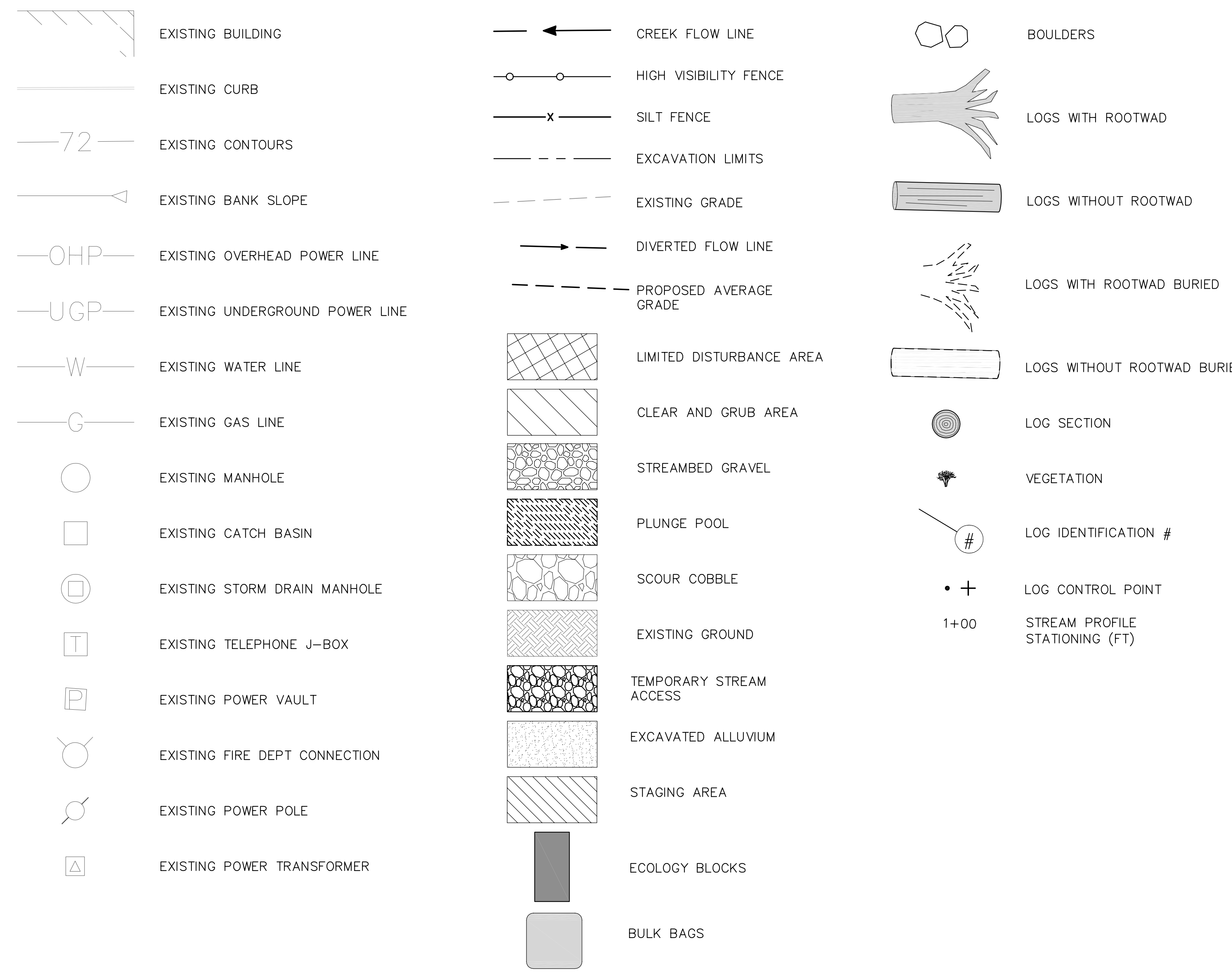
GENERAL NOTES

DRAWING G-2 SHT 2 OF 23

ABBREVIATIONS:

APPROX	APPROXIMATE(LY)
CB	CATCH BASIN
DBH	DIAMETER BREAST HEIGHT
DIA	DIAMETER
DWG	DRAWING
ESC	EROSION AND SEDIMENT CONTROL
EX	EXISTING
FAC	FACULTATIVE
FACU	FACULTATIVE UPLAND
FACW	FACULTATIVE WETLAND
FT	FEET
IN	INCHES
LWD	LARGE WOODY DEBRIS
MIN	MINIMUM
NI	NO INDICATOR
OHP	OVERHEAD POWER LINE
OHWM	ORDINARY HIGH WATER MARK
PSE	PUGET SOUND ENERGY
SDMH	STORM DRAIN MANHOLE
TEL	TELEPHONE
TYP	TYPICAL
UGP	UNDERGROUND POWER LINE
UGT	UNDERGROUND TELEPHONE LINE
UPL	OBLIGATE UPLAND

LEGEND:



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SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

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PROJECT MANAGER — DATE

C. BARTON	05/2008
DESIGNED BY	DATE
W. WIESZCZECINSKI	06/2008
DRAWN BY	DATE
M. EWBANK	06/2008
CHECKED BY	DATE

City of Bellevue UTILITIES

ABBREVIATIONS AND LEGEND

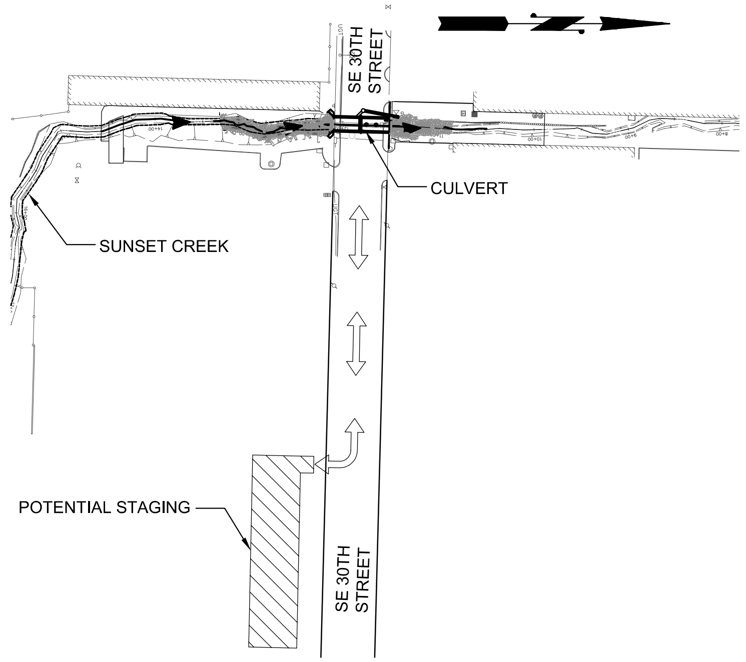
DRAWING G-3 — SHT 3 OF 23

ONE INCH — AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

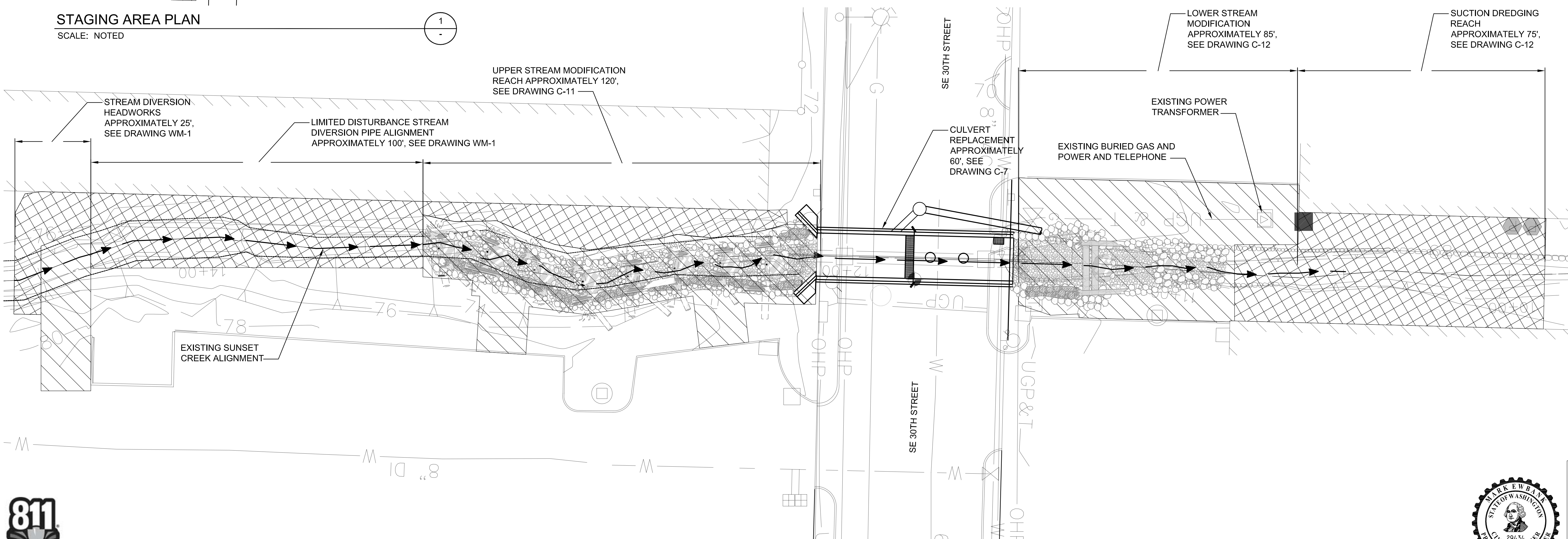
Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase I\G-3.dwg Cad User: Wojciech Wieszczecinski
Plot Date: 6/11/2008 11:52 AM

GENERAL NOTES:

1. FOR STREAM CORRIDOR SITE PREP DETAILS SEE DRAWING C-10
2. FOR SITE STAGING AREA SEE DETAIL 1 ON THIS SHEET



STAGING AREA PLAN 1 -
SCALE: NOTED



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60% DESIGN - NOT FOR CONSTRUCTION

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

MARK EWBANK STATE OF WASHINGTON 29434 CIVIL ENGINEER PROFESSIONAL ENGINEER

NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS

CIVILTECH ENGINEERING
10800 NE 8th Street Suite 820
Bellevue, WA 98004
Phone: 425.453.6488
Fax: 425.453.5848

SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER DATE

PROJECT MANAGER DATE

C. BARTON	05/2008
DESIGNED BY	DATE
W. WIESZCZECINSKI	06/2008
DRAWN BY	DATE
M. EWBANK	06/2008
CHECKED BY	DATE

City of Bellevue UTILITIES

SITE PLAN

DRAWING G-4

SHT 4 OF 23

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase I\G-4.dwg
Plot Date: 6/11/2008 11:53 AM
Cad User: Wojciech Wieszczecinski

REMOVAL NOTES:

1. REMOVE CONC CURB AND SIDEWALK
2. SAW CUTTING PAVEMENT
3. REMOVE ASPHALT CONC PAVEMENT
4. REMOVE CATCH BASIN
5. EXCAVATE AND REMOVE CMP CULVERTS
6. REMOVE SAFETY RAILING
7. REMOVE ROCKERY WALL AS NECESSARY TO FACILITATE CULVERT INSTALLATION. KEEP ROCK FOR CHANNEL MODIFICATIONS.

GENERAL NOTES:

1.) FOR REMOVAL, RELOCATION, AND ADJUSTMENT OF WATER VALVES, FIRE HYDRANTS, WATER METERS, AND OTHER FEATURES RELATED TO WATER MAIN, SEE UTILITY PLAN, SHEETS C3 AND C4.

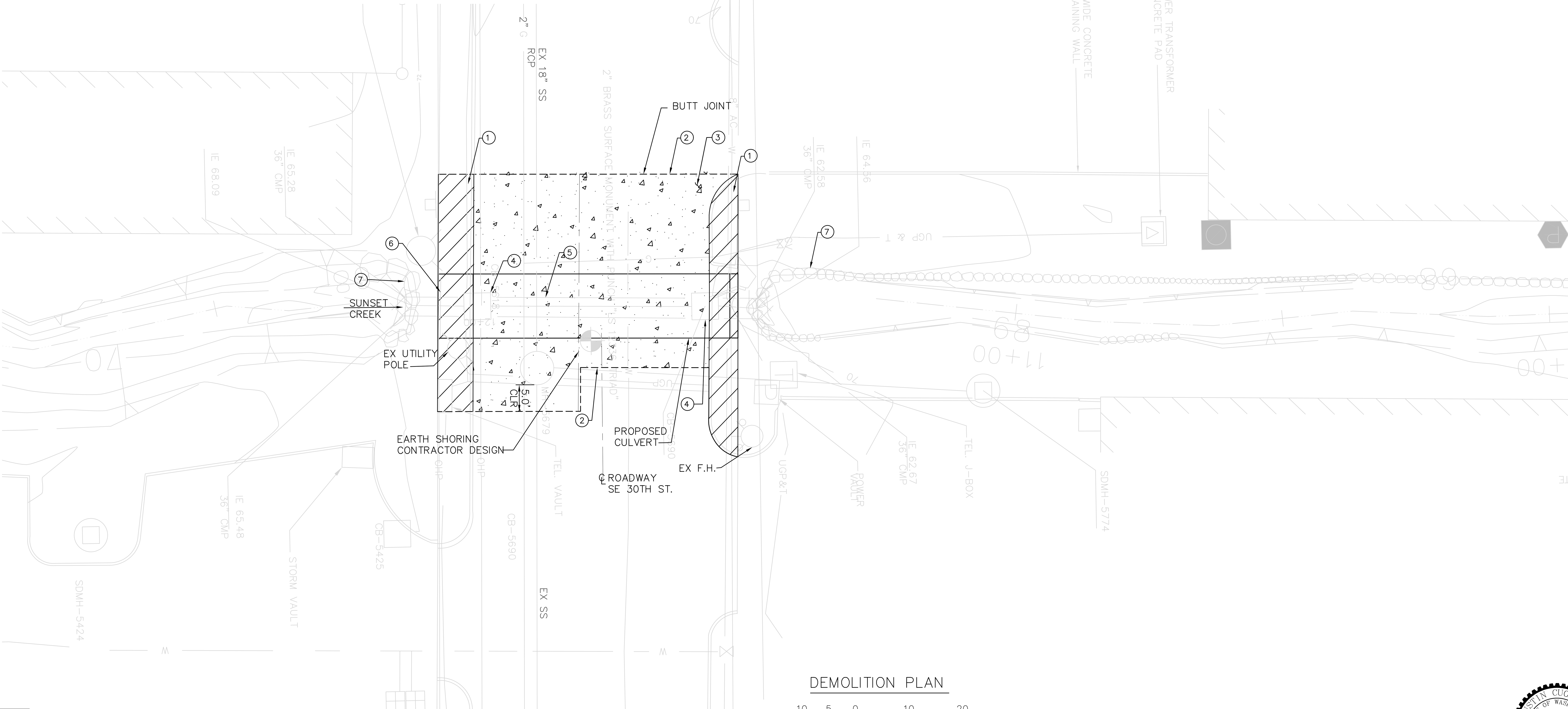
2.) FOR REMOVAL OR RELOCATION OF POWER POLE AND TELEPHONE POLE, SEE UTILITY PLAN, SHEETS C3 AND C4.

3.) FOR REMOVAL, RELOCATION, AND ADJUSTMENT OF OTHER EXISTING UTILITIES, SEE SHEETS C3 AND C4.

LEGEND

CURB & SIDEWALK REMOVAL

FULL DEPTH PAVEMENT REMOVAL



DEMOLITION PLAN

10 5 0 10 20

SCALE IN FEET

VERTICAL DATUM:
CITY OF BELLEVUE #140 NAVD'88 ELEV.=210.42
TOP NE CORNER 3'x3' CONCRETE FOOTING FOR 2'x2' BRICK PILLAR AT SW CORNER 128TH AVENUE SE AND SE 26TH PLACE.

811 Know what's below. Call before you dig.

60% DESIGN - NOT FOR CONSTRUCTION

NORTH 1/2, SEC. 10, TWP. 24 N., RGE 5 E., W.M.

DUSTIN CUONG ONG, STATE OF WASHINGTON, 35684, REGISTERED PROFESSIONAL ENGINEER

EXPIRES

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS

CIVILTECH ENGINEERING
10800 NE 8th Street Suite 820
Bellevue, WA 98004
Phone: 425.453.6488
Fax: 425.453.5848

SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER DATE

PROJECT MANAGER DATE

D.C. ONG	04/2008
DESIGNED BY	DATE
J. ROBERTS	04/2008
DRAWN BY	DATE
D.C. ONG	04/2008
CHECKED BY	DATE

City of Bellevue UTILITIES

ROADWAY CORRIDOR DEMOLITION PLAN

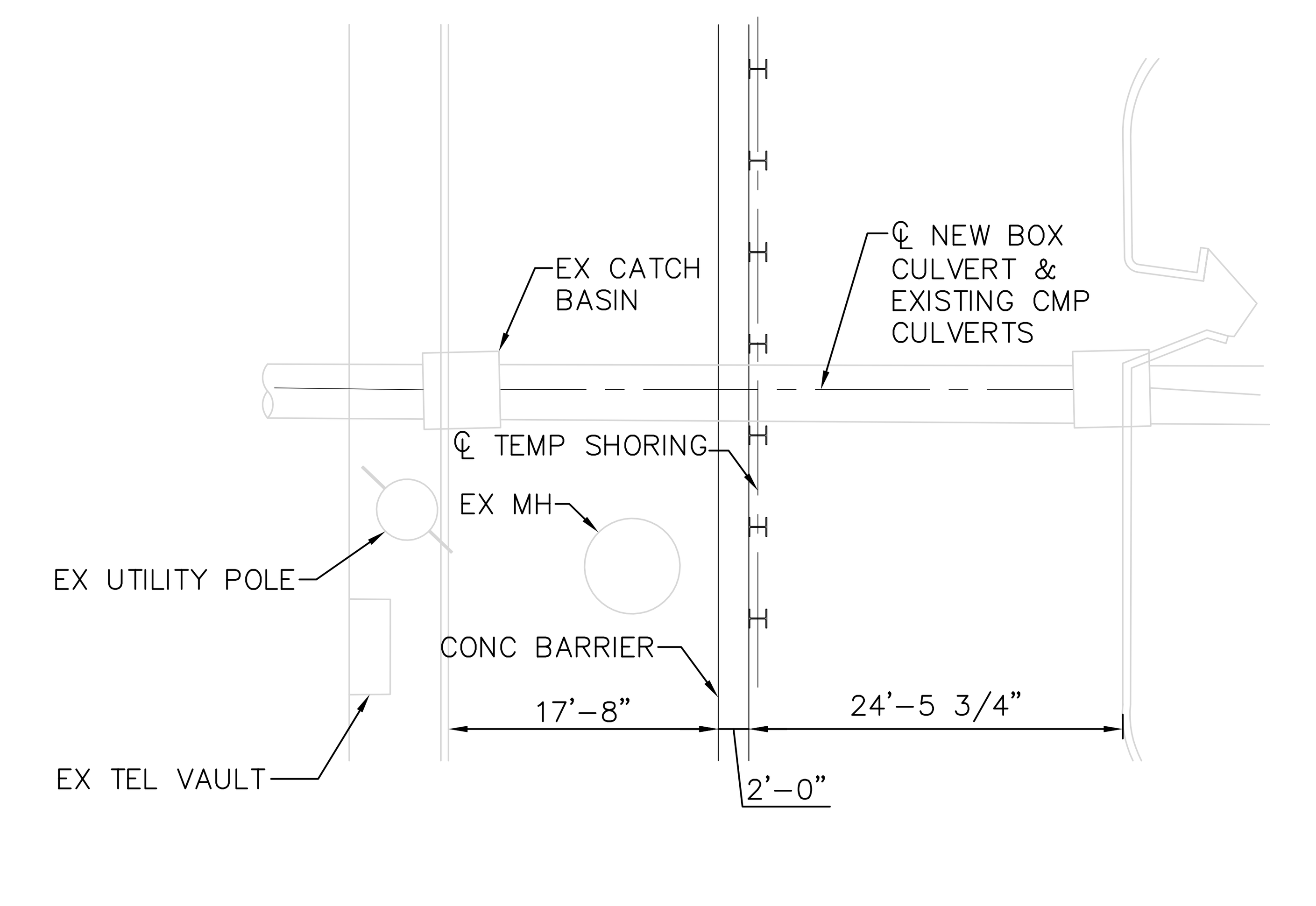
DRAWING C-1

SHT 5 OF 24

Path: P:\Structural\2007\27015 - SE 30 & Sunset Cr (Herrera)\Cad\Drawing\C-1.dwg
Plot Date: 6/10/2008 2:31 PM Cad User: Jeff Roberts

STAGE 1

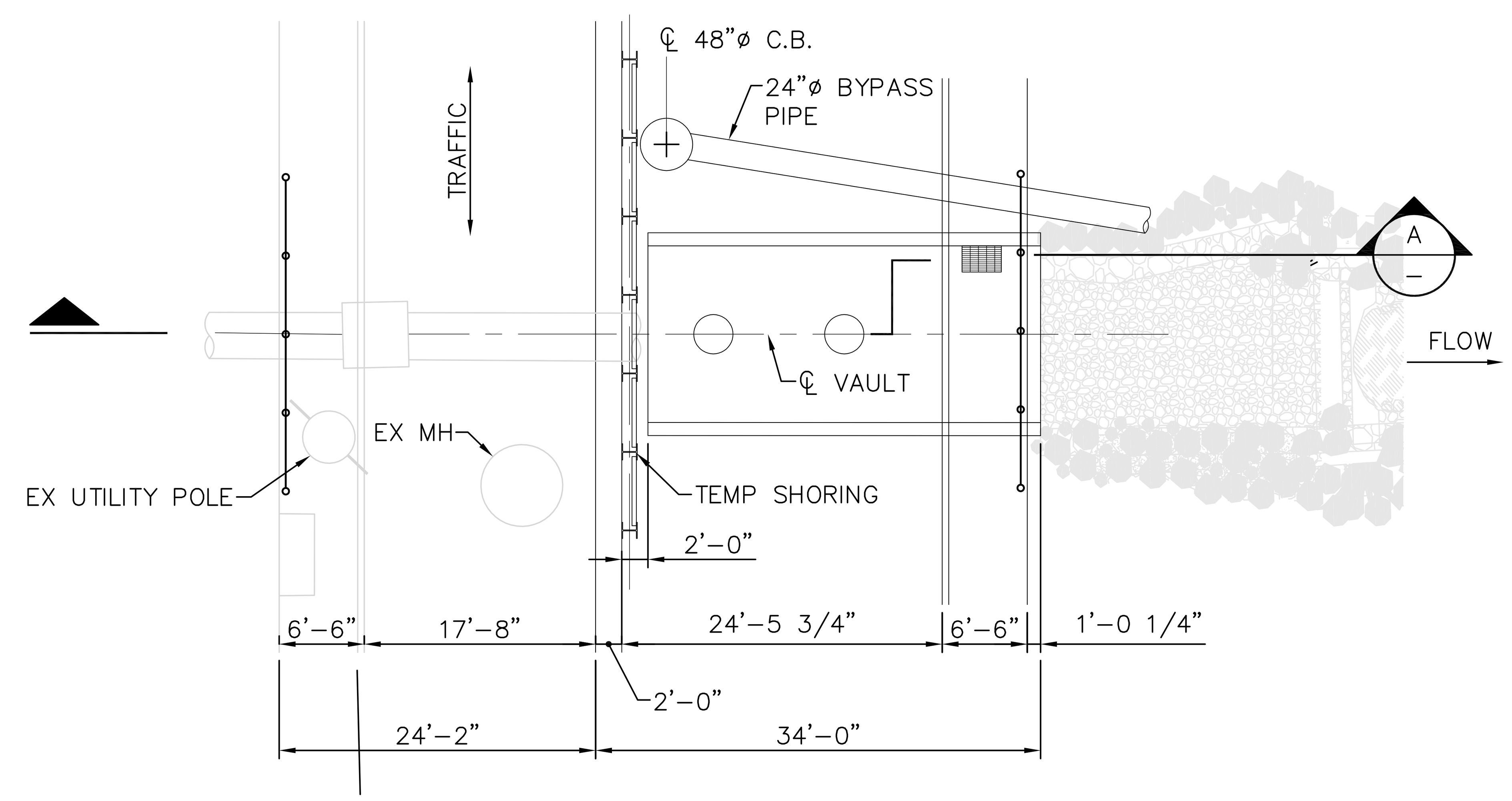
1. PREPARE ROAD CLOSURE AND PLACE CLOSURE SIGNS
2. REMOVE STRUCTURES AND OBSTRUCTIONS
3. INSTALL TEMPORARY SHORING (SOLDIER PILE SHOWN) AT LOCATIONS SHOWN.
4. INSTALL TEMPORARY TRAFFIC BARRIER



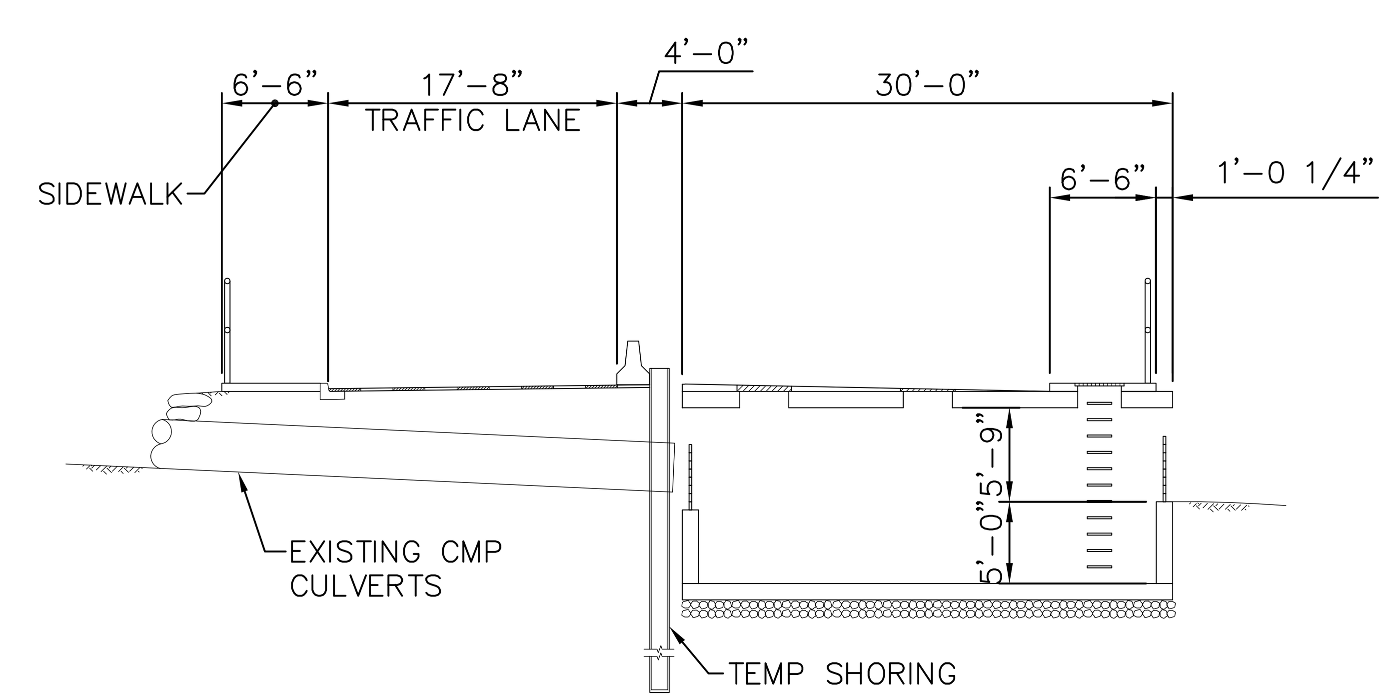
STAGE 1 (PLAN)
SCALE: 1"=10'

STAGE 2

1. CLOSE NORTH LANES. MAINTAIN ONE LANE OPEN AT ALL TIMES, ON SOUTH SIDE OF STREET.
2. INSTALL TEMPORARY PIPE TO DIVERT STREAM FLOW (NOT SHOWN)
3. START EXCAVATION AND REMOVE EXISTING ROCKERIES AND CMP CULVERT.
4. PREPARE FOUNDATION SOILS
5. INSTALL 3-SIDED BOXES, 48"ø TYPE 2 CB, AND 24"ø BYPASS PIPE
6. CONSTRUCT BAFFLE WALLS, REMOVABLE LIDS, AND LADDERS
7. CONSTRUCT DOWNSTREAM CHANNEL MODIFICATIONS



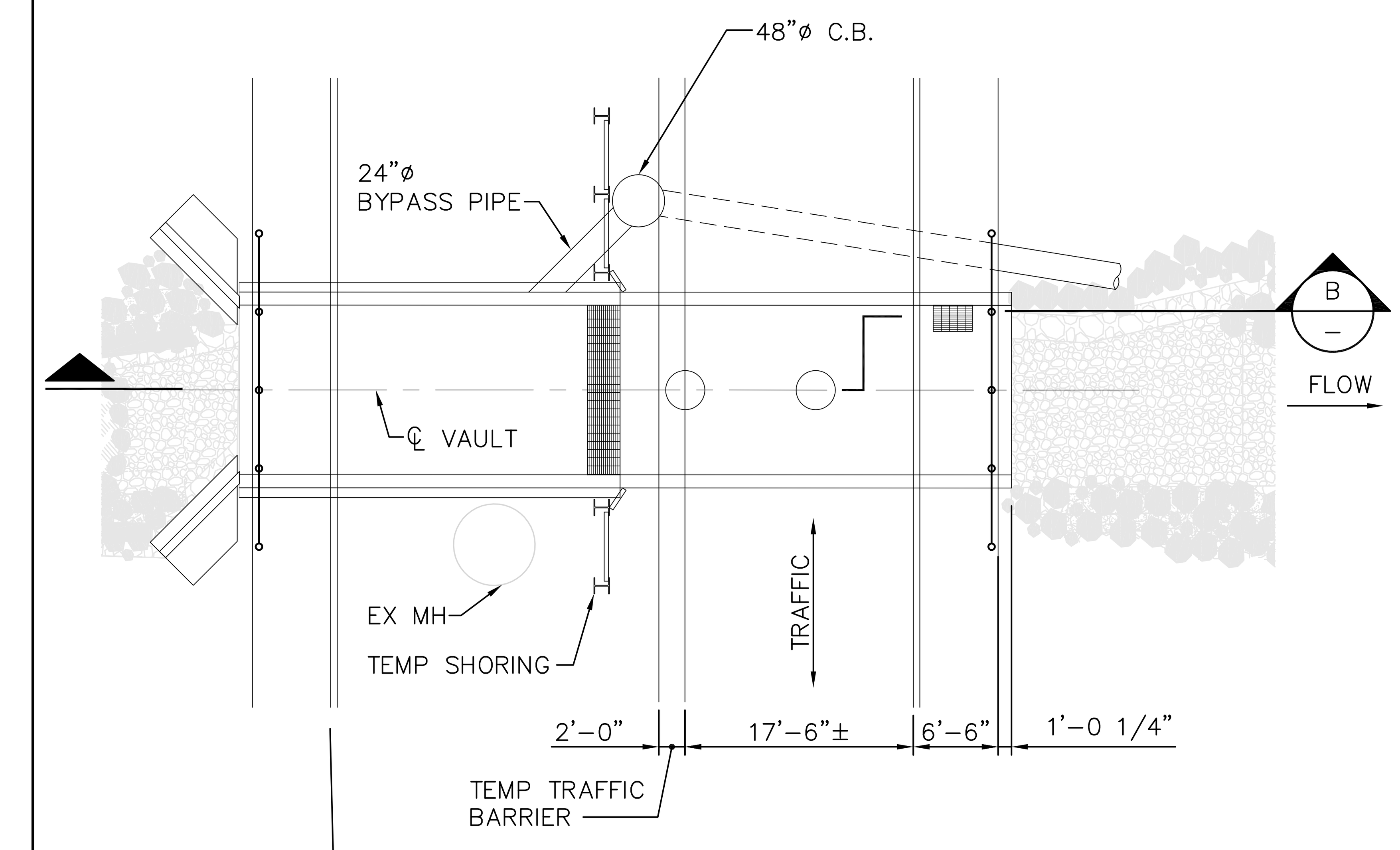
STAGE 2 (PLAN)
SCALE: 1"=10'



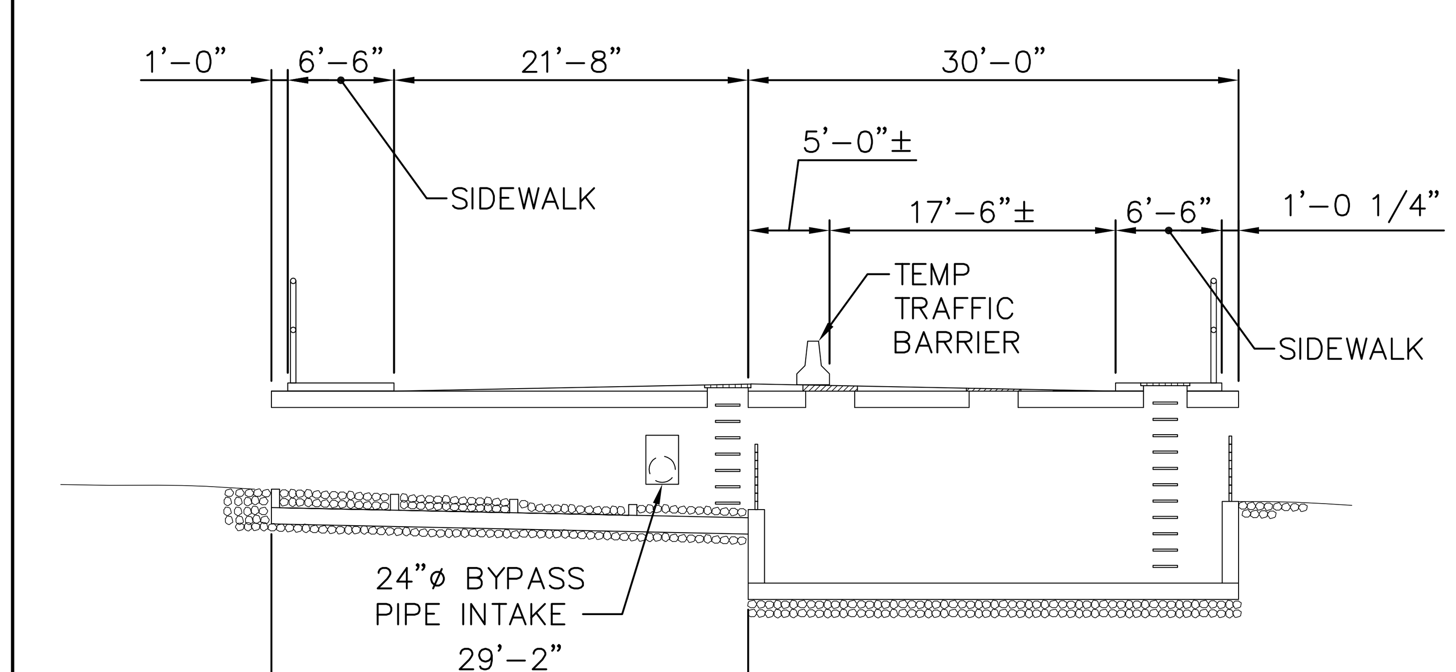
SECTION A
SCALE: 1"=10'

STAGE 3

1. RELOCATE TEMPORARY TRAFFIC BARRIER AT THE LOCATION SHOWN
2. OPEN NORTH LANE TO TRAFFIC, CLOSE SOUTH SIDE OF STREET
3. BEGIN EXCAVATION AND REMOVE EXISTING ROCKERIES AND REMAINING CMP CULVERT. REMOVE SOLDIER PILES THAT INTERFERE WITH NEW VAULT STRUCTURE. PROTECT EXISTING 5'ø MANHOLE DURING EXCAVATION.
4. PREPARE FOUNDATION SOILS
5. INSTALL 4-SIDED BOXES AND WING WALLS. CONSTRUCT 24"ø BYPASS CONNECTION TO 48"ø C.B., PIPE, AND BAFFLES
6. CONSTRUCT UPSTREAM CHANNEL MODIFICATIONS
7. CONSTRUCT SIDEWALKS AND CURBS, PLACE ROADWAY CONCRETE SURFACE OVER CULVERT, AND INSTALL HANDRAILS



STAGE 3 (PLAN)
SCALE: 1"=10'



SECTION B
SCALE: 1"=10'

60% DESIGN - NOT FOR CONSTRUCTION

811 Know what's below. Call before you dig.

DUSTIN CUONG ONG, STATE OF WASHINGTON, 35684, REGISTERED PROFESSIONAL ENGINEER
EXPIRES

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS

CIVILTECH ENGINEERING
10800 NE 8th Street Suite 820
Bellevue, WA 98004
Phone: 425.453.6488
Fax: 425.453.5848

SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By
DESIGN MANAGER DATE
PROJECT MANAGER DATE

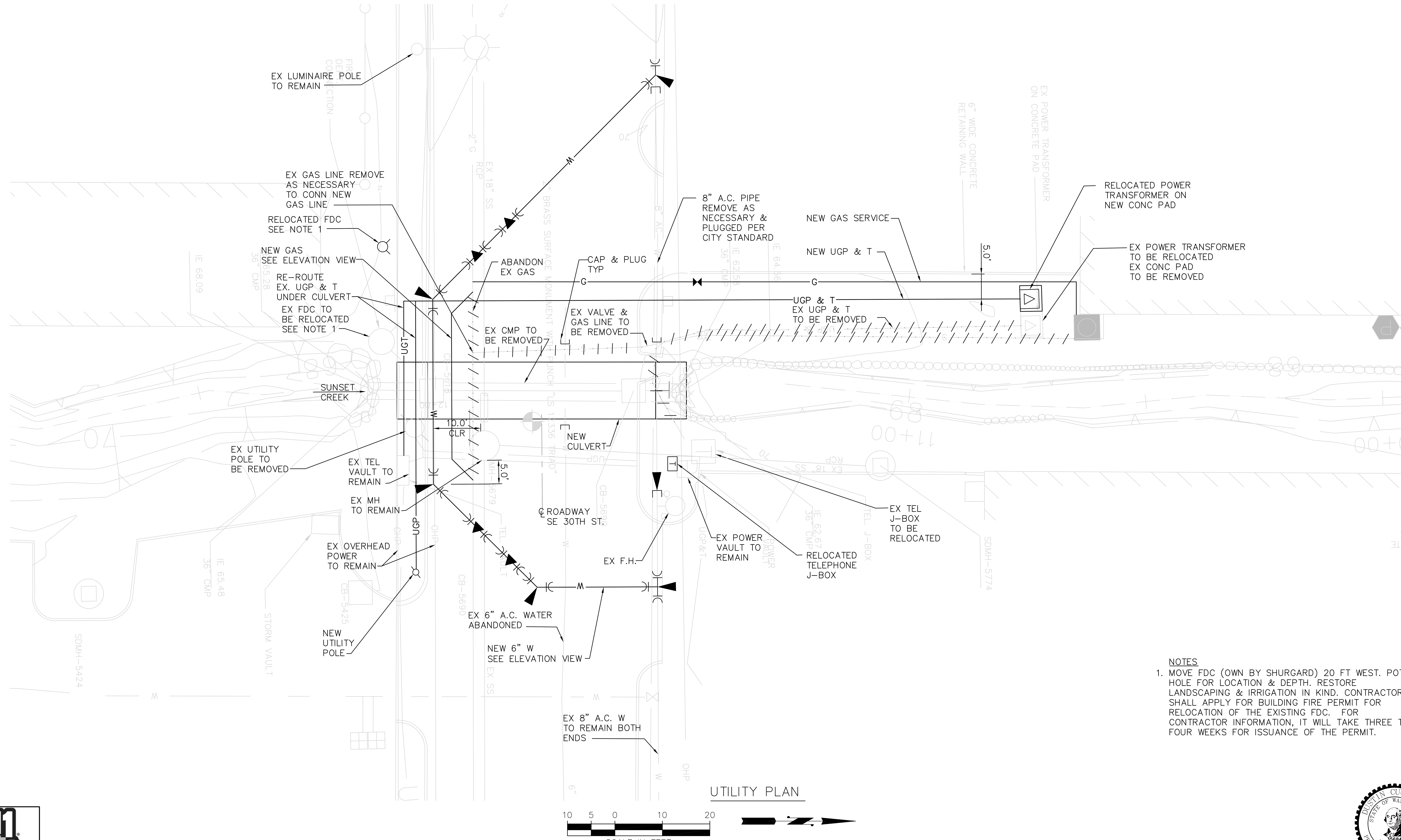
D.C. ONG	04/2008
DESIGNED BY	DATE
J. ROBERTS	04/2008
DRAWN BY	DATE
D.C. ONG	04/2008
CHECKED BY	DATE

City of Bellevue UTILITIES

ROADWAY PHASING PLAN AND NOTES

DRAWING C-2 SHT 6 OF 24

Path: P:\Structural\2007\27015 - SE 30 & Sunset Cr (Herrera)\Cad\Drawing\C-2.dwg
Plot Date: 6/10/2008 2:39 PM Cad User: Jeff Roberts



NOTES
1. MOVE FDC (OWN BY SHURGARD) 20 FT WEST. POT HOLE FOR LOCATION & DEPTH. RESTORE LANDSCAPING & IRRIGATION IN KIND. CONTRACTOR SHALL APPLY FOR BUILDING FIRE PERMIT FOR RELOCATION OF THE EXISTING FDC. FOR CONTRACTOR INFORMATION, IT WILL TAKE THREE TO FOUR WEEKS FOR ISSUANCE OF THE PERMIT.

ONE INCH
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NORTH 1/2, SEC. 10, TWP. 24 N., RGE 5 E., W.M.

EXPIRES

NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS
CIVILTECH ENGINEERING
10800 NE 8th Street Suite 820
Bellevue, WA 98004
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SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

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PROJECT MANAGER DATE

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J. ROBERTS	04/2008
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D.C. ONG	04/2008
CHECKED BY	DATE

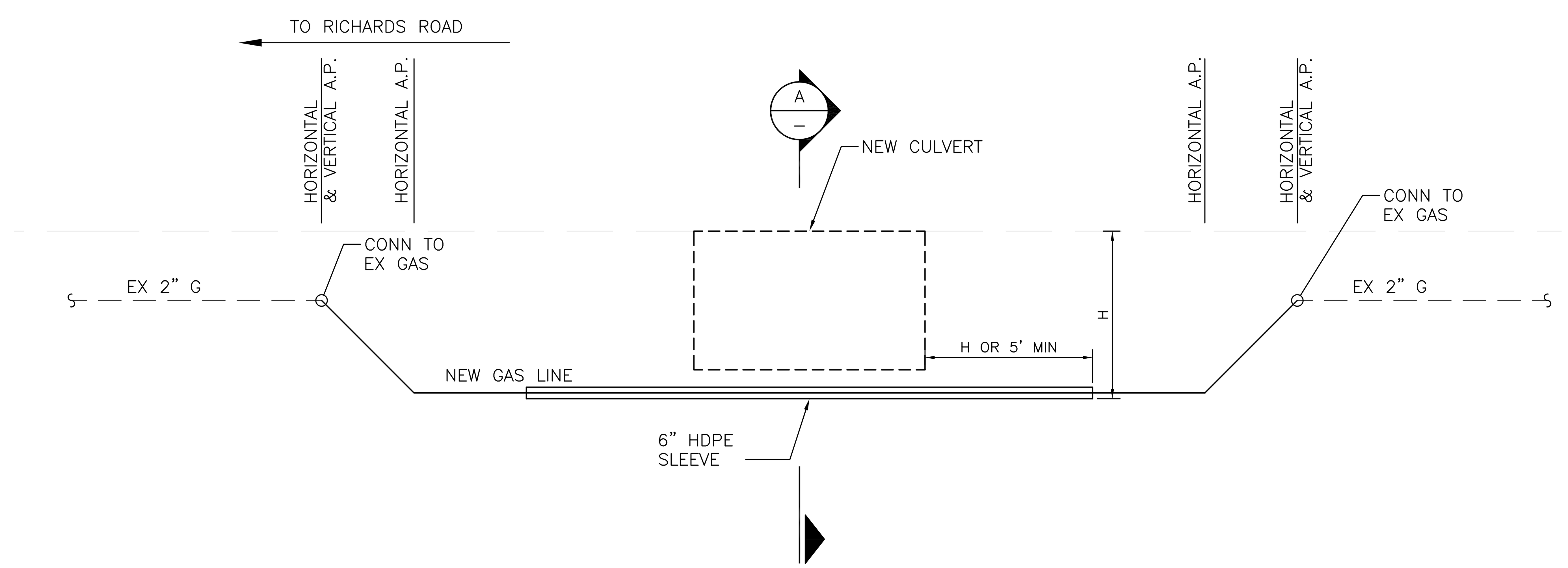
City of Bellevue
UTILITIES

UTILITIES PLAN
DRAWING C-3
SHT 7 OF 24

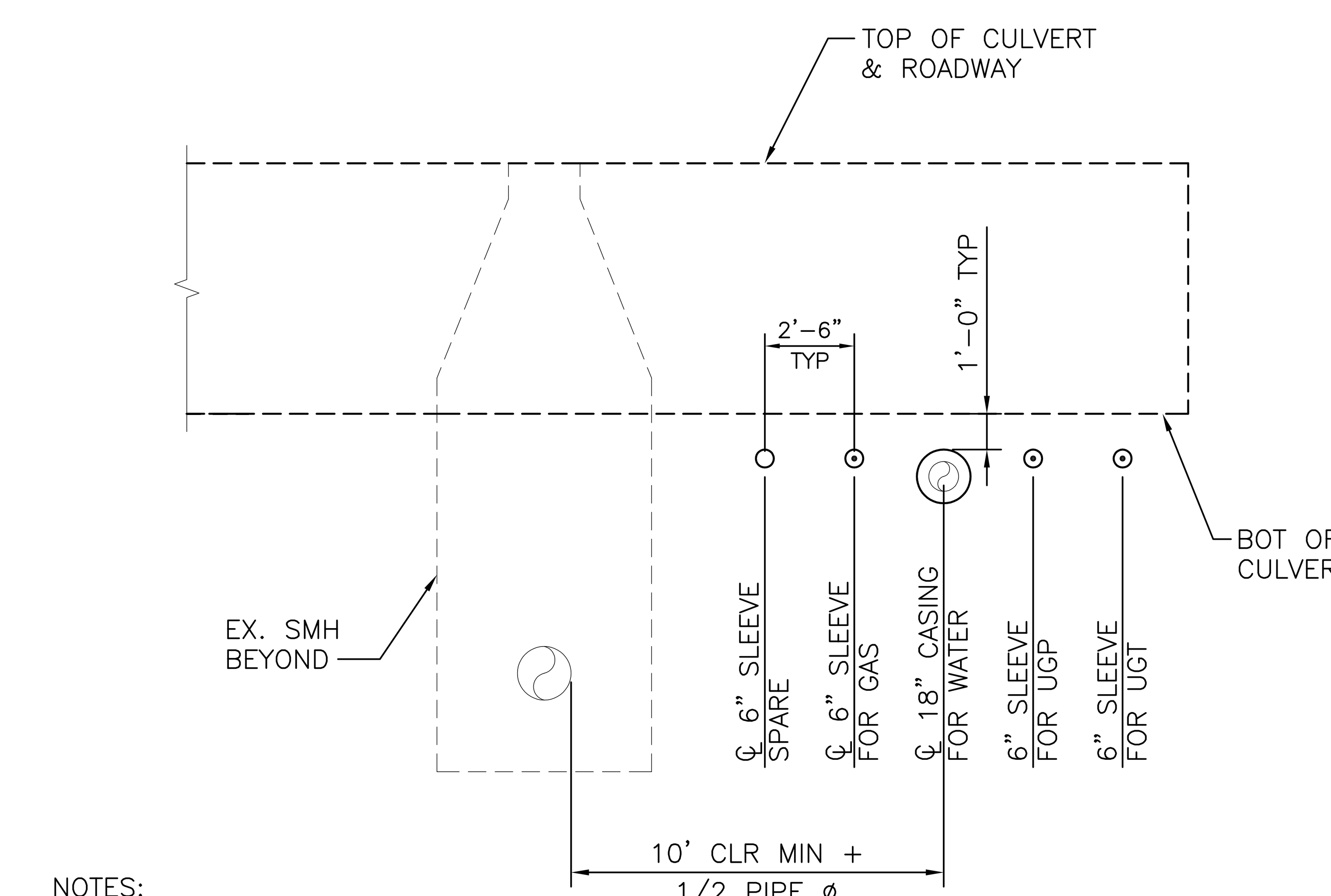
Path: P:\Structural\2007\27015 - SE 30 & Sunset Cr (Herrera)\Cad\Drawing\C-3.dwg
Plot Date: 6/10/2008 2:39 PM Cad User: Jeff Roberts

PROFILE 8" WATER LINE RE-ALIGNMENT

1. HORIZONTAL THRUST BLOCK
2. VERTICAL THRUST BLOCK
3. 8" – 45° HORIZONTAL BEND (MJ)
4. 8" – 45° VERTICAL BEND (MJ)
5. 8" – NIPPLE



PROFILE GAS LINE RE-ALIGNMENT



NOTES:
1. 6" SLEEVE SHALL BE HDPE
2. 12" SLEEVE SHALL BE ASTM A53 GRADE B

SLEEVE DETAIL (A)
SCALE: NTS

EXPIRES

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Plot Date: 6/10/2008 2:40 PM Cad User: Jeff Roberts

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CIVILTECH ENGINEERING
10800 NE 8th Street Suite 820
Bellevue, WA 98004
Phone: 425.453.6488
Fax: 425.453.5848

SE 30TH STREET / SUNSET CREEK
CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER	DATE
PROJECT MANAGER	DATE

D.C. ONG	04/2008
DESIGNED BY	DATE
J. ROBERTS	04/2008
DRAWN BY	DATE
D.C. ONG	04/2008
CHECKED BY	DATE

City of Bellevue
UTILITIES

UTILITIES DETAILS

DRAWING C-4 SHT 8 OF 24

ⓧ ROADWAY CONSTRUCTION NOTES:

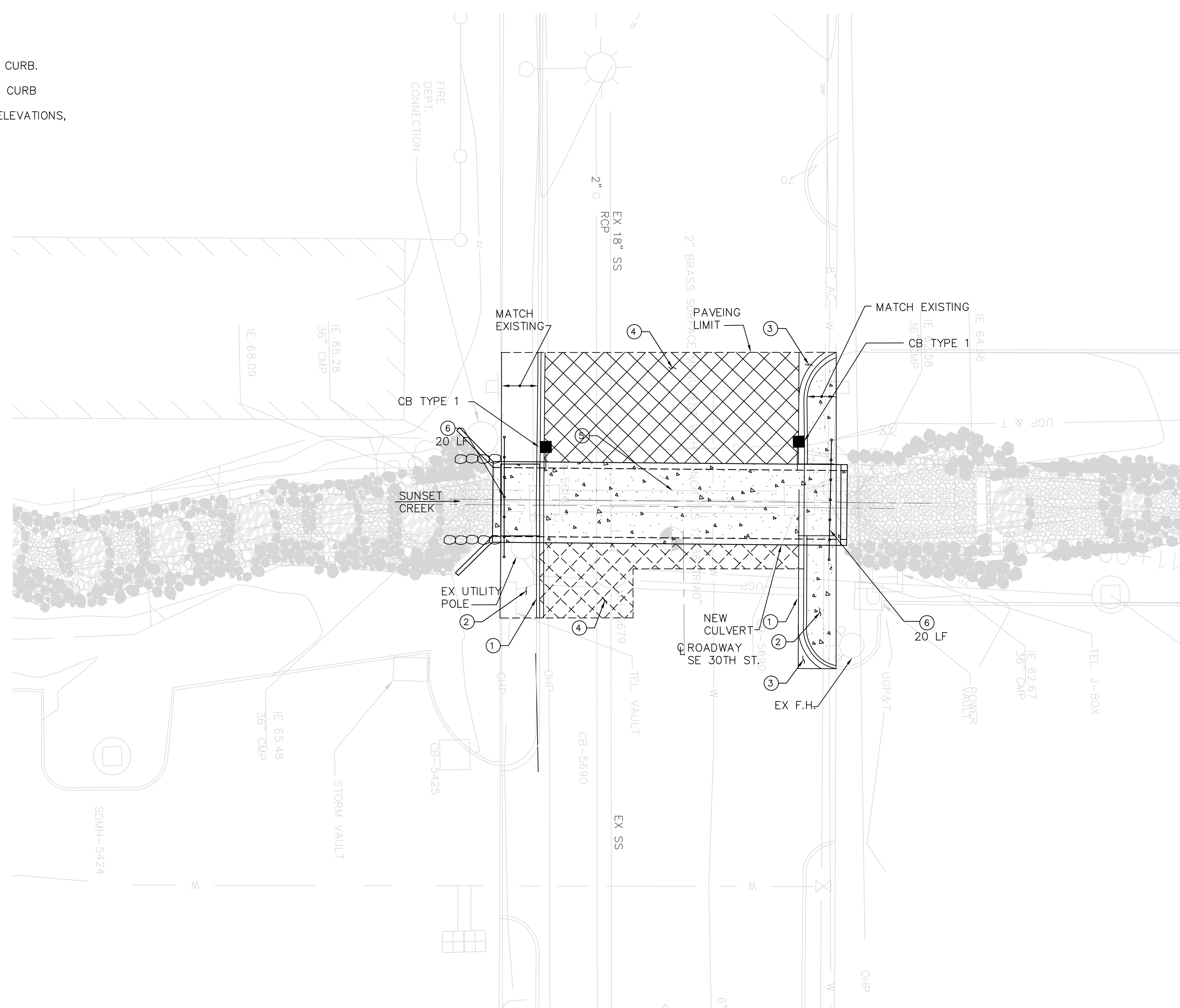
1. CONSTRUCT CEMENT CONCRETE TRAFFIC CURB AND GUTTER PER CITY OF BELLEVUE STANDARD DETAIL TE–10.
2. CONSTRUCT CURBSIDE SIDEWALK PER CITY OF BELLEVUE STANDARD DETAIL TE–11.
3. CONSTRUCT DRIVEWAY APPROACH PER CITY OF BELLEVUE STANDARD DETAIL DEV–5.
4. PAVEMENT THICKNESS WILL BE 4 INCHES OF HOT MIX ASPHALT CLASS 1/2" PG 64–22
5. REPLACE CULVERT, SEE SHEET C–7.
6. INSTALL METAL SAFETY RAILING PER CITY OF BELLEVUE STANDARD DETAIL TE–34.
7. 4" CRUSHED SURFACING TOP COURSE.
8. COMPACT GRAVEL BORROW OR NATIVE SOIL TO 95% DRY DENSITY.
9. 6 INCHES OF COMMERCIAL HOT MIX ASPHALT CLASS 1" PG 64–22

GENERAL NOTES:

1. ROADWAY DIMENSIONS ARE TO FACE OF CURB.
2. SIDEWALK DIMENSIONS ARE TO BACK OF CURB
3. FOR TOP OF CURB RETURN DATA AND ELEVATIONS, MATCH EXISTING

LEGEND

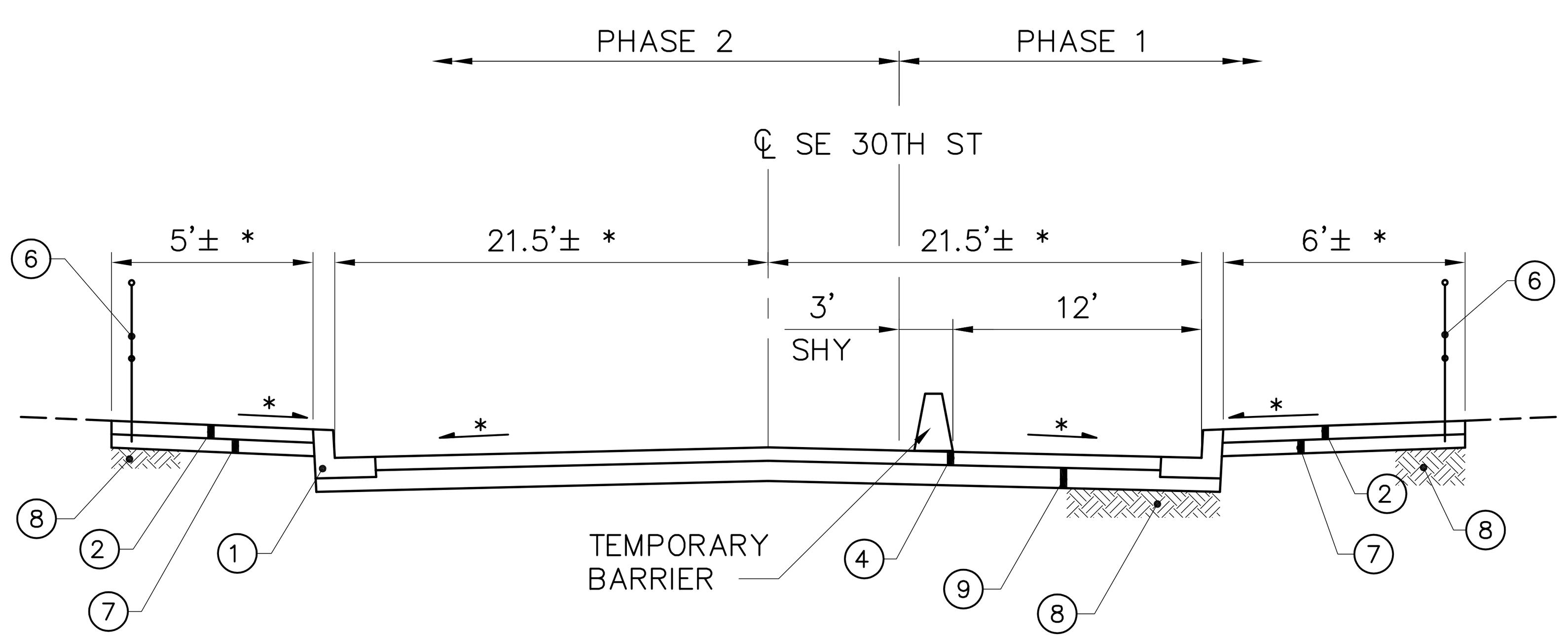
(crosshatch)	FULL DEPTH PAVEMENT
(stipple)	CEMENT CONCRETE



PAVING PLAN

10 5 0 10 20

SCALE IN FEET



TYPICAL ROADWAY SECTION

* VERIFY IN FIELD & MATCH EXISTING CONDITION FOR FIT–UP

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HERRERA ENVIRONMENTAL CONSULTANTS

CIVILTECH ENGINEERING 10800 NE 8th Street Suite 820 Bellevue, WA 98004 Phone: 425.453.6488 Fax: 425.453.5848

SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

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D.C. ONG	04/2008
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J. ROBERTS	04/2008
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D.C. ONG	04/2008
CHECKED BY	DATE

City of Bellevue UTILITIES

DUSTIN CUONG ONG STATE OF WASHINGTON 35684 REGISTERED PROFESSIONAL ENGINEER

EXPIRES

ONE INCH — AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

ROADWAY PLAN AND SECTION

DRAWING C–5 SHT 9 OF 24

Path: P:\Structural\2007\27015 - SE 30 & Sunset Cr (Herrera)\Cad\Drawing\C-5.dwg Cad User: Jeff Roberts Plot Date: 6/10/2008 2:41 PM

BLANK SHEET

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SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

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D.C. ONG	04/2008
CHECKED BY	DATE

CITY OF BELLEVUE WASHINGTON

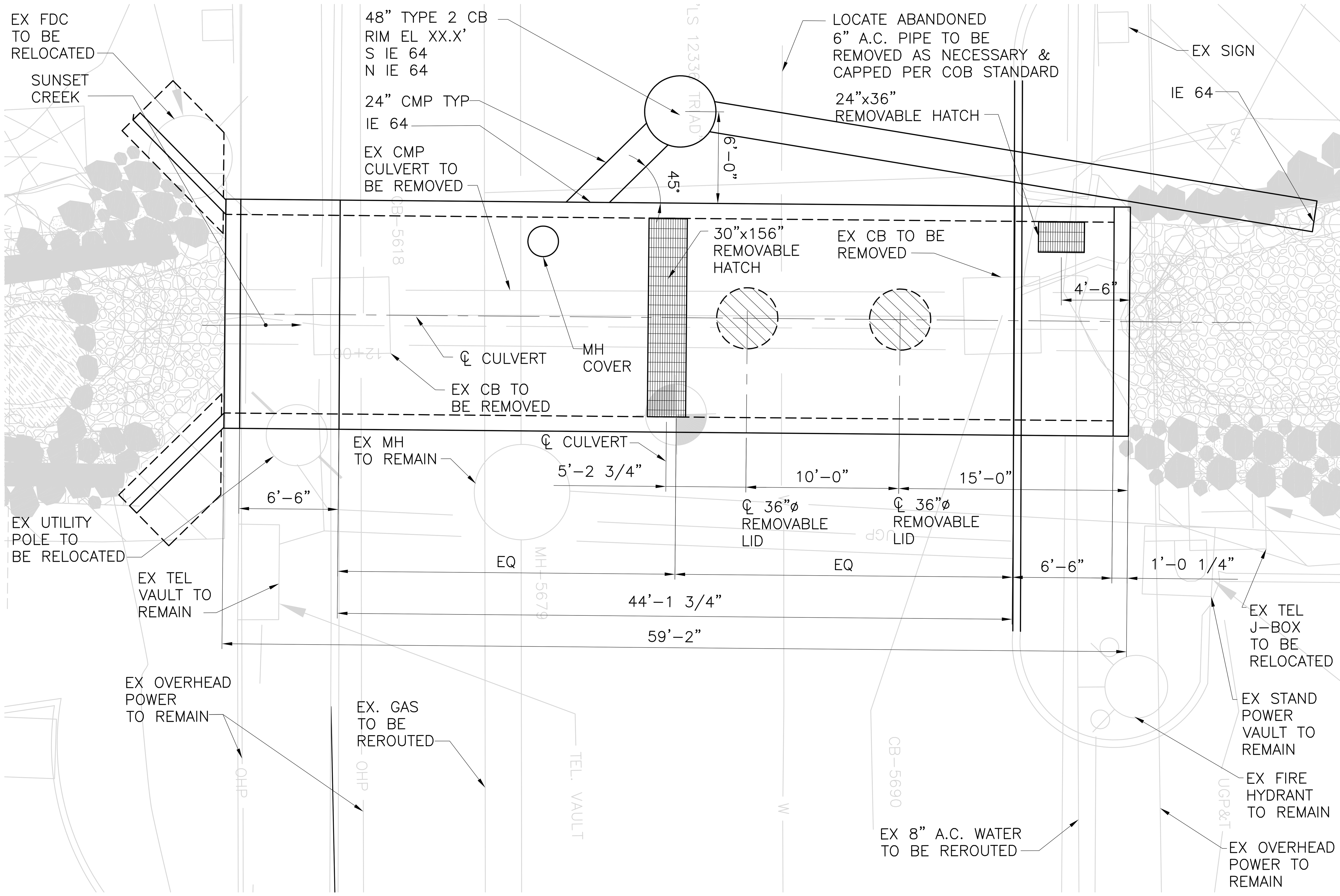
City of Bellevue UTILITIES

ROADWAY SECTION

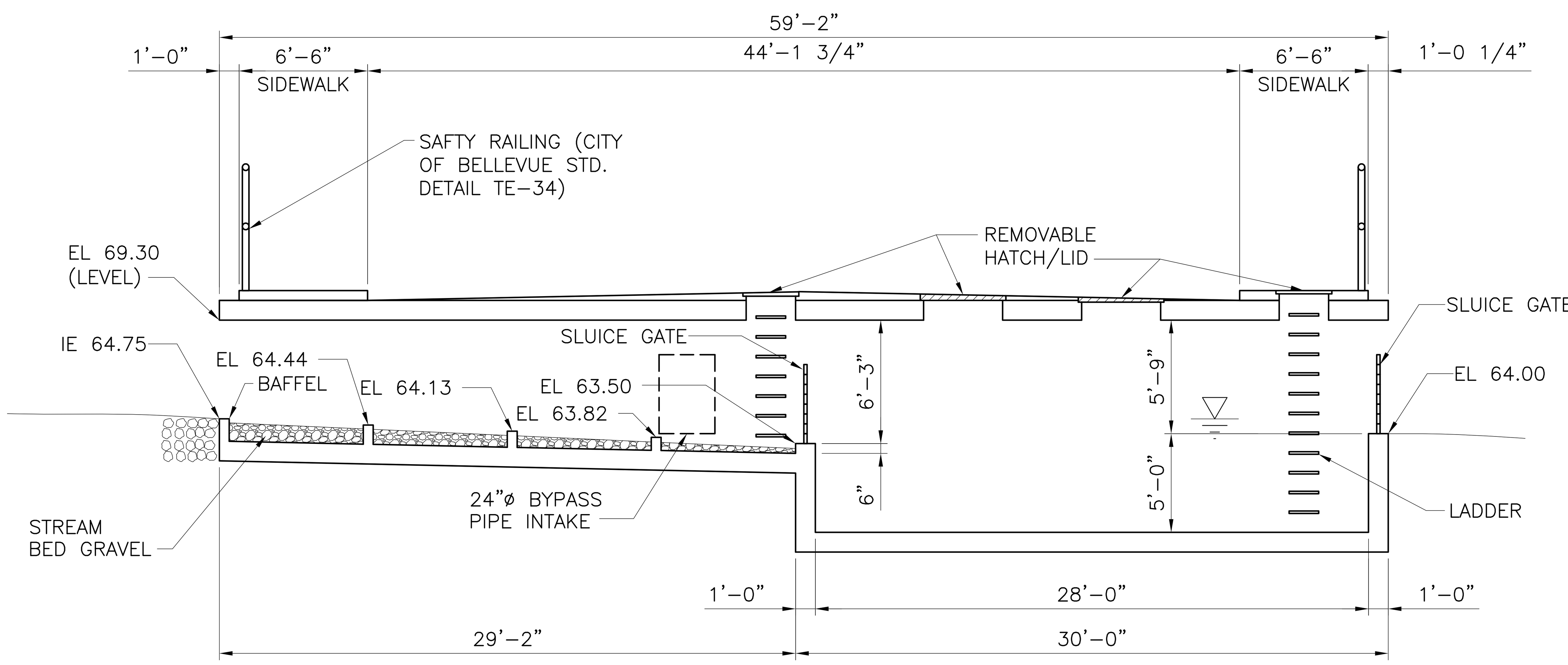
DRAWING C-6

SHT 10 OF 24

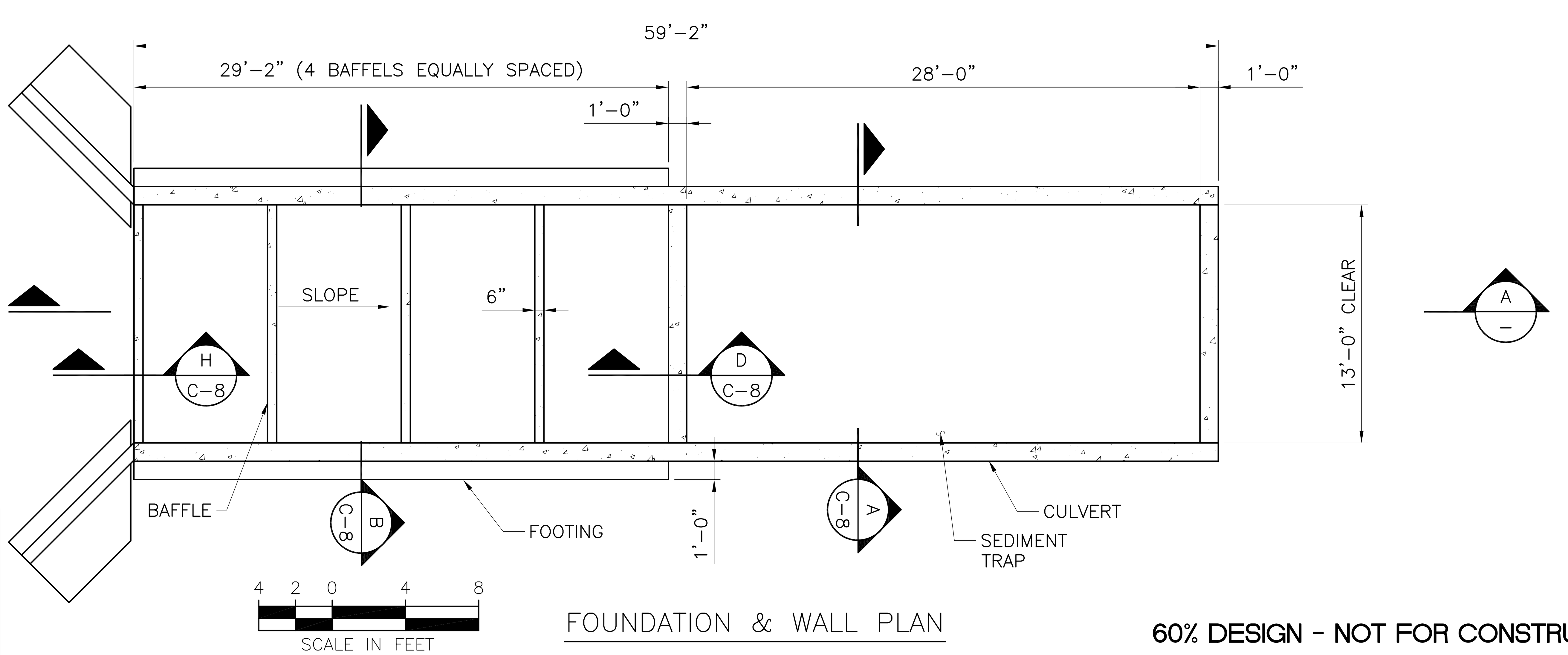
ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY



CULVERT LAYOUT PLAN



PROFILE–SECTION (A / –)
SCALE: 3/8"=1'-0"



FOUNDATION & WALL PLAN

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SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By
DESIGN MANAGER DATE
PROJECT MANAGER DATE

D.C. ONG	04/2008
DESIGNED BY	DATE
J. ROBERTS	04/2008
DRAWN BY	DATE
D.C. ONG	04/2008
CHECKED BY	DATE

City of Bellevue UTILITIES

CULVERT REPLACEMENT PLAN AND NOTES

DRAWING C-7 SHT 11 OF 24

DUNG N. CUONG ONG STATE OF WASHINGTON 35684 REGISTERED PROFESSIONAL ENGINEER
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Path: P:\Structural\2007\27015 - SE 30 & Sunset Cr (Herrera)\Cad\Drawing\C-7.dwg
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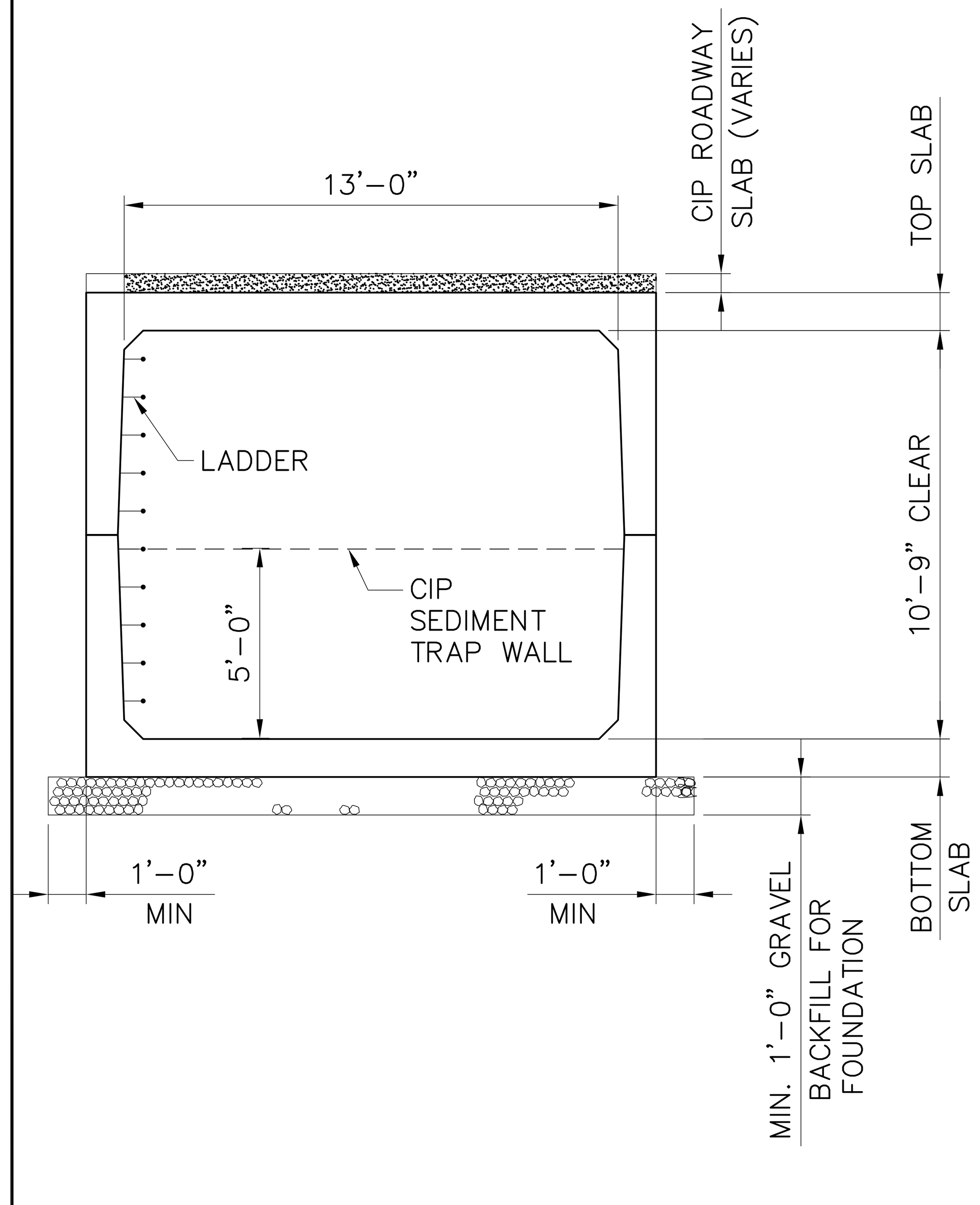
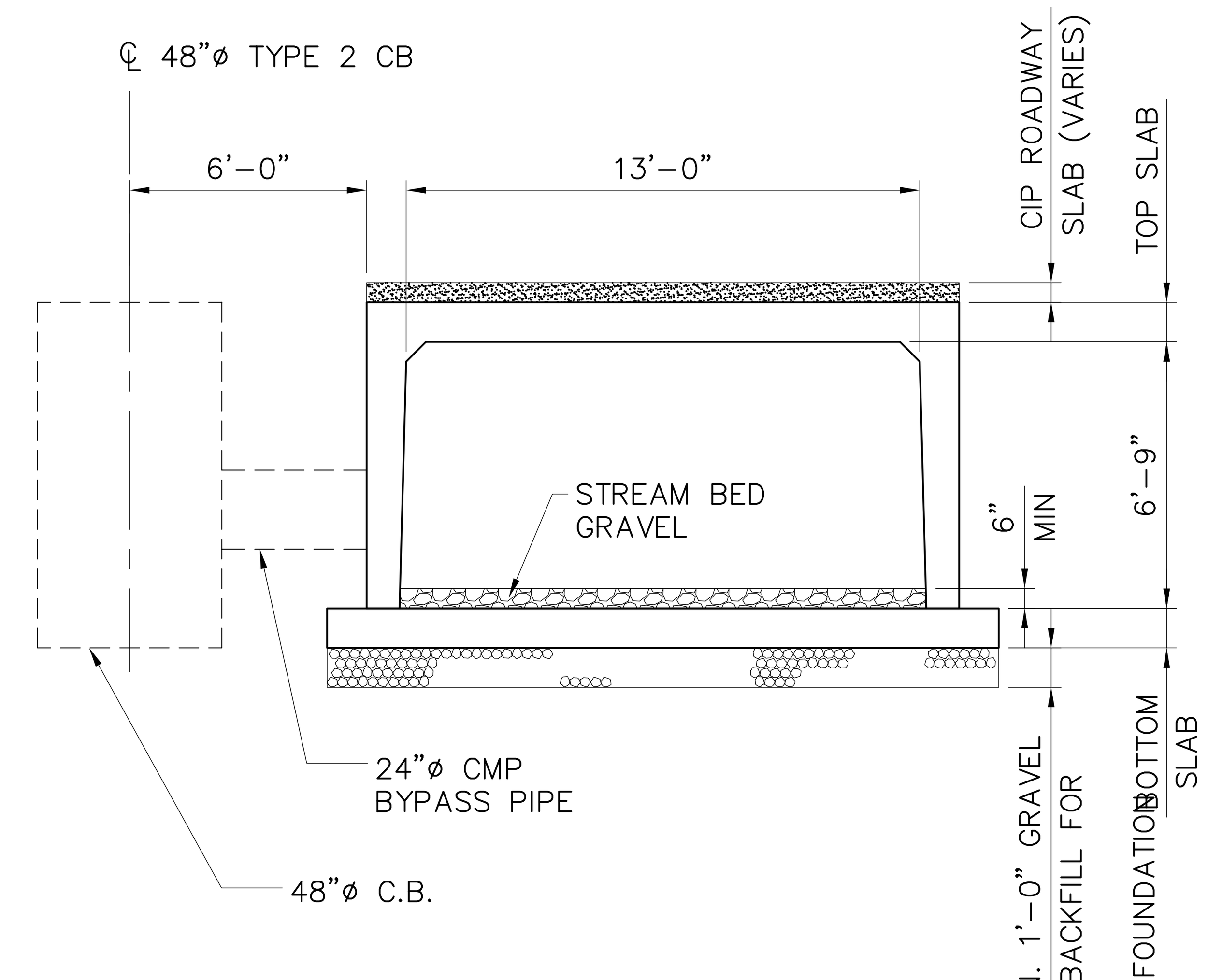
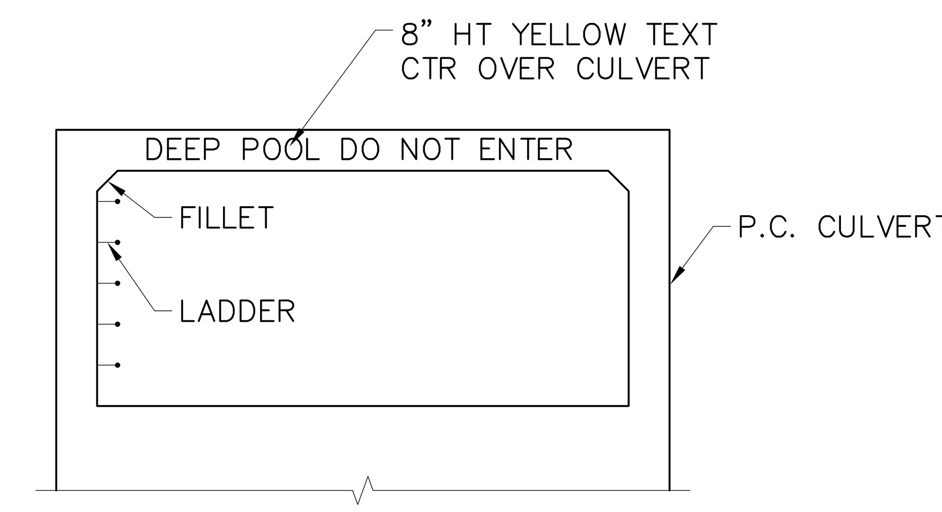
Cad User: Jeff Roberts



SECTION (A / C-7)
SCALE: 1/4"=1'-0"

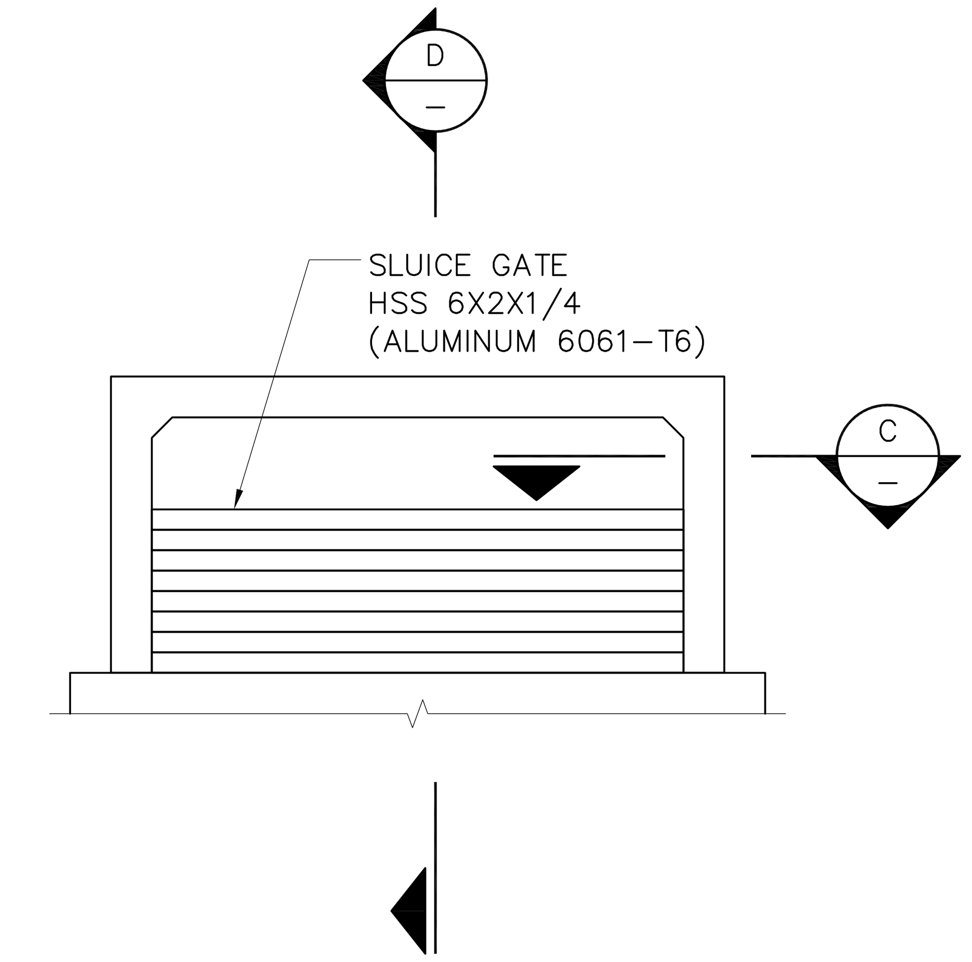


SECTION (B / C-7)
SCALE: 1/4"=1'-0"

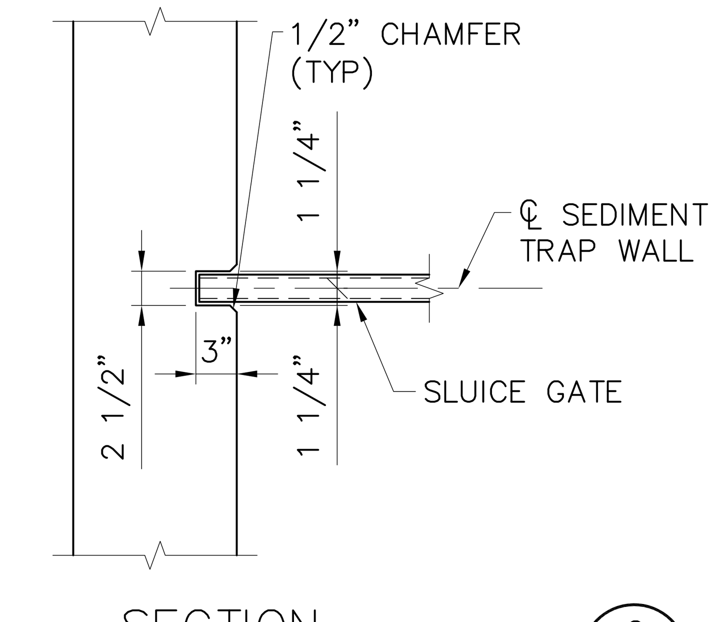


NOTE:
WARNING SIGN AT BOTH ENDS OF CULVERT.

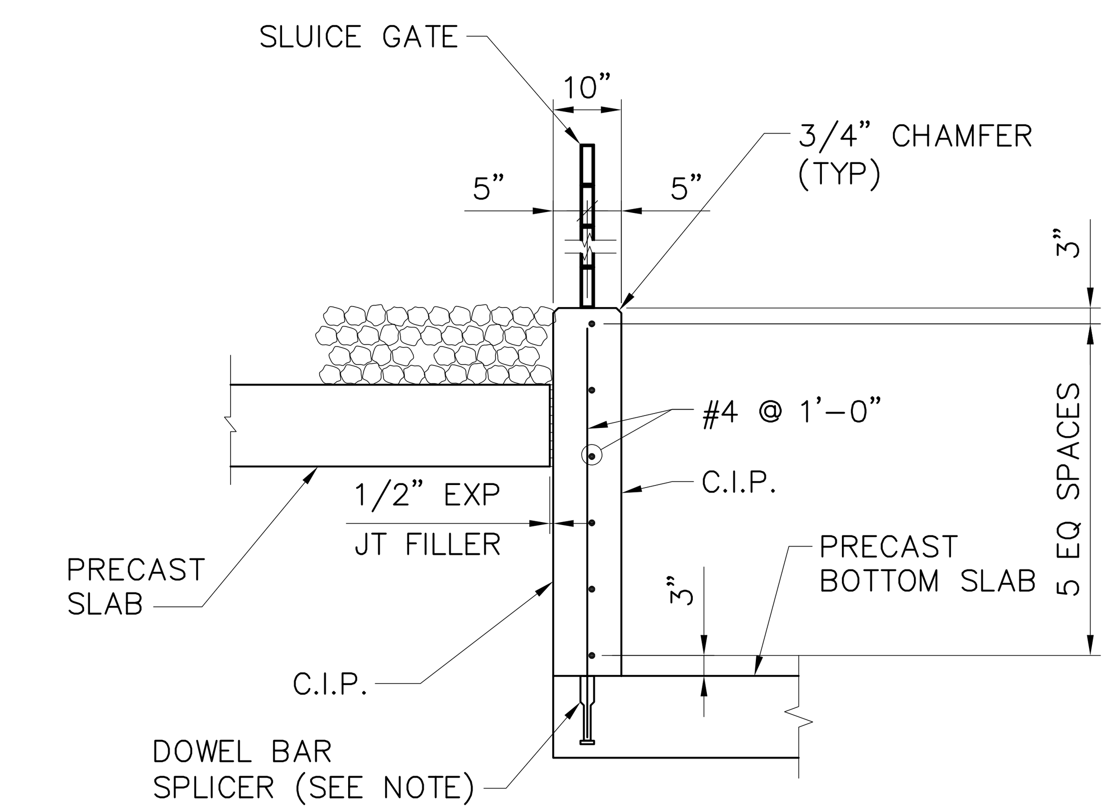
WARNING DETAIL (1 / C-7)
SCALE: 1/4"=1'-0"



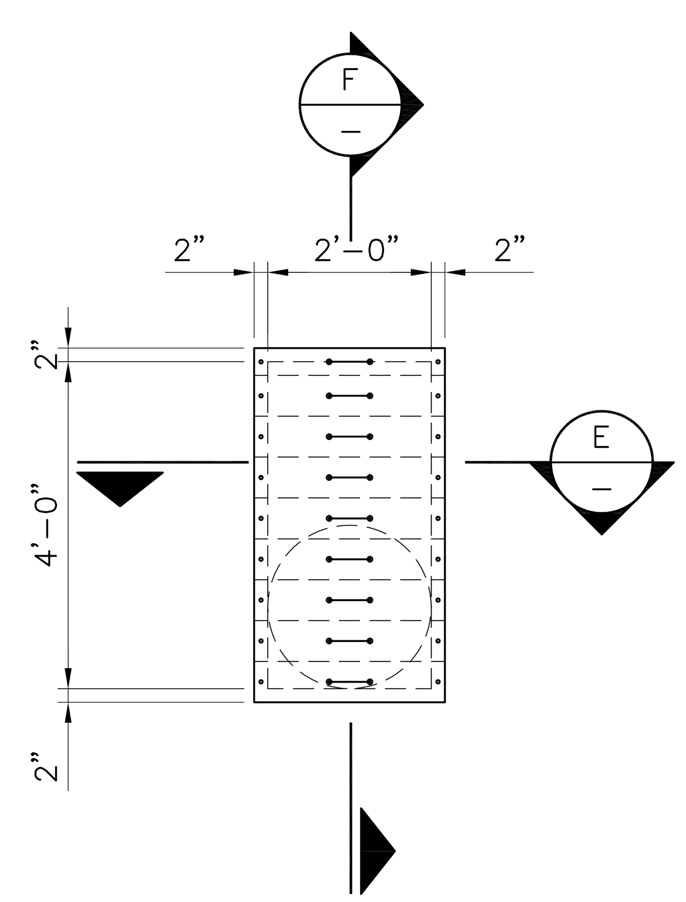
SLUICE GATE ELEVATION (2 / C-7)
SCALE: 1/4"=1'-0"



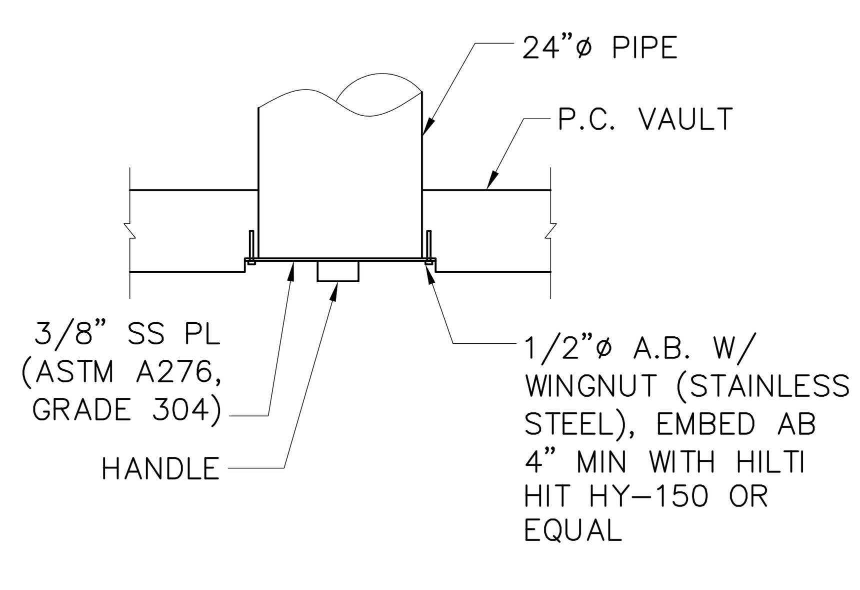
SECTION (C / –)
SCALE: 1/2"=1'-0"



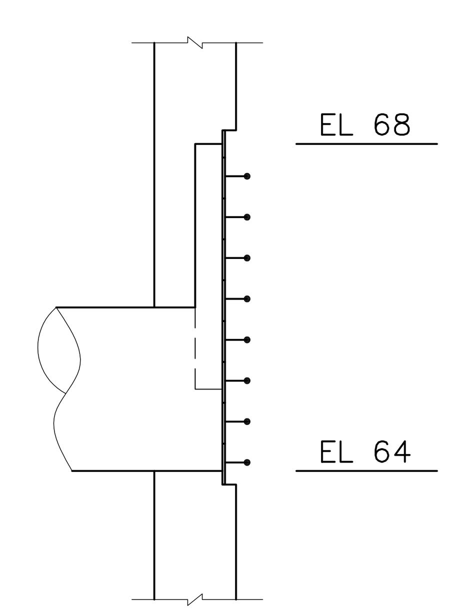
SECTION (D / C-7)
SCALE: 1/2"=1'-0"
(WALL @ BOX OUTLET END-SIMILAR)



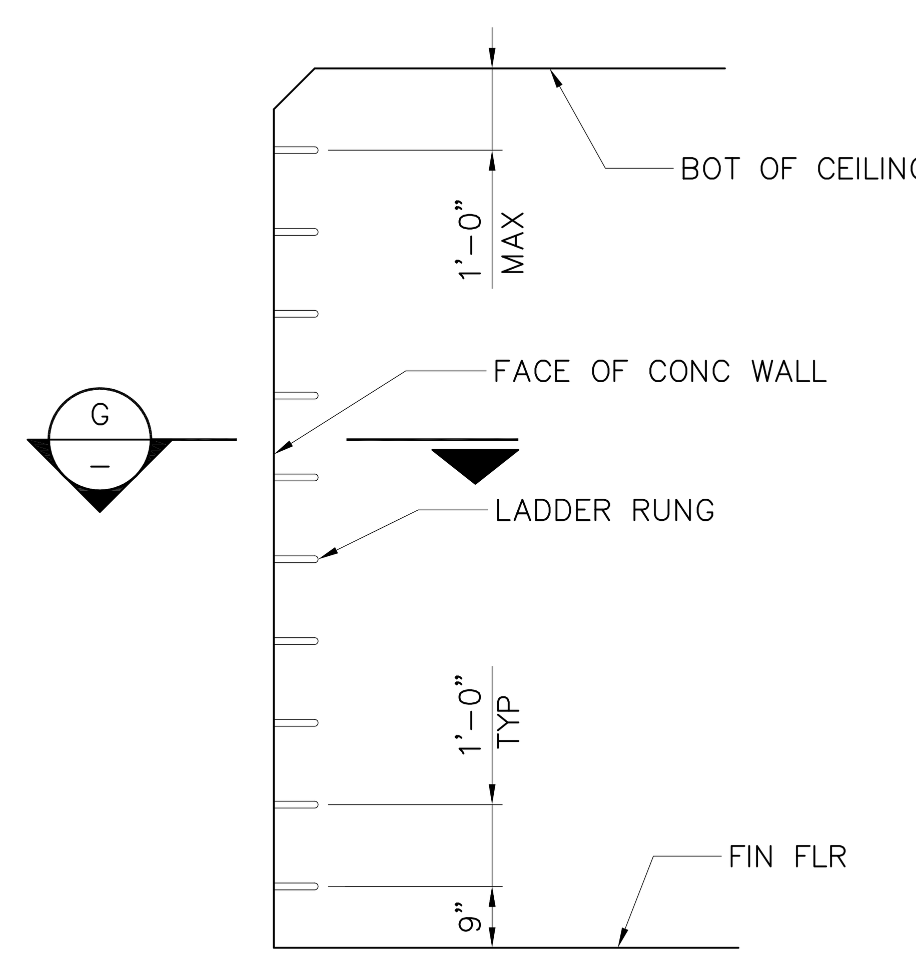
BYPASS INTAKE GATE ELEVATION (3 / –)
SCALE: 1/2"=1'-0"



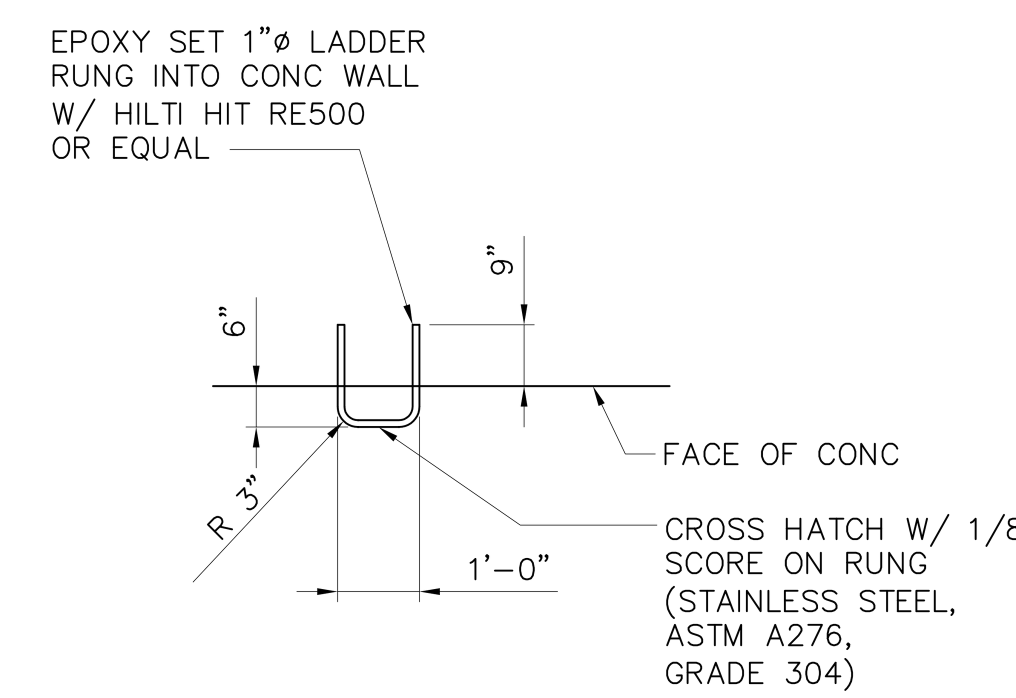
SECTION (E / –)
SCALE: 1/2"=1'-0"



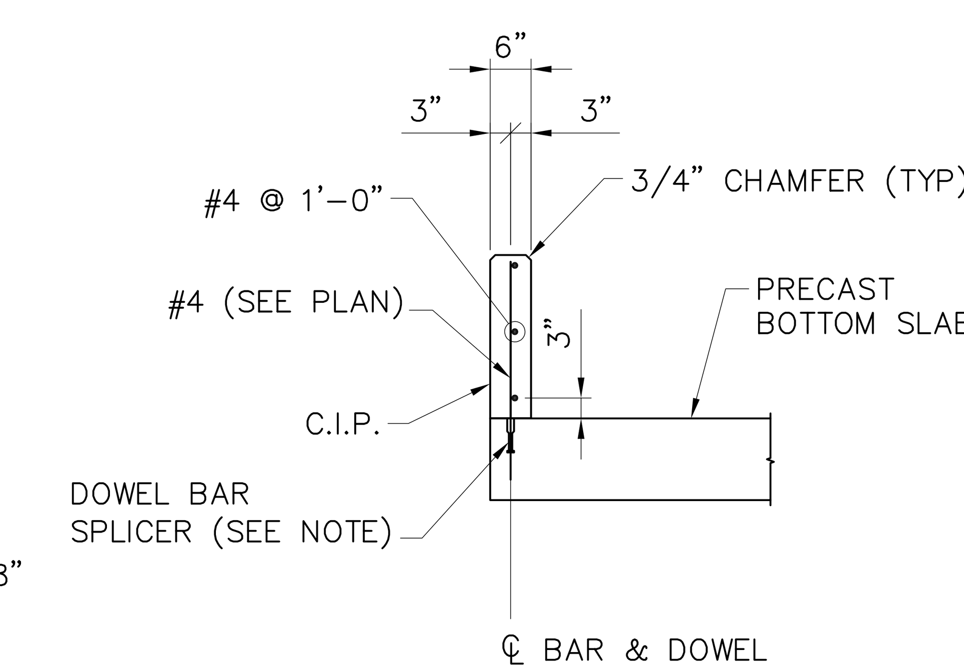
SECTION (F / –)
SCALE: 1/2"=1'-0"



LADDER ELEVATION (4 / –)
SCALE: 1/2"=1'-0"



SECTION (G / –)
SCALE: 1/2"=1'-0"



SECTION (H / C-7)
SCALE: 1/2"=1'-0"
(TYP ALL BAFFLES UNLESS NOTED)

NOTES
1. ALL BARS & DOWEL BAR SPLICERS SHALL BE EPOXY COATED
2. f'c= 4000 PSI (MIN) fy = 60 KSI (ASTM A615)
3. DOWEL BAR SPLICERS SHALL BE DAYTON SUPERIOR D-108-A HEADED OR D-102-A 90° HOOKED OR OTHER EQUIVALENT.

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HERRERA ENVIRONMENTAL CONSULTANTS

CIVILTECH ENGINEERING
10800 NE 8th Street Suite 820
Bellevue, WA 98004
Phone: 425.453.6488
Fax: 425.453.5848

SE 30TH STREET / SUNSET CREEK
CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER — DATE
PROJECT MANAGER — DATE

D.C. ONG	04/2008
DESIGNED BY	DATE
J. ROBERTS	04/2008
DRAWN BY	DATE
D.C. ONG	04/2008
CHECKED BY	DATE

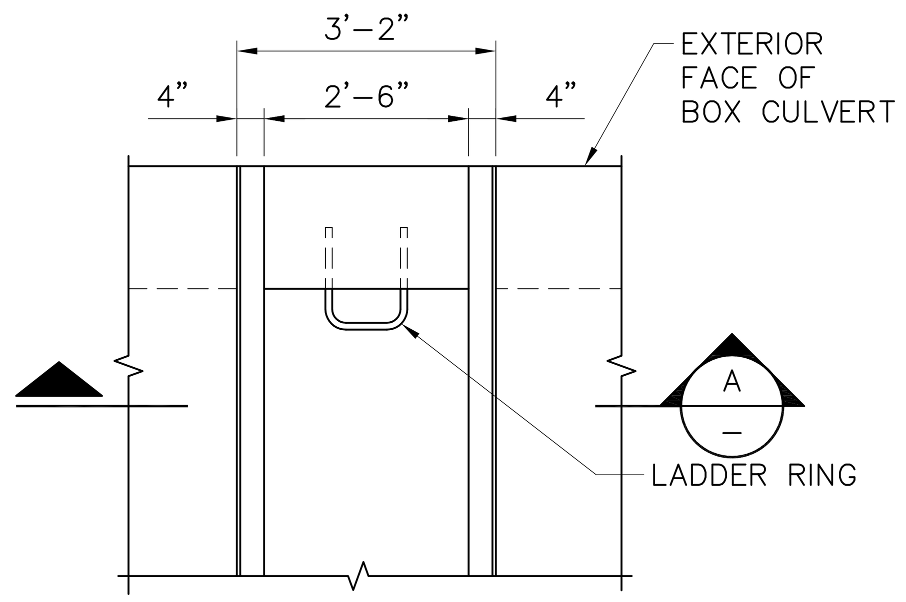
City of Bellevue
UTILITIES

CULVERT REPLACEMENT
PROFILE AND NOTES

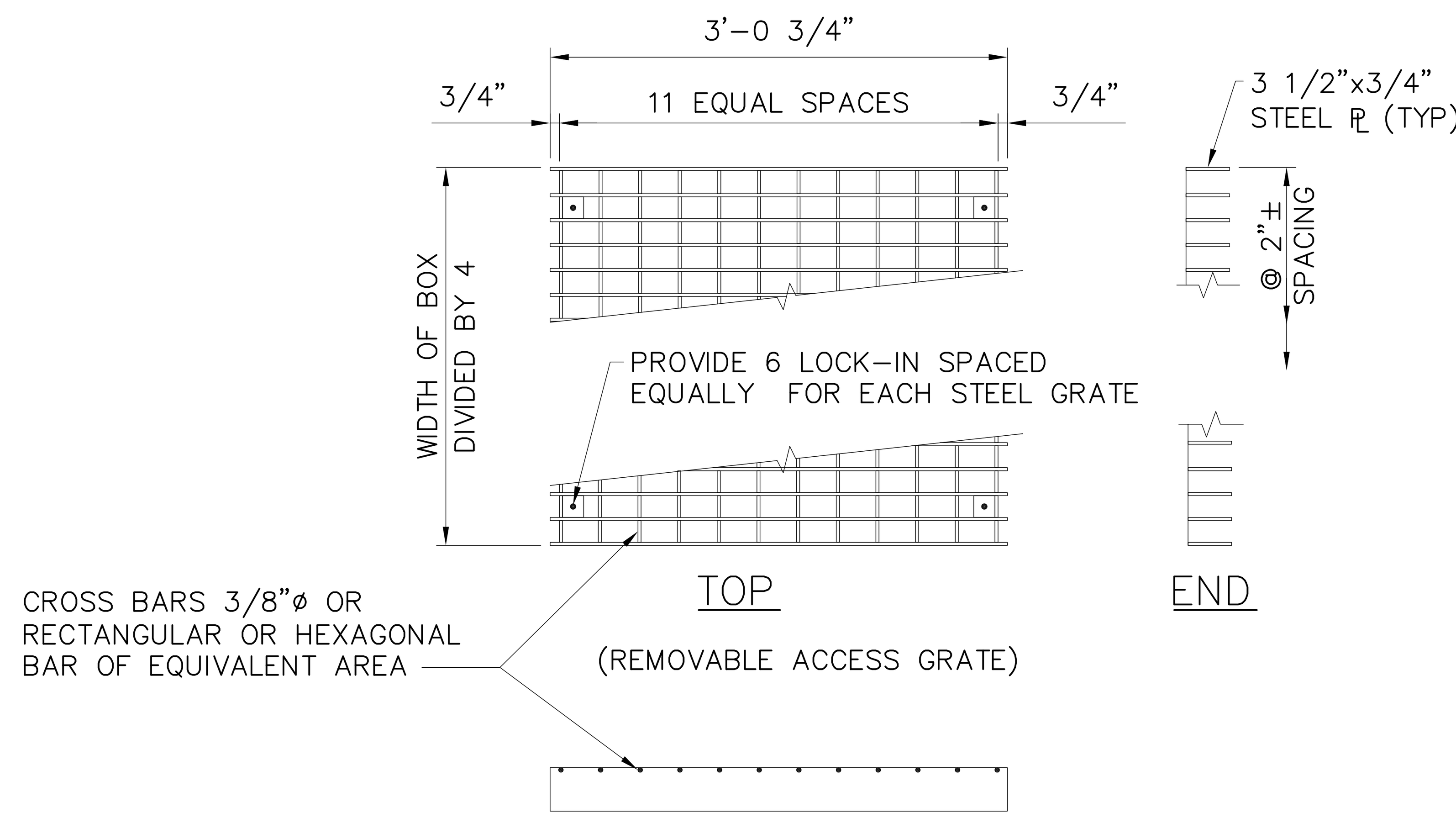
DRAWING C-8 | SHT 12 OF 24

DUSTIN CUONG ONG — STATE OF WASHINGTON — 35684 — REGISTERED PROFESSIONAL ENGINEER — EXPIRES

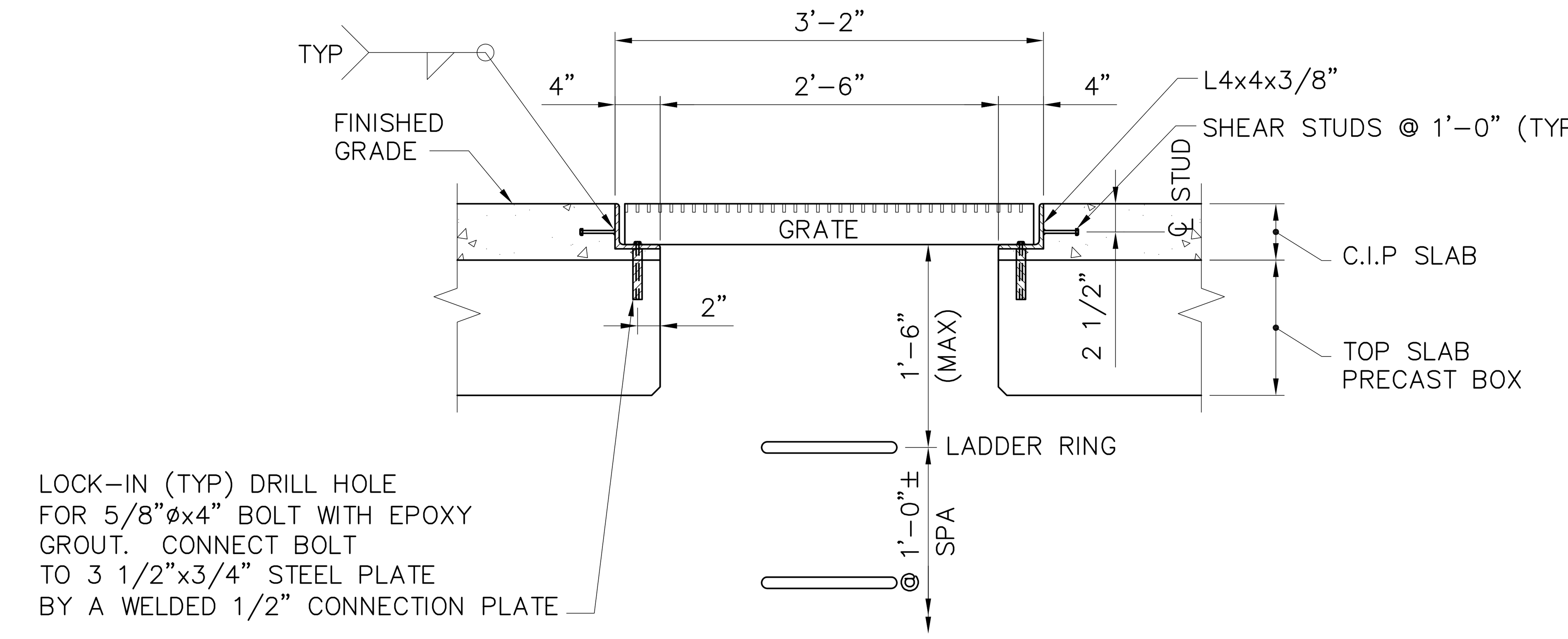
Path: P:\Structural\2007\27015 - SE 30 & Sunset Cr (Herrera)\Cad\Drawing\C-8.dwg
Plot Date: 6/11/2008 10:51 AM
Cad User: Jeff Roberts



PLAN
SCALE: 1/2" = 1'-0"
(30"x WIDTH OF CULVERT REMOVABLE LID)
(STEEL GRATE, LOCK-IN BOLT & SHEAR STUDS NOT SHOWN)



REMOVABLE ACCESS GRATE (1/–)
SCALE: 1"=1'-0"



SECTION (A/–)
SCALE: 1"=1'-0"

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NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS

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Bellevue, WA 98004
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SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By
DESIGN MANAGER — DATE
PROJECT MANAGER — DATE

D.C. ONG	04/2008
DESIGNED BY	DATE
J. ROBERTS	04/2008
DRAWN BY	DATE
D.C. ONG	04/2008
CHECKED BY	DATE

City of Bellevue
UTILITIES

SECTIONS AND DETAILS

DRAWING C-9 SHT 13 OF 24

DUSTIN CUONG ONG — STATE OF WASHINGTON — 35684 — REGISTERED PROFESSIONAL ENGINEER
EXPIRES

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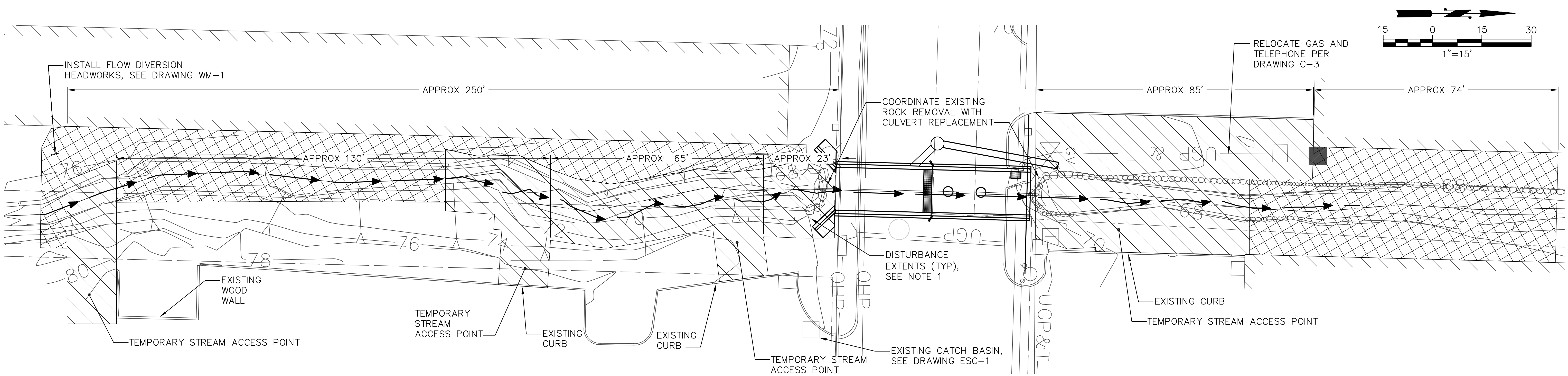
Plot Date: 6/10/2008 2:43 PM Cad User: Jeff Roberts

GENERAL NOTES:

1. CONTRACTOR SHALL FENCE THE PERIMETER OF THE CONSTRUCTION ZONE WITH A MINIMUM OF 6' TALL CHAINLINK FENCING PRIOR TO COMMENCEMENT OF ANY CONSTRUCTION ACTIVITIES.
2. PRIOR TO ANY CLEARING OR GRUBBING THE CONTRACTOR SHALL INSTALL TREE PROTECTION FOR ALL TREES DESIGNATED/FLAGGED BY THE CITY OF BELLEVUE TO REMAIN. TREE PROTECTION SHALL CONSIST OF ¾" 4'X'4 PLYWOOD BOXES CENTERED ON THE TRUNK OF THE TREE OR APPROVED EQUAL.
3. EXISTING PARKING LOT CURBS AND PAVEMENT USED FOR ACCESS SHALL BE PROTECTED FROM DAMAGE BY THE CONTRACTOR. DAMAGE INCURRED DURING CONSTRUCTION TO ADJACENT PROPERTY SHALL BE THE SOLE RESPONSIBILITY OF THE CONTRACTOR.



STREAM CORRIDOR SITE PREPARATION PLAN 1/C-1

SCALE: NOTED

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase I\C-10.dwg
Plot Date: 6/11/2008 11:37 AM Cad User: Wojciech Wieszczecinski

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HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
Suite 1100
Seattle, Washington
98121-1820
206-441-9080
206-441-9108 FAX
http://www.herreralnc.com

SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER DATE

PROJECT MANAGER DATE

C. BARTON	05/2008
DESIGNED BY	DATE
W. WIESZCZECINSKI	06/2008
DRAWN BY	DATE
M. EWBANK	06/2008
CHECKED BY	DATE

City of Bellevue
UTILITIES

MARK EWBANK, STATE OF WASHINGTON, 29434, CIVIL ENGINEER, PROFESSIONAL ENGINEER

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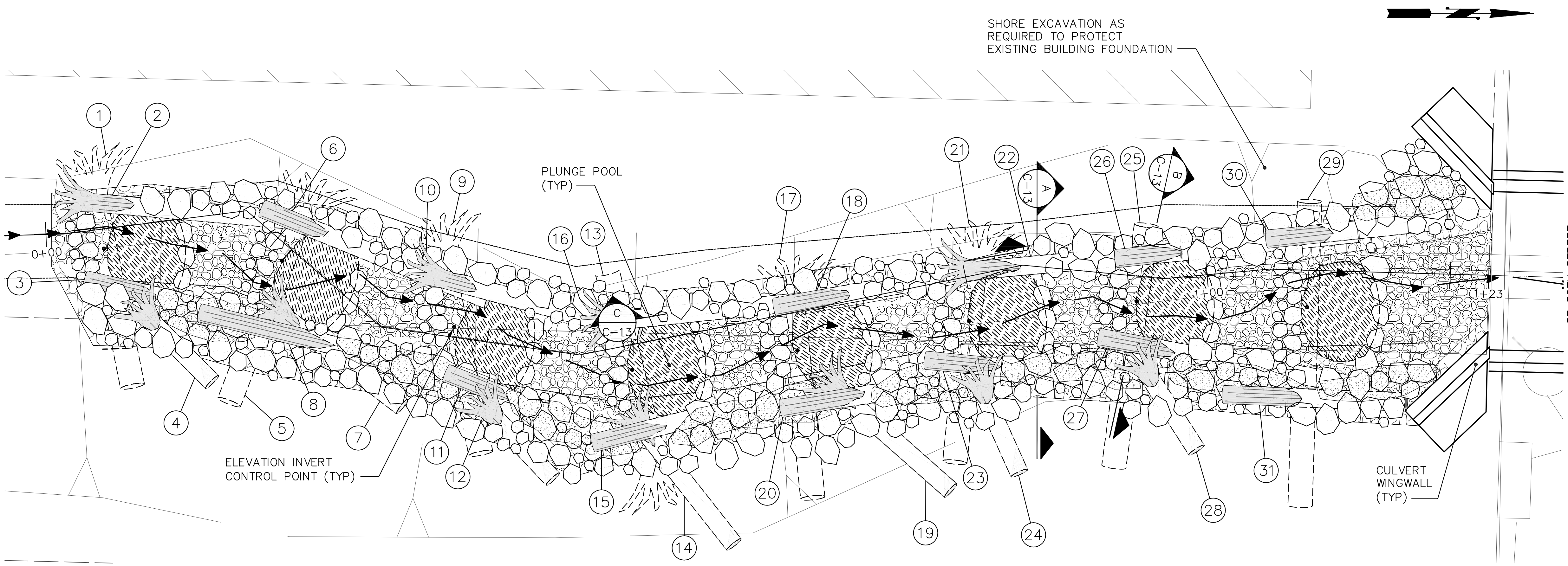
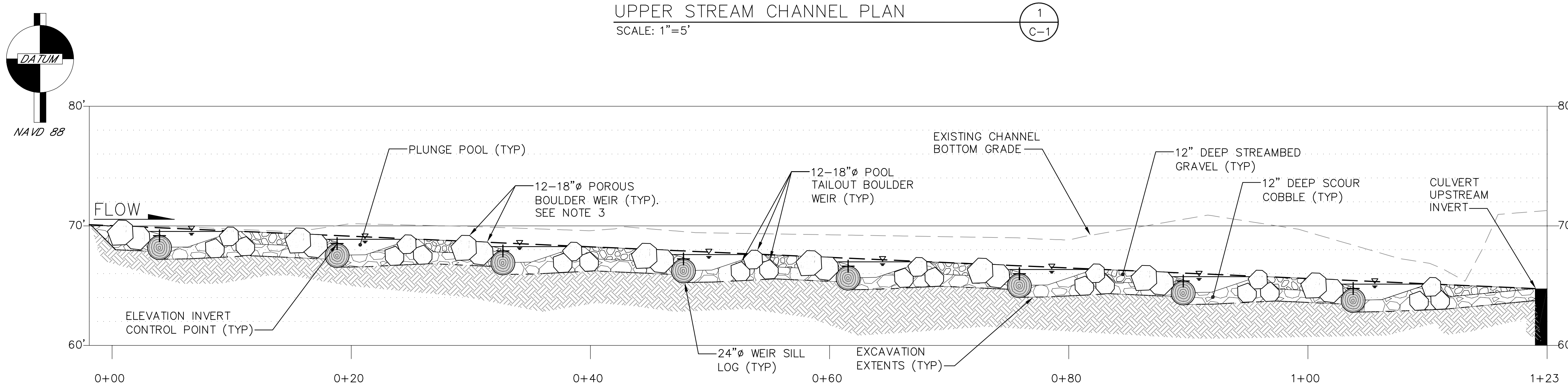
STREAM CORRIDOR SITE PREPARATION PLAN

DRAWING C-10 SHT 14 OF 23



UPPER STREAM CHANNEL PLAN (1 / C-1)

SCALE: 1"=5'



UPPER STREAM CHANNEL PROFILE (A / –)

SCALE: 1"=5'

GENERAL NOTES:

1. FILL ALL VOIDS DURING BACKFILLING AND CONSOLIDATE FILL USING WYCO 992A–FI–10 10 CONCRETE VIBRATOR OR APPROVED EQUAL.
2. LOG IDENTIFICATION NUMBERS REFLECT POTENTIAL CONSTRUCTION SEQUENCING AND LOG PLACEMENT SEQUENCING. SEE DRAWING C–13 FOR LOG SCHEDULE.
3. CONTACT POINTS BETWEEN BOULDERS SHALL BE MAINTAINED 4" ABOVE PLUNGE POOL WATER SURFACE.

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

MARK EWBANK
STATE OF WASHINGTON
29434
CIVIL ENGINEER
PROFESSIONAL ENGINEER

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NO	DATE	BY	APPR	REVISIONS

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98121-1820
206-441-9080
206-441-9108 FAX
http://www.herrerainc.com

SE 30TH STREET / SUNSET CREEK
CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER DATE
PROJECT MANAGER DATE

C. BARTON	05/2008
DESIGNED BY	DATE
W. WIESZCZECINSKI	06/2008
DRAWN BY	DATE
M. EWBANK	06/2008
CHECKED BY	DATE

CITY OF BELLEVUE WASHINGTON
City of Bellevue
UTILITIES

UPPER STREAM CHANNEL
MODIFICATIONS PLAN AND PROFILE

DRAWING C-11 SHT 15 OF 23

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase I\C-11.dwg Cad User: Wojciech Wieszczecinski
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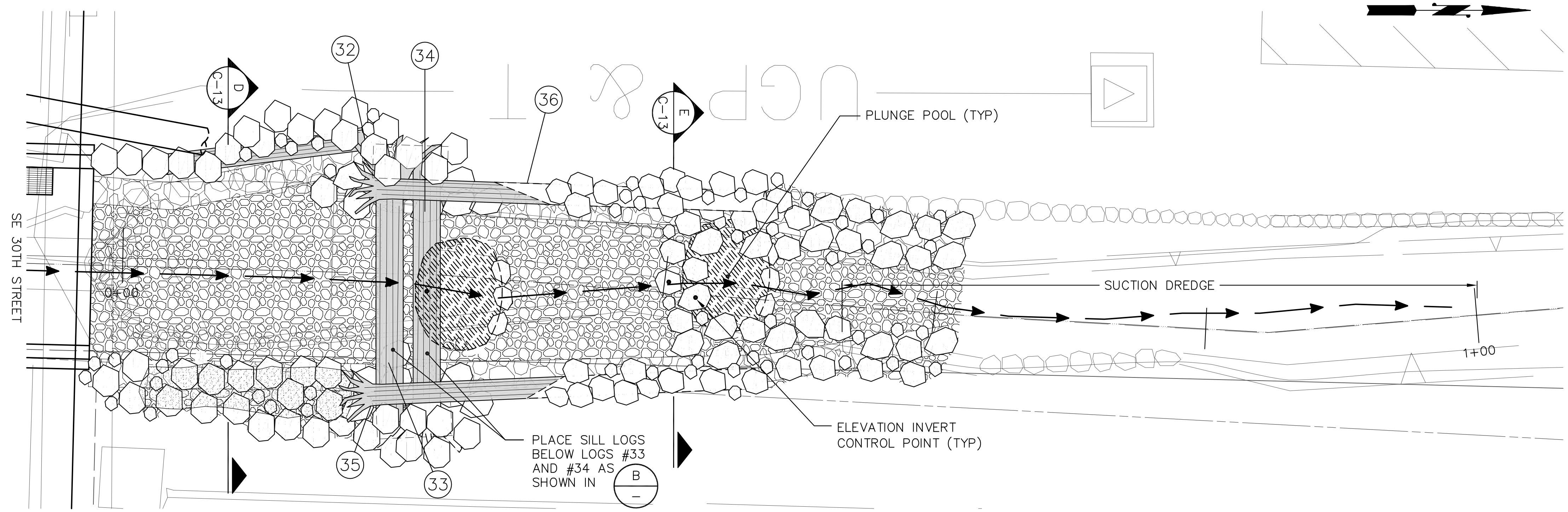
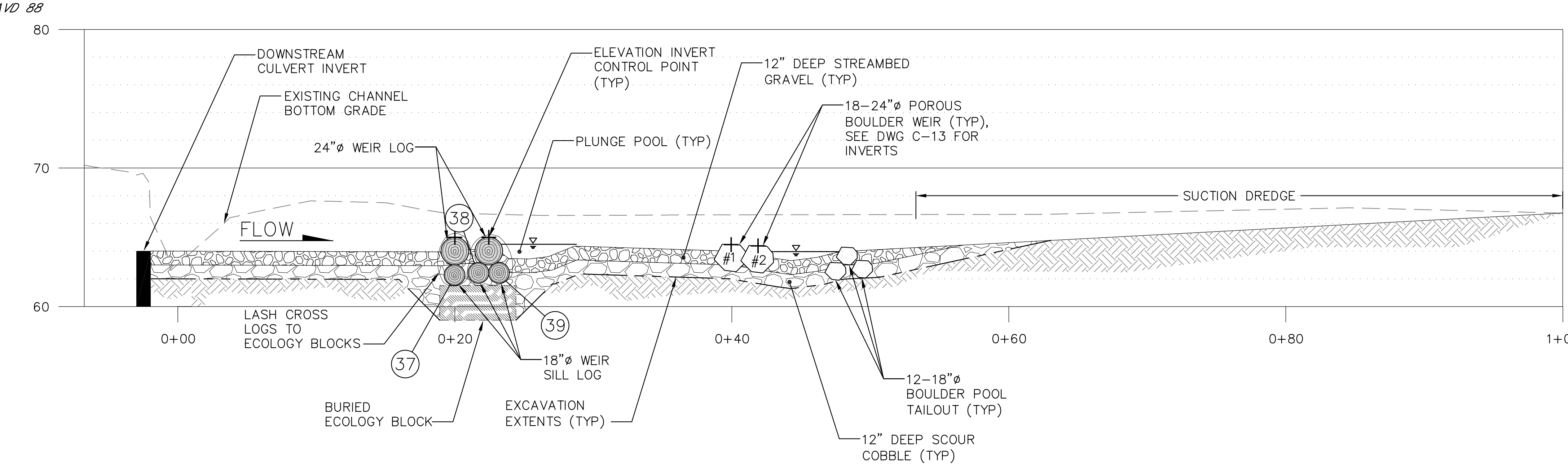


LOWER STREAM CHANNEL PLAN 1 C-1

SCALE: 1"=5'

DATUM
NAVD 88



LOWER STREAM CHANNEL PROFILE B –

SCALE: 1"=5'

GENERAL NOTES:

1. FILL ALL VOIDS DURING BACKFILLING AND CONSOLIDATE FILL USING WYCO 992A-FI-10 10 CONCRETE VIBRATOR OR APPROVED EQUAL.
2. LOG IDENTIFICATION NUMBERS REFLECT POTENTIAL CONSTRUCTION SEQUENCING AND LOG PLACEMENT SEQUENCING. SEE DRAWING C-13 FOR LOG SCHEDULE.

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City of Bellevue UTILITIES

LOWER STREAM CHANNEL MODIFICATIONS PLAN AND PROFILE

DRAWING C-12 SHT 16 OF 23

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase I\C-12.dwg
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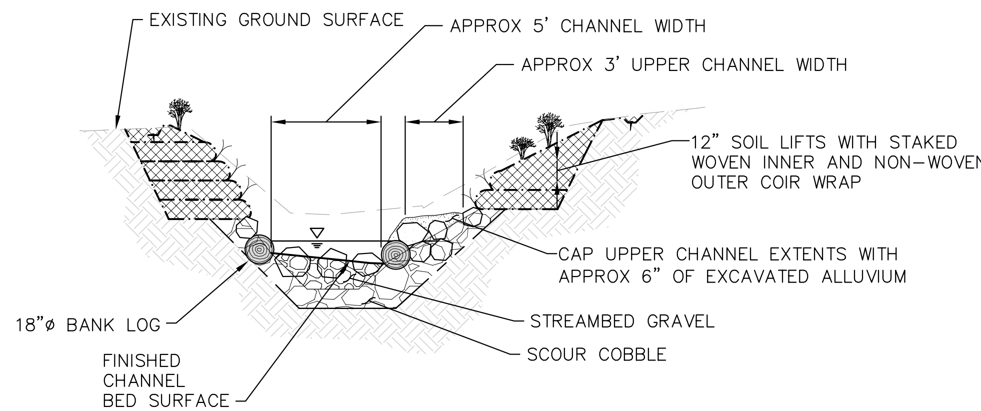
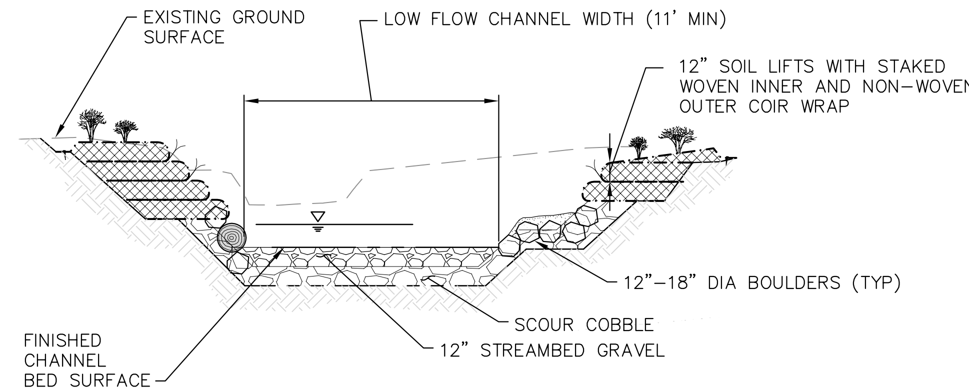
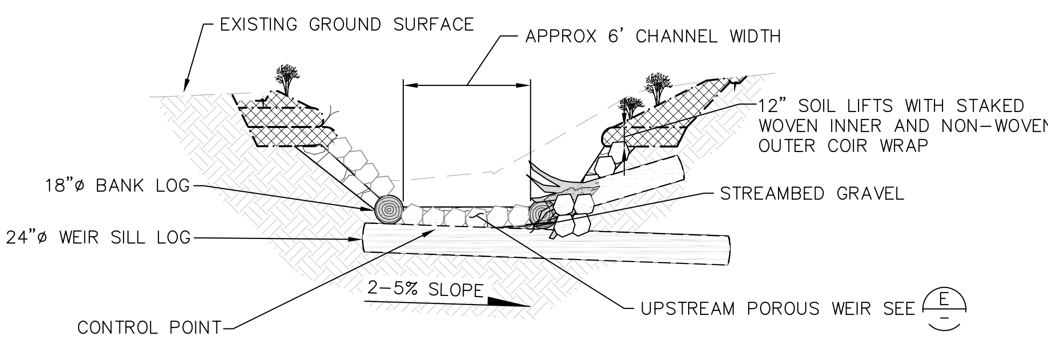


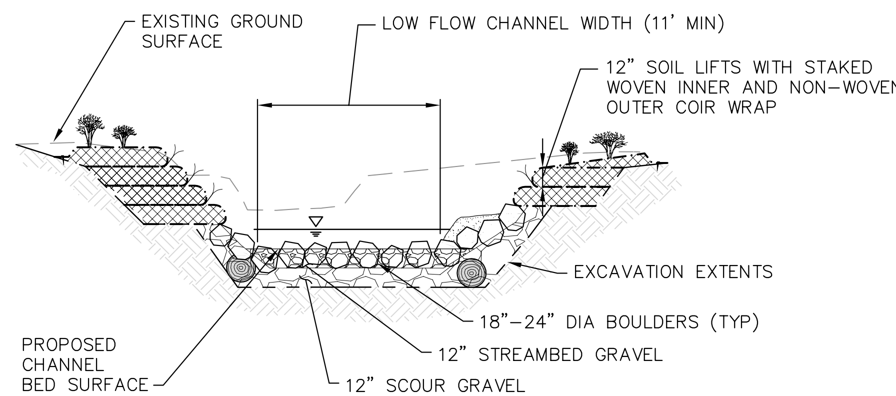
SECTION–TYPICAL UPSTREAM CHANNEL (A / C-11)
SCALE: 1"=5'



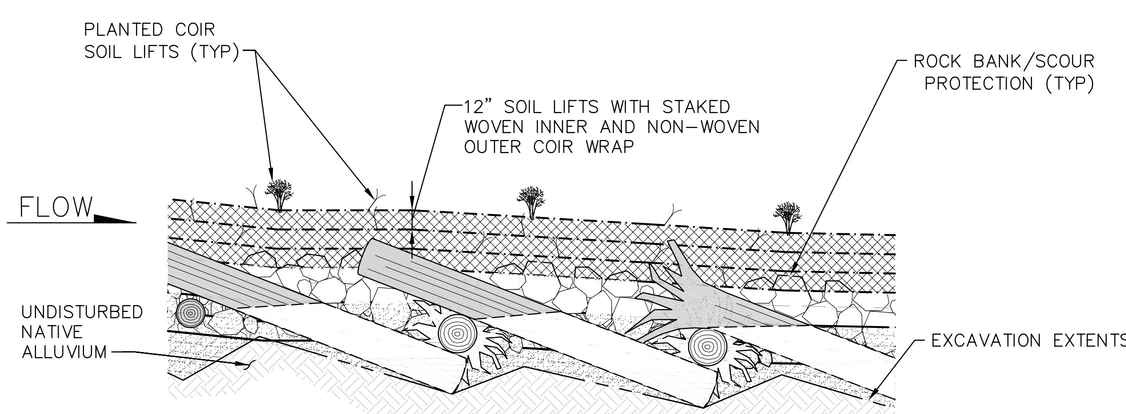
SECTION–TYPICAL DOWNSTREAM CHANNEL (D / C-12)
SCALE: 1"=5'



SECTION–TYPICAL UPSTREAM LOG GRADE CONTROL (B / C-11)
SCALE: 1"=5'



SECTION–TYPICAL DOWNSTREAM CHANNEL AT BOULDER WEIR (E / C-12)
SCALE: 1"=5'



SECTION–TYPICAL UPSTREAM CHANNEL BANK (C / C-11)
SCALE: 1"=5'

TABLE – DOWNSTREAM LOG SCHEDULE:

LOG #	DIA. (IN)	LENGTH (FT)	ROOTWAD	INVERT ELEVATION	APPROX STATION
32	18–22	15	NO	–	
33	24	22	YES	65.0	0+20
34	24	22	YES	65.0	0+22
35	18–22	30	YES	–	
36	18–22	30	YES	–	
37	18–22	22	NO	–	0+19
38	18–22	22	NO	–	0+21
39	18–22	22	NO	–	0+23

TABLE – UPSTREAM LOG SCHEDULE:

LOG #	DIA. (IN)	LENGTH (FT)	ROOTWAD	INVERT ELEVATION	APPROX STATION	DOWN SLOPE DIRECTION
1	24	20	YES	69.2	0+04	EAST
2	18–22	25	YES	–		
3	18–22	20	NO	–		
4	18–22	10	YES	–		
5	24	20	YES	68.5	0+21	WEST
6	18–22	15	NO	–		
7	18–22	18	YES	–		
8	18–22	25	NO	–		
9	24	20	YES	67.9	0+37	EAST
10	18–22	20	YES	–		
11	18–22	20	NO	–		
12	18–22	10	YES	–		
13	24	20	YES	67.2	0+52	WEST
14	18–22	15	YES	–		
15	18–22	20	NO	–		
16	18–22	20	YES	–		
17	24	20	YES	66.6	1+01	EAST
18	18–22	20	NO	–		
19	18–22	18	NO	–		
20	18–22	20	NO	–		
21	24	20	NO	66.0	1+15	WEST
22	18–22	18	NO	–		
23	18–22	20	NO	–		
24	18–22	20	NO	–		
25	24	20	NO	65.4	1+30	EAST
26	18–22	20	NO	–		
27	18–22	20	NO	–		
28	18–22	10	YES	–		
29	24	25	NO	64.8	1+44	WEST
30	18–22	15	NO	–		
31	18–22	15	NO	–		

TABLE – DOWNSTREAM BOULDER INVERTS:

BOULDER #	INVERT ELEVATION	APPROX STATION
#1	64.47	0+40
#2	64.38	0+42

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W. WIESZCZECINSKI 06/2008 DRAWN BY DATE
M. EWBANK 06/2008 CHECKED BY DATE

City of Bellevue UTILITIES

MARK EWBANK STATE OF WASHINGTON 29434 CIVIL ENGINEER PROFESSIONAL ENGINEER

ONE INCH — AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

STREAM CHANNEL MODIFICATIONS DETAILS
DRAWING C-13
SHT 17 OF 23

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase I\C-13.dwg Cad User: Wojciech Wieszczecinski
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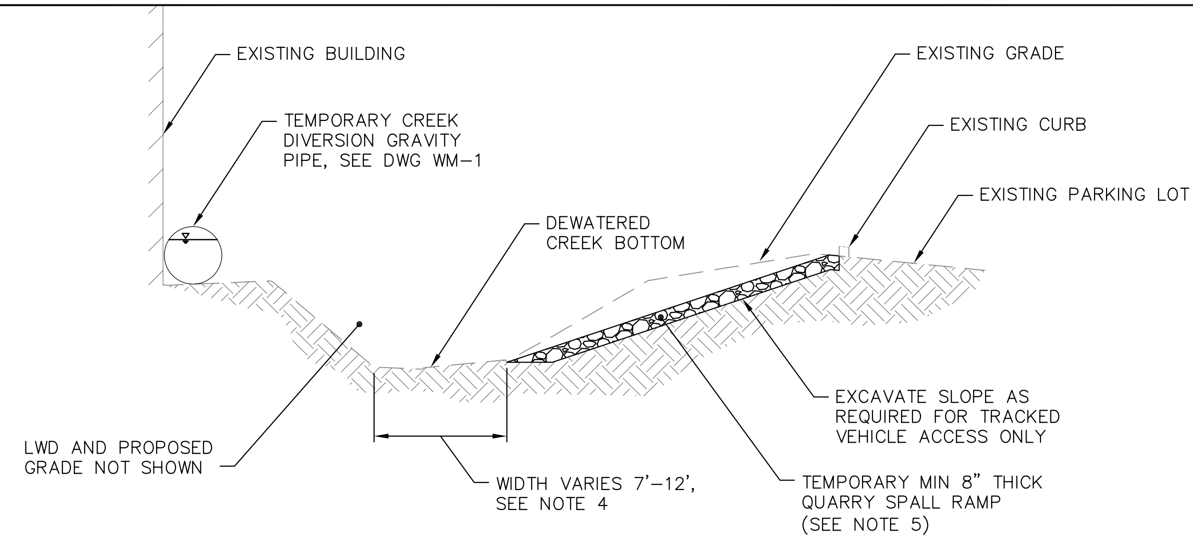
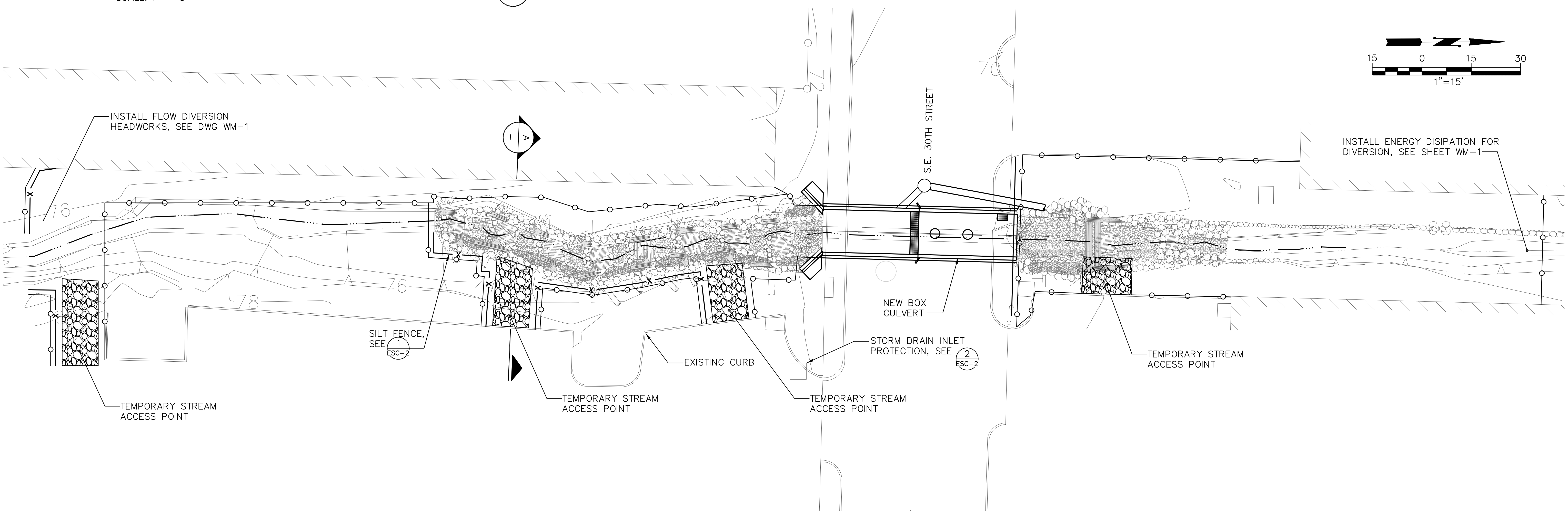


TEMPORARY STREAM ACCESS SECTION (TYP.) A –

SCALE: 1" = 5'

GENERAL NOTES:

1. NO MECHANIZED EQUIPMENT SHALL BE STORED WITHIN 100' OF CREEK.
2. HIGH VISIBILITY FENCE AND SILT FENCE SHALL BE INSTALLED PRIOR TO COMMENCING CLEARING AND GRUBBING. A MINIMUM OF 2 DAYS NOTICE WILL BE GIVEN TO THE ENGINEER TO ALLOW FOR APPROVAL OF CLEARING LIMITS PRIOR TO ANY CLEARING OR GRUBBING ACTIVITIES.
3. CONTRACTOR SHALL MAINTAIN SAFE ACCESS TO PARKING LOT FOR PRIVATE PROPERTY OWNERS DURING CONSTRUCTION.
4. TEMPORARY ACCESS FOR TRACKED EQUIPMENT ON CHANNEL ALIGNMENT MAY REQUIRE TEMPORARY GRADING OF CHANNEL BOTTOM.
5. QUARRY SPALLS FOR TEMPORARY STREAM ACCESS SHALL BE REMOVED WHEN NO LONGER NEEDED.



TESC PLAN 1 C-1

SCALE: NOTED

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M. EWBANK	06/2008
CHECKED BY	DATE

City of Bellevue UTILITIES

TEMPORARY EROSION AND SEDIMENT CONTROL PLAN

DRAWING ESC-1 SHT 18 OF 23

MARK EWBANK STATE OF WASHINGTON 29434 PROFESSIONAL ENGINEER CIVIL ENGINEER

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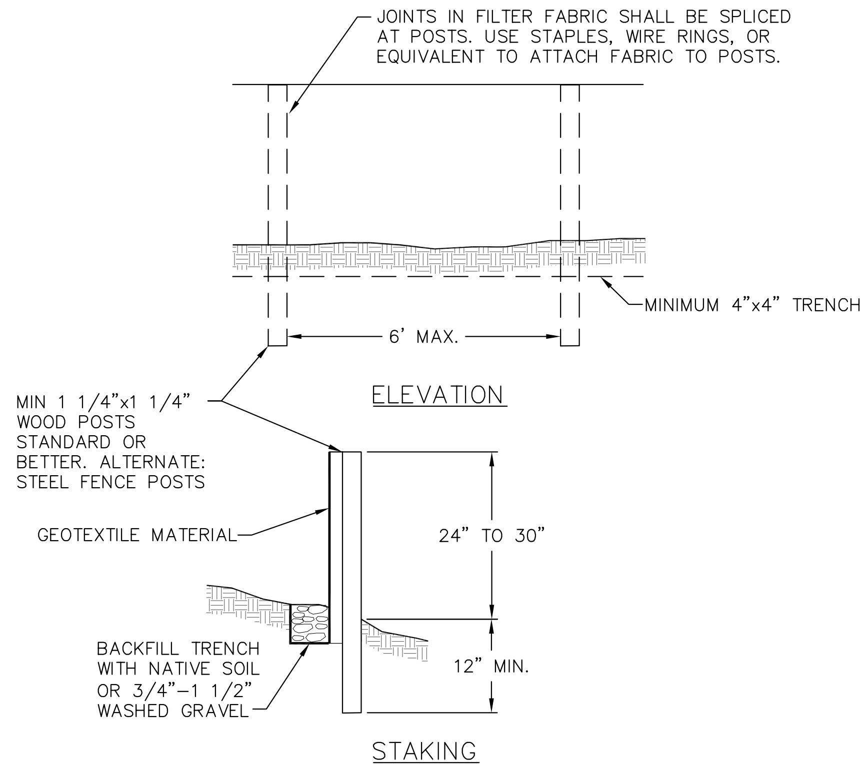
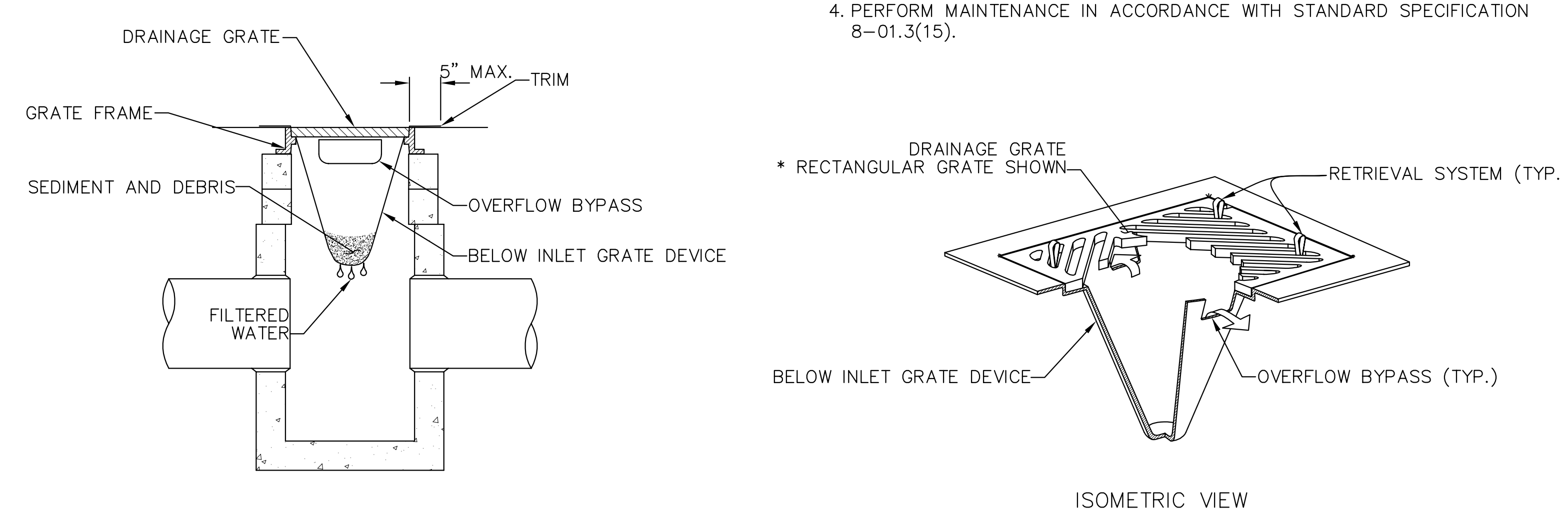


SILT FENCE DETAIL 1 ESC-1
SCALE: NTS



NOTES:

1. SIZE THE BELOW INLET GRATE DEVICE (BIGD) FOR THE STORM WATER STRUCTURE IT WILL SERVICE.
2. THE BIGD SHALL HAVE A BUILT–IN HIGH–FLOW RELIEF SYSTEM (OVERFLOW BYPASS).
3. THE RETRIEVAL SYSTEM MUST ALLOW REMOVAL OF THE BIGD WITHOUT SPILLING THE COLLECTED MATERIAL.
4. PERFORM MAINTENANCE IN ACCORDANCE WITH STANDARD SPECIFICATION 8–01.3(15).

STORM DRAIN INLET PROTECTION 2 ESC-1
SCALE: NTS

NOTES:

1. THE FILTER FABRIC (CONSTRUCTION GEOTEXTILE FOR TEMPORARY SILT FENCE) SHALL BE PURCHASED IN A CONTINUOUS ROLL, 5FT WIDE, CUT TO THE LENGTH OF THE BARRIER TO AVOID USE OF JOINTS. WHEN JOINTS ARE NECESSARY, THE FILTER FABRIC SHALL BE SPLICED TOGETHER ONLY AT A SUPPORT POST, WITH A MINIMUM 6 INCH OVERLAP, AND SECURELY FASTENED TO THE POST.
2. THE FENCE POSTS SHALL BE SPACED A MAXIMUM OF 6 FEET APART AND DRIVEN SECURELY INTO THE GROUND A MINIMUM OF 12 INCHES.
3. A TRENCH SHALL BE EXCAVATED A MINIMUM OF 4 INCHES WIDE BY 4 INCHES DEEP, UPSLOPE AND ADJACENT TO THE POST TO ALLOW THE FILTER FABRIC TO BE BURIED.
4. THE FILTER FABRIC SHALL BE STAPLED OR WIRED TO THE POSTS, AND 12 INCHES OF THE FABRIC SHALL BE EXTENDED INTO THE TRENCH. THE FABRIC SHALL NOT EXTEND MORE THAN 30 INCHES ABOVE THE ORIGINAL GROUND SURFACE. FILTER FABRIC SHALL NOT BE STAPLED TO TREES.
5. THE TRENCH SHALL BE BACKFILLED WITH NATIVE SOIL OR WITH 3/4"–1 1/2" WASHED GRAVEL.
6. SILT FENCES SHALL BE REMOVED AT DIRECTION OF ENGINEER, BUT NOT BEFORE THE UPSLOPE AREA HAS BEEN PERMANENTLY STABILIZED.
7. SILT FENCES SHALL BE INSPECTED IMMEDIATELY AFTER EACH RAINFALL EVENT AND AT LEAST DAILY DURING PROLONGED RAINFALL. ANY REQUIRED REPAIRS SHALL BE MADE IMMEDIATELY.
8. SILT FENCE PERFORMANCE SHALL BE EVALUATED AND SILT FENCE LOCATIONS SHALL BE EVALUATED AND ADJUSTED AS DIRECTED OR APPROVED BY THE ENGINEER AND THE PERMITTING AUTHORITY.
9. SILT FENCE SHALL BE INSTALLED AS SHOWN ON DRAWINGS.
10. ANY DEVIATION OR CHANGE TO SILT FENCE DETAILS MUST BE APPROVED BY THE OWNERS REPRESENTATIVE.
11. THE CONTRACTOR SHALL MAINTAIN A COPY OF THE MANUFACTURER'S SPECIFICATIONS FOR FILTER FABRIC ON SITE.
12. MAINTENANCE STANDARDS:
    A. ANY DAMAGE SHALL BE REPAIRED IMMEDIATELY.
    B. IF CONCENTRATED FLOWS ARE EVIDENT UPHILL OF THE SILT FENCE, THEY MUST BE INTERCEPTED AND CONVEYED TO A SEDIMENT TRAP OR POND, OR OTHERWISE DIVERTED TO A LOCATION THAT DOES NOT RESULT IN TURBID DISCHARGES TO SURFACE WATERS.
    C. THE UPHILL SIDE OF THE SILT FENCE SHALL BE CHECKED FOR SIGNS OF THE SILT FENCE CLOGGING, ACTING AS A BARRIER TO FLOW, AND CAUSING CHANNELIZATION OF FLOWS PARALLEL TO THE FENCE. IF SUCH CHANNELIZATION OCCURS, THE CONTRACTOR SHALL REPLACE THE FENCE OR REMOVE THE TRAPPED SEDIMENT.
    D. SEDIMENT SHALL BE REMOVED AND PROPERLY DISPOSED OF WHEN THE SEDIMENT IS 6 INCHES HIGH.
    E. IF THE FILTER FABRIC HAS DETERIORATED DUE TO ULTRAVIOLET BREAKDOWN, IT SHALL BE REPLACED.

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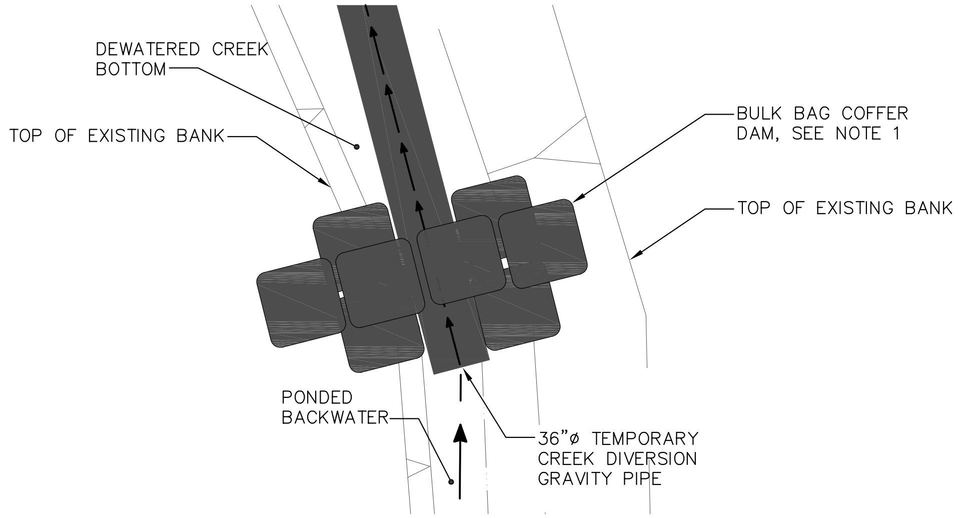
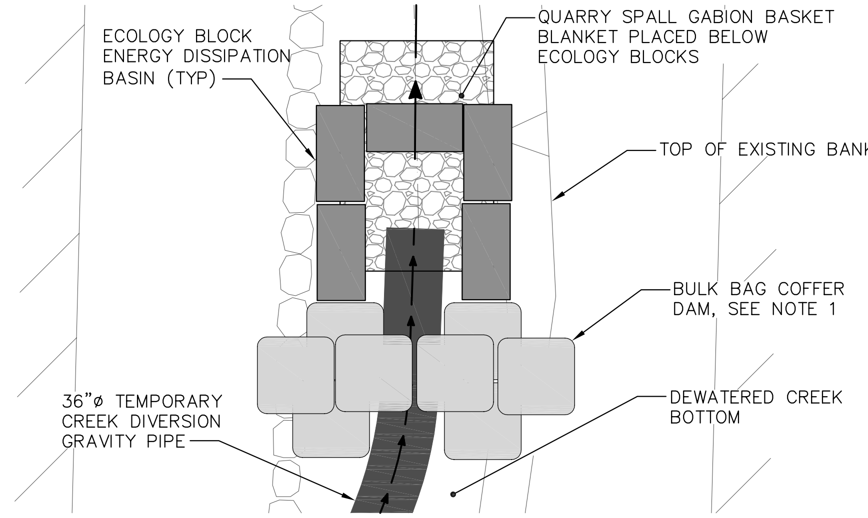


UPSTREAM COFFER DAM DETAIL (1/–)

SCALE: 1" = 5'

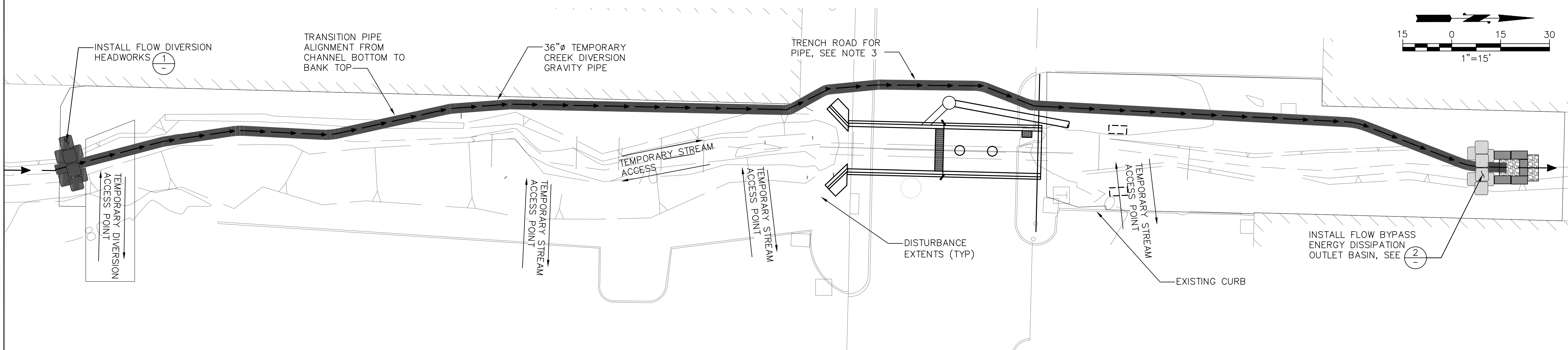


DOWNSTREAM OUTLET STRUCTURE DETAIL (2/–)

SCALE: 1" = 5'

GENERAL NOTES:

1. BULK BAGS SHALL BE FILLED WITH CLEAN WASHED ROUNDED GRAVEL.
2. TEMPORARY PUMPING OF CREEK DURING GRAVITY PIPE, UPSTREAM COFFERDAM, AND DOWNSTREAM OUTFALL DISSIPATION INSTALLATION AND REMOVAL WILL BE REQUIRED.
3. COORDINATE TEMPORARY DIVERSION PIPE TRENCH WITH CULVERT SHORING REQUIREMENTS AND UTILITY RELOCATION.
4. COORDINATE FISH EXCLUSION WITH CREEK DIVERSION.



STREAM CHANNEL DIVERSION PLAN (1/C–1)

SCALE: NOTED

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City of Bellevue UTILITIES

FLOW DIVERSION AND FISH EXCLUSION DETAILS

DRAWING WM-1 SHT 20 OF 23

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Plot Date: 6/11/2008 11:45 AM Cad User: Wojciech Wieszczecinski

PLANT SCHEDULE

RIPARIAN LOW LIGHT 1 (RLL1)	SPECIES ABBRV	SCIENTIFIC NAME
	ALRU	ALNUS RUBRA
	THPL	THUJA PLICATA
	ACCI	ACER CIRCINATUM
	COCO	CORYLUS CORNUTA
	RUPA	RUBUS PARVIFLORUS
	SYAL	SYMPHORICARPOS ALBUS
	POMU	POLYSTICHUM MUNTIUM

RIPARIAN LOW LIGHT 2 (RLL2)	SPECIES ABBRV	SCIENTIFIC NAME
	ALRU	ALNUS RUBRA
	PSME	PSEUDOTSUGA MENZIESII
	ACCI	ACER CIRCINATUM
	COCO	CORYLUS CORNUTA
	MAAQ	MAHONIA AQUIFOLIUM
	RONU	ROSA NUTKANA
	RUPA	RUBUS PARVIFLORUS
	SYAL	SYMPHORICARPOS ALBUS

RIPARIAN HIGH LIGHT 1&2 (RHL)	SPECIES ABBRV	SCIENTIFIC NAME
	ALRU	ALNUS RUBRA
	PSME	PSEUDOTSUGA MENZIESII
	HODI	HOLODISCUS DISCOLOR
	MAAQ	MAHONIA AQUIFOLIUM
	RONU	ROSA NUTKANA
	POBA	POPULUS BALSAMIFERA
	SYAL	SYMPHORICARPOS ALBUS

LIVE STAKES (LS)	SPECIES ABBRV	SCIENTIFIC NAME
	COSE	CORNUS SERICEA
	SALU	SALIX LUCIDA SSP. LASIANDRA
	SASC	SALIX SCOULERIANA
	SASI	SALIX SITCHENSIS

LEGEND:

EXISTING CREEK FLOW LINE

PLANTING KEY LEGEND:

PLANTING MIX. SEE PLANTING LEGEND

PLANTING AREA NUMBER

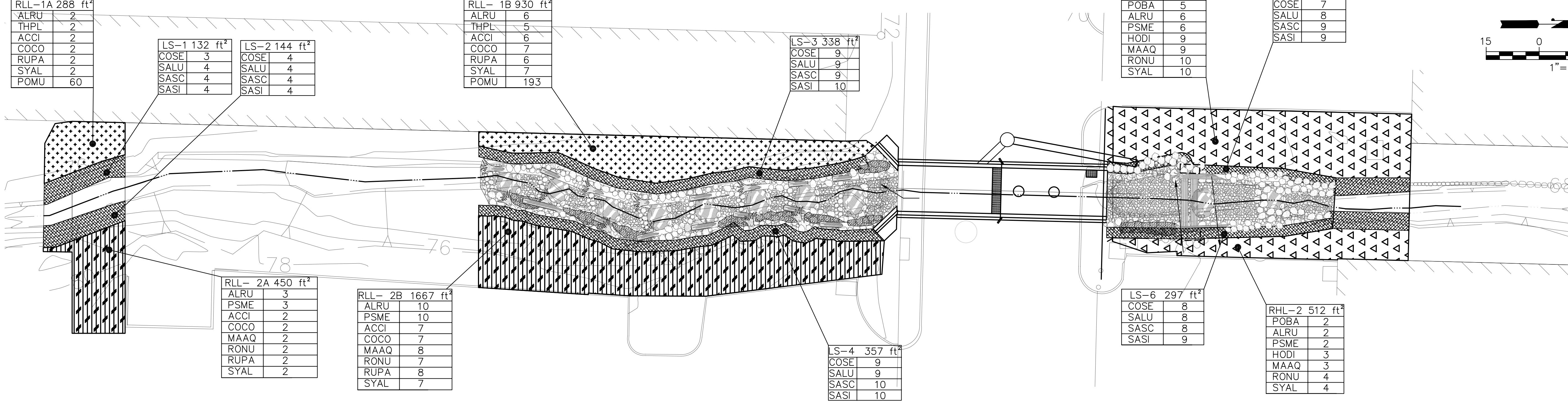
RLL-1B	649 ft²
ALRU	4
THPL	4
ACCI	3
COCO	4
RUPA	4
SYAL	4
POMU	133

PLANTING ABBREV. SEE PLANTING LEGEND

QUANTITY OF PLANTS IN AREA

GENERAL NOTES:

1. NOXIOUS WEEDS SHALL BE REMOVED PRIOR TO COMMENCING CONSTRUCTION. WEEDS SHALL BE REMOVED BY SELECTIVE CLEARING METHODS WITHIN THE RIPARIAN ENHANCEMENT ZONES. THE WORK SITE SHALL BE MAINTAINED IN A WEED FREE CONDITION THROUGHOUT CONSTRUCTION UNTIL THE CLOSE OF THE CONTRACT. AT A MINIMUM, HIMALAYAN BLACKBERRY, REED CANARYGRASS, JAPANESE KNOTWEED AND ENGLISH IVY SHALL BE COMPLETELY REMOVED FROM THE PROJECT SITE.
2. SELECTIVE CLEARING METHODS CONSIST OF LIGHTWEIGHT HAND OR HAND-HELD EQUIPMENT TO PREVENT DAMAGE TO ROOTS OF EXISTING VEGETATION, COMPACTION OF SOIL, AND DISPERSAL OF SEEDS OR POLLEN FROM INVASIVE PLANTS.
3. NATIVE SEED MIX SHALL BE APPLIED TO ALL DISTURBED AREAS TO STABILIZED SOILS & TO PROVIDE HERBACEOUS COVER. SEEDING SHALL OCCUR AFTER SOIL PREPARATION AND GRADING HAS BEEN APPROVED BY ENGINEER. NATIVE SEED MIX SHALL BE APPLIED BY HAND TO FACES OF SOIL LIFTS PRIOR TO WRAPPING WITH WOVEN GEOTEXTILE. ALL OTHER AREAS WILL BE HYDROSEEDED.
4. ALL PLANTS, EXCEPT AS NOTED, SHALL BE NURSERY CONTAINER GROWN A MINIMUM OF ONE YEAR AND CONTAINERIZED PER ANSI STANDARDS. PLANT MATERIAL IS TO BE SUPPLIED BY COMMERCIAL NURSERIES THAT SPECIALIZE IN NATIVE PLANTS. PLANT SUBSTITUTIONS ARE SUBJECT TO APPROVAL BY THE ENGINEER.
5. SPECIFICATIONS FOR SIZE AND CONDITION ON DWG P-3 ARE MINIMUM.
6. PLANT SPECIES SELECTIONS FOR EACH PLANTING AREA ARE BASED ON PREDICTED LIGHT AND WATER AVAILABILITY. PLANTS SHALL BE RANDOMLY MIXED THROUGHOUT EACH PLANTING ZONE. VERIFICATION OF APPROPRIATE ENVIRONMENTAL CONDITIONS PER SPECIES REQUIREMENTS WILL BE NECESSARY TO ACHIEVE MAXIMUM PLANT SURVIVAL. LAYOUT OF ALL PLANT MATERIAL AND SEEDING TO BE APPROVED BY THE ENGINEER PRIOR TO INSTALLATION. PLANTING PLAN MAY REQUIRE MODIFICATION FOLLOWING ASSESSMENT OF AS-BUILT CONDITIONS: USE PLAN FOR QUANTITIES – FINAL LOCATIONS OF PLANTS SUBJECT TO CHANGE.
7. SHRUBS, TREES AND, LIVE STAKES SHALL BE INSTALLED ACCORDING TO DETAILS ON DWG. P-2.
8. DISCREPANCIES BETWEEN PLANS AND SITE CONDITIONS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER PRIOR TO PROCEEDING.
9. ENGINEER TO APPROVE GRADING PRIOR TO PLANTING.
10. KEEP ALL PLANT MATERIAL WELL-WATERED AND SHADED UNTIL THE ACTUAL TIME OF PLANTING: DO NOT ALLOW PLANT MATERIAL TO BE EXPOSED TO SUNLIGHT OR OTHER DRYING CONDITIONS PRIOR TO PLANTING.
11. ALL SHRUB AND TREE PLANTING SHALL OCCUR DURING THE DORMANT SEASON (NOVEMBER THROUGH FEBRUARY).
12. THOROUGHLY WATER ALL PLANTED AREAS IMMEDIATELY AFTER PLANTING AND WATER FOR OPTIMUM HEALTH DURING DRY PERIODS DURING THE PLANT ESTABLISHMENT PERIOD.
13. EXISTING AREAS DISTURBED BY CONSTRUCTION ACTIVITIES AND NOT SHOWN TO BE RE-LANDSCAPED ON THESE PLANS SHALL BE RESTORED AND SEEDED AS DIRECTED BY THE ENGINEER.
14. SEE SPECIFICATIONS FOR ADDITIONAL SEEDING, PLANTING, AND SOIL PREPARATION NOTES.
15. ALL TREE OR SHRUB PLANTINGS SHALL BE SETBACK A MINIMUM OF 5 FEET FROM ALL PAVEMENT EDGES, AND ALL TREE PLANTINGS SHALL BE SETBACK A MINIMUM OF 10 FEET FROM BUILDINGS.



RLL-1A	288 ft²
ALRU	2
THPL	2
ACCI	2
COCO	2
RUPA	2
SYAL	2
POMU	60

LS-1	132 ft²
COSE	3
SALU	4
SASC	4
SASI	4

LS-2	144 ft²
COSE	4
SALU	4
SASC	4
SASI	4

RLL- 1B	930 ft²
ALRU	6
THPL	5
ACCI	6
COCO	7
RUPA	6
SYAL	7
POMU	193

LS-3	338 ft²
COSE	9
SALU	9
SASC	9
SASI	10

RHL-1	1408 ft²
POBA	5
ALRU	6
PSME	6
HODI	9
MAAQ	9
RONU	10
SYAL	10

LS-5	297 ft²
COSE	7
SALU	8
SASC	9
SASI	9

RLL- 2A	450 ft²
ALRU	3
PSME	3
ACCI	2
COCO	2
MAAQ	2
RONU	2
RUPA	2
SYAL	2

RLL- 2B	1667 ft²
ALRU	10
PSME	10
ACCI	7
COCO	7
MAAQ	8
RONU	7
RUPA	8
SYAL	7

LS-4	357 ft²
COSE	9
SALU	9
SASC	10
SASI	10

LS-6	297 ft²
COSE	8
SALU	8
SASC	8
SASI	9

RHL-2	512 ft²
POBA	2
ALRU	2
PSME	2
HODI	3
MAAQ	3
RONU	4
SYAL	4

STREAM CHANNEL SITE PREP PLAN 1 / C-1

SCALE: NOTED

ONE INCH

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
Suite 1100
Seattle, Washington
98121-1820
206-441-9080
206-441-9108 FAX
http://www.herrerainc.com

SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER DATE

PROJECT MANAGER DATE

C. ELLIOT 05/2008
DESIGNED BY DATE
W. WIESZCZECINSKI 06/2008
DRAWN BY DATE
K. LEPINE 06/2008
CHECKED BY DATE

City of Bellevue UTILITIES

PLANTING PLAN

DRAWING P-1

SHT 21 OF 23

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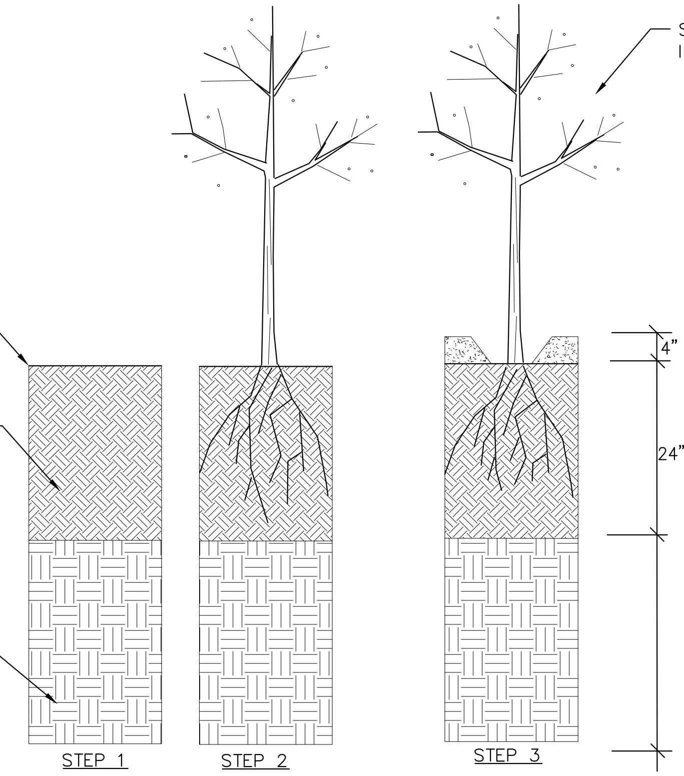
Plot Date: 6/11/2008 11:46 AM

NOTE:

1. COMPLETE STEP 1 AFTER EARTH WORK. COMPLETE STEPS 2 AND 3 BETWEEN NOVEMBER AND FEBRUARY



PLANTING AREA PREPARATION (SEE SPECIAL PROVISIONS)

STEP 1
- ADD 24" TOPSOIL TYPE A
- HYDROSEED WITH SEED MIX

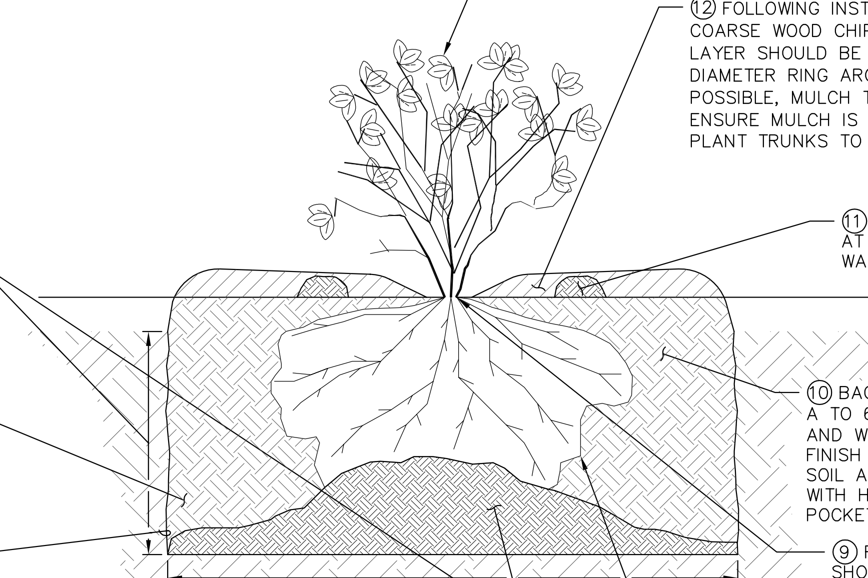
STEP 2
- INSTALL PLANT (SEE PLANTING DETAIL AND NOTE 1)

STEP 3
- INSTALL BARK MULCH AND SOIL BERM RINGS (SEE PLANTING DETAIL AND NOTE 1)

TOPSOIL TYPE A AMENDMENT AND PLANTING SEQUENCE OF WORK (1 –)

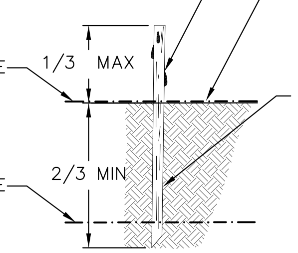
SCALE: NTS

NOTES:
- INSPECT PLANT MATERIAL PRIOR TO ACCEPTANCE OF DELIVERY. PLANTS SHOULD BE FREE OF DISEASE AND INJURY AND SHOULD NOT EXHIBIT POOR PRUNING OR CIRCLING, GIRDLING, OR KINKED ROOTS.
- PLANTING HOLES ON SLOPES SHOULD BE 3x ROOTBALL WIDTH.



CONTAINERIZED TREE/SHRUB INSTALLATION SEQUENCE (2 –)

SCALE: NTS



NOTES:

1. BASAL END OF LIVE STAKES SHOULD BE 0.5–1.5 INCHES IN DIAMETER AND AT LEAST 36 INCHES IN LENGTH.
2. KEEP LIVE STAKES COVERED, COOL, AND MOIST AT ALL TIMES PRIOR TO PLANTING. AT NO TIME SHOULD LIVE STAKES BE EXPOSED AND ALLOWED TO DRY OUT.
3. WHEN PLANTING ON STREAM BANKS, ANGLE STAKES SLIGHTLY DOWNSTREAM.

LIVE STAKE INSTALLATION (3 –)

SCALE: NTS

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SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER — DATE
PROJECT MANAGER — DATE

C. ELLIOT	05/2008
DESIGNED BY	DATE
W. WIESZCZECINSKI	06/2008
DRAWN BY	DATE
K. LEPINE	06/2008
CHECKED BY	DATE

City of Bellevue UTILITIES

PLANTING DETAILS

DRAWING P-2 SHT 22 OF 23

STRUCTURAL CLASS	SPECIES ABBRV	QUANTITY	SCIENTIFIC NAME	COMMON NAME	WETLAND INDICATOR	MATERIAL TYPE & SIZE	SPACING ON CENTER (FEET)	NOTES
TREES								
	POBA	7	POPULUS BALSAMIFERA	BLACK COTTONWOOD	FAC	1 GAL CONT. 12" HEIGHT	9	
	ALRU	29	ALNUS RUBRA	RED ALDER	FAC	1 GAL CONT. 12" HEIGHT	9	
	PSME	23	PSEUDOTSUGA MENZIESII	DOUGLAS FIR	FACU	2 GAL CONT. 24" HEIGHT	9	
	SALU	42	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW	NI	LIVE STAKE 36" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	INSTALL AT OHWM AND BELOW
	THPL	6	THUJA PLICATA	WESTERN RED CEDAR	FAC	2 GAL CONT. 24" HEIGHT	9	
SHRUBS								
	ACCI	17	ACER CIRCINATUM	VINE MAPLE	FAC–	1 GAL CONT. 12" HEIGHT	5	
	COSE	40	CORNUS SERICEA	RED OSIER DOGWOOD	FACW	LIVE STAKE 36" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	INSTALL AT OHWM AND BELOW
	COCO	18	CORYLUS CORNUTA	BEAKED HAZELNUT	FACU	1 GAL CONT. 12" HEIGHT	5	
	HODI	12	HOLODISCUS DISCOLOR	OCEANSPRAY	UPL	1 GAL CONT. 12" HEIGHT	5	
	MAAQ	23	MAHONIA AQUIFOLIUM	TALL OREGON GRAPE	UPL	1 GAL CONT. 12" HEIGHT	5	
	RONU	25	ROSA NUTKANA	NOOTKA ROSE	FAC	1 GAL CONT. 12" HEIGHT	5	
	RUPA	17	RUBUS PARVIFLORUS	THIMBLEBERRY	FAC–	1 GAL CONT. 12" HEIGHT	5	
	SYAL	31	SYMPHORICARPOS ALBUS	SNOWBERRY	FACU	1 GAL CONT. 12" HEIGHT	5	
	SASC	44	SALIX SCOULERIANA	SCOULER'S WILLOW	FAC	LIVE STAKE 36" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	INSTALL AT OHWM AND ABOVE
	SASI	46	SALIX SITCHENSIS	SITKA WILLOW	FACW	LIVE STAKE 36" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	INSTALL AT OHWM AND BELOW
HERBS								
	POMU	196	POLYSTICHUM MUNITUM	SWORD FERN	FACU	1 GAL CONT.	2	

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Plot Date: 6/11/2008 11:49 AM

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SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER DATE

PROJECT MANAGER DATE

C. ELLIOT	05/2008
DESIGNED BY	DATE
W. WIESZCZECINSKI	06/2008
DRAWN BY	DATE
K. LEPINE	06/2008
CHECKED BY	DATE

City of Bellevue
UTILITIES

PLANT MATERIAL LIST

DRAWING P-3

SHT 23 OF 23

City of Bellevue
Development Services Department
Land Use Staff Report

Proposal Name:	City of Bellevue Utilities Department SE 30th Street/Sunset Creek Flood Improvement Project
Proposal Address:	Sunset Creek - vicinity of 13200 SE 30th Street
Proposal Description:	Application for a Critical Areas Land Use permit to replace an existing twin barrel 42-inch diameter culvert on Sunset Creek at SE 30th Street with an integrated fish-passable culvert and sediment capture structure. Installation of the new structure will require modifications of the stream channel upstream and downstream of SE 30th. The purpose of the project is flood control and sediment management.
File Number:	**08-128529 LO**
Applicant:	Brian Ward, City of Bellevue Utilities Department
Decisions Included:	Critical Areas Land Use Permit (Process II. LUC 20.30P)
Planner:	**Heidi M. Bedwell**, Planner
State Environmental Policy Act Threshold Determination:	**Determination of Non-Significance**

Michael A. Paine for
Carol V. Helland, Environmental Coordinator
Development Services Department

Director's Decision: **Approval with Conditions**

Michael A. Paine for
Carol V. Helland, Land Use Director
Development Services Department

Application Date:	July 30, 2008
Notice of Application Publication Date:	September 11, 2008
Decision Publication Date:	March 12, 2009
Project/SEPA Appeal Deadline:	March 26, 2009

For information on how to appeal a proposal, visit Development Services Center at City Hall or call (425) 452-6800. Comments on State Environmental Policy Act (SEPA) Determinations can be made with or without appealing the proposal within the noted comment period for a SEPA Determination. Appeal of the Decision must be received in the City's Clerk's Office by 5 PM on the date noted for appeal of the decision.

CONTENTS

I. Proposal Description

The applicant requests a Critical Areas Land Use Permit approval to replace an existing twin barrel 42-inch diameter culvert on Sunset Creek at SE 30^{th} Street with an integrated fish-passable culvert and sediment capture structure. Installation of the new structure will require modifications of the stream channel upstream and downstream of SE 30^{th}. The purpose of the project is flood control and sediment management. The existing twin culverts are not currently passable to fish at all flows. Extensive sediment deposition in Sunset Creek downstream of these culverts presents a low flow barrier to fish passage, and sediment deposition upstream of SE 30th Street has created conditions that are a likely barrier to passage during high flow conditions. The proposed project would improve fish passage conditions in Sunset Creek at the SE 30^{th} Street culvert and address barrier conditions in the channel both upstream and downstream of the structure.

The replacement of the culvert, and associated restoration of the stream channel and restoration of the riparian corridor is allowed as a flood control measure with a Critical Areas Land Use Permit accompanied by a Critical Areas Report per Land Use Code (LUC) 20.25H.080.B.2 for modification of stream channel.

II. Site Description, Zoning, Land Use and Critical Areas

A. Site Description

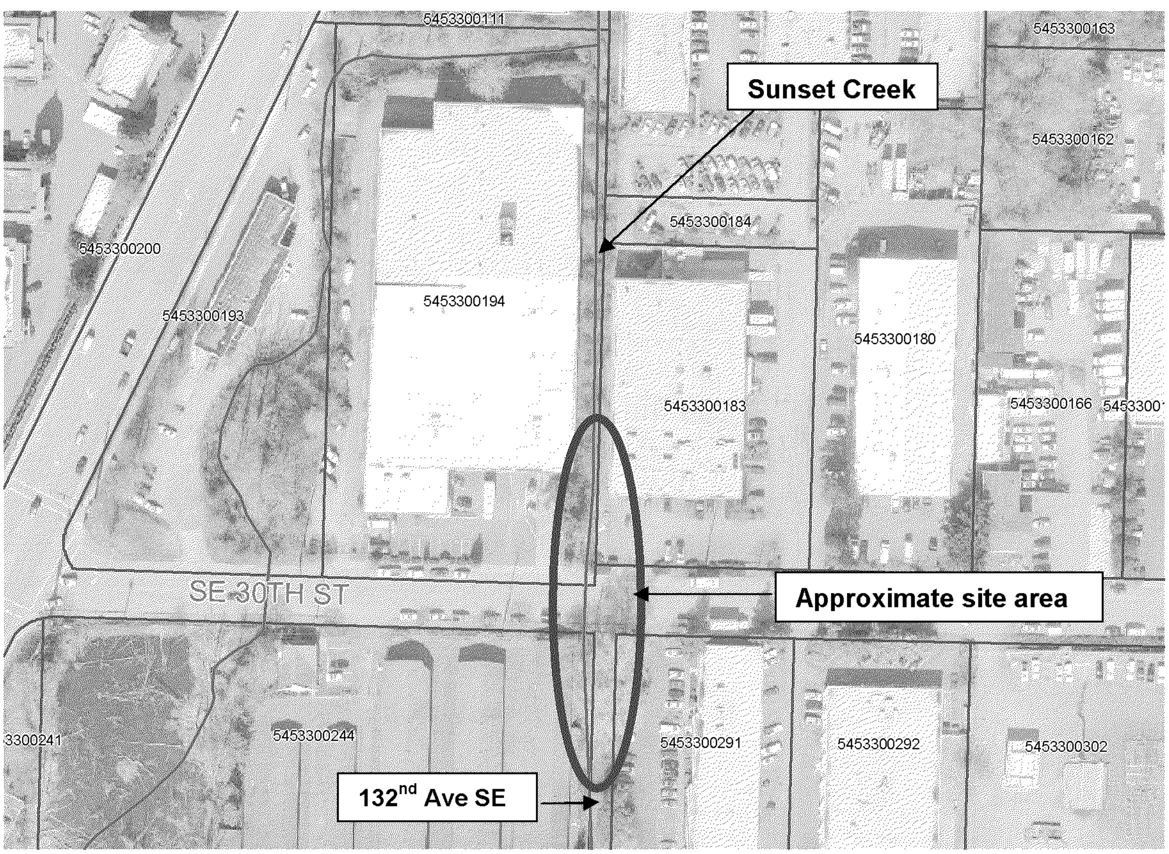
The project site is on a portion of Sunset Creek, east of Richards Road. The project improvements are proposed to occur within existing city street right-of-way and adjacent privately-owned parcels. The culvert replacement site is located within the right-of-way of SE 30th Street along the same alignment as the existing twin 42-inch diameter culverts.

Historic development of the area prior to institution of critical areas protections has encroached upon the stream buffer. Buildings, roadways, and paved parking lots limit the existing and potential riparian zone to an average width of 10 to 30 feet. Upstream channel modifications are to occur primarily within an existing city right-of-way for 132nd Avenue SE, which was never constructed in this location.

Downstream of SE 30th-Sunset Creek

Upstream of SE 30th- Sunset Creek

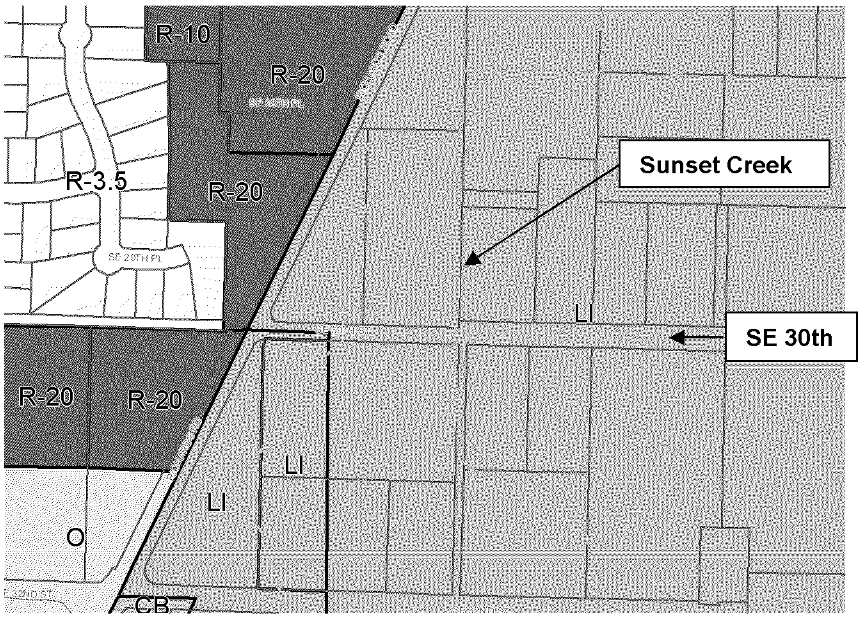
Some channel modification, site access and revegetation activities associated with upstream channel modifications will occur on private parcels (tax parcel numbers 5453300244 and 5453300291). Downstream channel modifications are proposed on private parcels (tax parcel numbers 5453300194 and 5453300183).



B. Zoning and Uses

The proposed activities would be conducted on properties zoned Light-Industrial (LI). The general dimensional standards in LUC 20.20.010 do not apply, because there is no structural development proposed. The existing uses on the affected properties are permitted and there is no proposed change in use of the properties.

The project site and surrounding properties are designated light-industrial in the Comprehensive Plan and are developed with light industrial and warehouse uses.



C. Critical Areas Functions and Values

1. Streams and Riparian Areas

Riparian vegetation along stream banks mitigates the impacts of urbanization and support healthy stream conditions. Riparian vegetation affects water temperature by providing shade to reduce solar exposure and regulate high ambient air temperatures, slowing or preventing increases in water temperature.

Upland and wetland riparian areas retain sediments, nutrients, pesticides, pathogens, and other pollutants that may be present in runoff, protecting water quality in streams. The roots of riparian plants also hold soil and prevent erosion and sedimentation that may affect spawning success or other behaviors, such as feeding.

Both upland and wetland riparian areas reduce the effects of flood flows. Riparian areas and wetlands reduce and desynchronize peak crests and flow rates of floods. Upland and wetland areas can infiltrate flood flows, which in turn, are released to the stream as base flow.

Stream riparian areas, or buffers, can be a significant factor in determining the quality of wildlife habitat. For example, buffers comprised of native vegetation with multi-canopy structure, snags, and down logs provide habitat for the greatest range of wildlife species. Vegetated riparian areas also provide a source of large woody debris that helps create and maintain diverse in-stream habitat, as well as create woody debris jams that store sediments and moderate flood velocities.

Sparsely vegetated or vegetated buffers with non-native species may not perform the needed functions of stream buffers. In cases where the buffer is not well vegetated, it is necessary to either increase the buffer width or require that the standard buffer width be restored or revegetated. Until the newly planted buffer is established the near term goals for buffer functions may not be attained.

Riparian areas often have shallow groundwater tables, as well as areas where groundwater and surface waters interact. Groundwater flows out of riparian wetlands, seeps, and springs to support stream baseflows. Surface water that flows in to riparian areas during floods or as direct precipitation infiltrates into groundwater in riparian areas and is stored for later discharge to the stream.

2. Floodplains

The value of floodplains can be described in terms of both the hydrologic and ecological functions that they provide. Flooding occurs when either runoff exceeds the capacity of rivers and streams to convey water within their banks, or when engineered stormwater systems become overwhelmed. Studies have linked urbanization with increased peak discharge and channel degradation (Dunne and Leopold 1978; Booth and Jackson 1997; Konrad 2000). Floodplains diminish the effects of urbanization by temporarily storing water and mediating flow to downstream reaches. The capacity of a floodplain to buffer upstream fluctuations in discharge may vary according to valley confinement, gradient, local relief, and flow resistance provided by vegetation. Development within the floodplain can dramatically affect the storage capacity of a floodplain, impact the hydrologic regime of a basin and present a risk to public health and safety and to property and infrastructure.

III. Consistency with Land Use Code Requirements

A. Zoning District Dimensional Requirements

The subject area is zoned Light-Industrial (LI). The general dimensional standards in LUC 20.20.010 do not apply, because there are no structural development proposed which would be subject to these standards.

B. Critical Areas Requirements LUC 20.25H

1. Analysis of Technical Feasibility for New or Expanded Allowed Uses

a. New or expanded facilities and systems are allowed within the critical area or critical area buffer only where no technically feasible alternative with less impact on the critical area or critical area buffer exists. A determination of technically feasible alternatives will consider:
   i. The location of existing infrastructure;
   ii. The function or objective of the proposed new or expanded facility or system;
   iii. Demonstration that no alternative location or configuration outside of the critical area or critical area buffer achieves the stated function or objective, including construction of new or expanded facilities or systems outside of the critical area;
   iv. Whether the cost of avoiding disturbance is substantially disproportionate as compared to the environmental impact of proposed disturbance; and
   v. The ability of both permanent and temporary disturbance to be mitigated.

b. If the applicant demonstrates that no technically feasible alternative with less impact on the critical area or critical area buffer exists, then the applicant shall comply with the following:

i. Location and design shall result in the least impacts on the critical area or critical area buffer;
ii. Disturbance of the critical area and critical area buffer, including disturbance of vegetation and soils, shall be minimized;
iii. Disturbance shall not occur in habitat used for salmonid rearing or spawning or by any species of local importance unless no other technically feasible location exists;
iv. Any crossing over of a wetland or stream shall be designed to minimize critical area and critical area buffer coverage and critical area and critical area buffer disturbance, for example by use of bridge, boring, or open cut and perpendicular crossings, and shall be the minimum width necessary to accommodate the intended function or objective; provided, that the Director may require that the facility be designed to accommodate additional facilities where the likelihood of additional facilities exists, and one consolidated corridor would result in fewer impacts to the critical area or critical area buffer than multiple intrusions into the critical area or critical area buffer;
v. All work shall be consistent with applicable City of Bellevue codes and standards;
vi. The facility or system shall not have a significant adverse impact on overall aquatic area flow peaks, duration or volume or flood storage capacity, or hydroperiod;
vii. Associated parking and other support functions, including, for example, mechanical equipment and maintenance sheds, must be located outside critical area or critical area buffer except where no feasible alternative exists; and
viii. Areas of new permanent disturbance and all areas of temporary disturbance shall be mitigated and/or restored pursuant to a mitigation and restoration plan meeting the requirements of LUC 20.25H.210.

Response: The Richards Creek, Sunset Creek, and East Creek channel network in the vicinity of SE 30th Street and Kamber Road has been directly impacted by channel realignment, channel confinement, and increased rates of sediment production associated with land development both local to the project area and in the upper watershed. These impacts include recurrent flooding and sedimentation problems, channel instability, and degraded habitat conditions. The proposed project includes the replacement of an existing twin barrel 42-inch diameter culvert on Sunset Creek at SE 30th Street with an integrated fish-passable culvert and sediment capture structure. This project is part one of a four-phased Flood Control and Sedimentation Plan developed by the City to address the impacts to this stream system. Phases I and II are funded and Phase II is anticipated to be constructed in 2010. Phases III and IV are dependent upon additional CIP funding.

Installation of the new structure will require modification of the stream channel upstream and downstream of SE 30th Street. These modifications will include eight grade control structures upstream and two grade control structures downstream of the culvert, riprap removal and replacement with bioengineered bank protection structures, and stream and riparian habitat enhancement. Channel and riparian modifications will take place over a segment of Sunset Creek extending from approximately 110 feet upstream to approximately 60 feet downstream of SE 30th Street.

The culvert replacement project is designed to address chronic flooding of Sunset Creek at SE 30th Street and adjacent businesses, and provide the ability to adaptively manage habitat conditions and flood conveyance capacity. Based on the engineering done in support of this project and contained in the Critical Areas Report Attachment 2, the integrated sediment trap will capture the majority of sediments transported to this reach of Sunset Creek in most years. This will allow for maintenance dredging to be conducted within the enclosed structure rather than the active channel. Sediment removal will be managed to optimize sediment delivery rates to the channel segment downstream of the structure, maintaining flood conveyance capacity and desirable habitat conditions for fish by providing a fish passable culvert.

The sediment storage capacity of the sediment retention (sedimentation) structure portion of the replacement culvert is designed to accommodate approximately 50 cubic yards of sediment. This volume was determined primarily through a consideration of estimated historical, existing, and potential future sediment delivery and transport rates, combined with practical sediment removal frequency for City of Bellevue maintenance crews. Additional secondary considerations included site constraints, cost implications and environmental impact associated with operations and maintenance activities. Current maintenance practice to remove sediments in the vicinity of the SE 30th culvert involve dredging materials directly from the stream channel on an up to yearly basis. Compared to the current maintenance practice, the proposed culvert maintenance will allow sediment to be removed within the culvert structure and will not involve modification to the stream channel. This will result is fewer environmental impacts to the critical areas.

The Critical Areas Report discusses in detail the rate of sediment delivery and reasons for the amount of sediment in the stream system. Sediment delivery rates are highly variable and episodic by nature. To accommodate for annual variability in sediment delivery, the capacity of the sedimentation structure is designed to accommodate delivery rates up to two times the estimated current rate. Given this design volume, sediment removal activities are forecast to be required every two years on average. The report additionally defines protocols for structure maintenance based on actual deposition rates and channel. So long as these protocols for maintenance and monitoring are followed, the facility shall not have a significant impact on critical area function and should provide flood protection and habitat improvement in the long term as compared to existing conditions.

3. **Performance Standards for Public Flood Protection Measures LUC 20.25H.055.C.3.c**

New public flood protection measures and expansion of existing ones may be permitted only in accordance with a design prepared by a qualified professional.

Response: A Critical Areas Report consistent with LUC 20.25H.230 has been prepared by Herrera Environmental Consultants (See Attachment 2). A discussion of how the critical areas report satisfies the critical areas report decision criteria can be found below.

4. **Performance Standards for New or Expanded Bridges and Culverts.** New culverts shall be designed in accordance with the Washington State Department of Fish and Wildlife "Design of Road Culverts for Fish Passage" now or as hereafter amended. Culvert expansions shall be considered new culverts and be required to be designed in accordance with "Design of Road Culverts for Fish Passage" now or as hereafter amended when the expansion is associated with a project increasing vehicular capacity and (i) there are fish present downstream; (ii) there is potential fish habitat upstream; and (iii) the benefits of so designing the culvert are substantial when compared to expanding the culvert based on its then-existing design.

   Response: Per the Critical Areas Report (Attachment 2) and the JARPA documentation, the proposal is designed in accordance with WDFW culvert design guidance (WDFW 2003), using the stream simulation method. The culvert replacement is intended to address flood control and sediment management issues at the existing road crossing. It will not change the traffic capacity of the existing roadway or otherwise facilitate new development however the design will provide improved fish passage over the existing culvert design.

5. **Consistency Critical Areas Performance Standards**

   The performance standards for the modification of a stream channel described in LUC 20.25H.080.B require the preparation of a critical areas report for a public flood control project that proposes to modify the stream channel, as allowed under LUC 20.25H.055. A critical areas report has been prepared by Herrera Environmental Consultants (See Attachment 2). A discussion of how the critical areas report satisfies the critical areas report decision criteria can be found below.

6. **Consistency with Critical Areas Report LUC 20.25.230.**

   The applicant supplied a complete critical areas report prepared by Herrera Environmental Consultants, a qualified professional. The report met the minimum requirements in LUC 20.25H.250 as determined by the Director. The critical areas report contained items discussed below.

   The critical areas report contained an accurate depiction of the critical areas on the site and those properties immediately adjacent to the site in a graphical format on the site plans. The critical areas report also includes a discussion of probable habitat and water quality impacts resulting from the proposed project.

The report was supplemented by materials provided to State and Federal permitting agencies including a Joint Aquatic Resources Permit Application and Biological Evaluation.

IV. Public Notice and Comment

Application Date:	July 30, 2008
Public Notice (500 feet):	September 11, 2008
Minimum Comment Period:	September 25, 2008

The Notice of Application for this project was published in the City of Bellevue weekly permit bulletin on September 11, 2008, which was advertised in Seattle Times on the same day. The weekly permit bulletin was mailed to property owners within 500 feet of the project site.

One comment letter was received regarding this project from Karen Walter with the Muckleshoot Indian Tribe Fisheries Division. See Attachment 5 for the full comment letter and applicant response. The following are a summary of the issues raised:

Comment *The proposed in-culvert sediment trap has the potential to starve downstream areas of Sunset Creek, Richards Creek and East Creek of spawning gravel necessary for successful spawning. The project should monitor downstream spawning areas to determine if there is a change in spawning gravel area and particle size distribution. Methods suggested.*

Response The objective of the proposed sediment trap is to reduce the delivery of sediment to the Sunset Creek channel downstream of SE 30th Street where the rate of sediment delivery has historically far exceeded the sediment transport capacity of the channel. Optimally, the trap would be sized to capture the sediment in excess of the downstream channel's sediment transport capacity, thereby maintaining a flux of gravel through the channel that would not result in net aggradation. Although the capacity of the trap is approximately 50 cubic yards, adaptive management of the trap, including documenting the amount of sediment captured by the trap, may determine that the optimal sediment removal volume is less than the capacity of the sediment trap. For example, if only 30 cubic yards of sediment are captured annually, the trap could be maintained with a storage capacity of 20 cubic yards so that that amount of sediment delivered in excess of this amount would be delivered to the downstream channel.

Currently, the City of Bellevue documents the condition of salmonid spawning in the Richards and Sunset Creek channels during the spawning season, generally from August to October. During this period City staff conduct surveys of Richards Creek from its confluence with Kelsey Creek to the project site every other week documenting spawning redds and counting fish carcasses. The frequency of surveys is adjusted to once per week if observations warrant the change. Salmon surveys are also conducted through the Salmon Watcher program, a program where volunteers go to designated locations each week to look for salmon. Richards and Sunset Creeks are part of that program.

These surveys will be complemented by the proposed channel monitoring protocol which will document changes in both channel geometry and substrate condition. The protocol for documenting substrate conditions will be guided by the protocols within the recommended document (TFW Monitoring Methods Manual for

Spawning Gravel Composition Surveys, TFW-AM9-99-006, 1999).

The protocol for documenting substrate conditions will include gathering bulk samples from areas representative of potential spawning habitat, such as riffle crests or gravel bar features at the proposed monitoring cross-sections. The samples will be gathered using a McNeil sampler. The information gathered will be suitable for:

- Evaluating the characteristics and composition of gravel within the sampling extent

- Estimating the percentage of fine sediment less than 0.85 mm in order to evaluate the potential impact of fine sediment on survival to emergence

- Comparing the composition of gravel from different locations within the sampling area and from other watersheds

- Monitoring trends in gravel composition over time.

At present there are very limited to no spawning areas located between the Richards Creek flow split and Kamber Road, therefore the proposed extent of the channel monitoring protocol is expected to capture the extent of the channel area containing potential spawning habitat that may be directly affected by an immediate reduction in bedload delivery.

Comment *Concerns regarding the monitoring plan and adaptive management strategy- lacks a numeric standard for the proposed gravel , the actual 'desirable habitat conditions to be maintained' for this project and the adaptive management protocols should be specifically identified, the monitoring plan should include standards regarding both adult and juvenile fish passage to ensure that the new culvert is passing all fish species and all life history stages.*

Response
See discussion in Section VII and conditions in Section IX requiring the Protocols for Channel Monitoring and Replacement Culvert Sedimentation Structure Maintenance to be prepared prior to the approval of the Clearing and Grading permit.

Comment *Phase I as currently proposed provides very little instream habitat diversity for salmonids. The proposed boulders and wood is such that the any pool habitat is likely to be minimal due to the type and orientation of these materials such that they will be resistant to scour necessary to create pool habitat. The design is for streambed and bank stabilization than instream habitat [sic]. The project should be modified by adding wood to additional upstream areas that is allowed to retain sediment and form pools with cover in a more natural manner than what is proposed.*

Response The project objective is for flood and sediment control. Instream habitat for salmonids is not the overall objective with the exception of fish passage at the culvert.

Comment *Removal of 8 trees that are 10 inches in diameter or greater. All of these trees should be used in the project to support the Phase I design or to create habitat for salmonids as recommended above. Otherwise, the project will result in* *an adverse impact to future wood recruitment (temporal loss) that could be avoided.*

Response Of the 8 trees that may be removed during utility relocation and channel modification activities, 3 are conifers and 5 are deciduous. Due to the stability requirements of the proposed channel modifications, and the greater decay rates of deciduous trees relative to coniferous trees, only the 3 Douglas firs are potentially suitable for incorporation into the proposed channel modifications. These 3 trees will be incorporated into the project designs to the extent possible. Opportunities for placing the remaining deciduous trees at other locations in the channel network will be evaluated. The proposed design includes planting 107 native trees during Phase I including; 7 black cottonwood, 29 red alder, 23 Douglas fir, 42 Pacific willow, and 6 Western red cedar. The long-term benefits of these trees are expected to include improved riparian habitat and wood recruitment for Sunset Creek that far exceeds the functions of the 8 trees to be removed.

Comment *The removal of these trees may adversely affect water temperature. An analysis or discussion about the potential loss of shade due to removal of these trees or shrubs that may be providing shade is lacking. A shade analysis should be conducted, and if there is a potential increase in water temperature, then additional tree planting should be required.*

Response A temporary increase in water temperatures was identified as a possible effect of the proposed tree removal. Page 2 of the BA Addendum states: *"Current conditions for water temperatures in Sunset Creek are rated as **at risk**. The proposed action [tree removal] will temporarily degrade water temperatures by reducing available shade. However, these effects will be offset by the deeper and narrower channel profile produced by the planned channel modifications. This will reduce the surface area exposed to insolation, which will mitigate the temporary reduction in shade. As the planned site revegetation matures, shading of the stream channel will increase relative to the current environmental baseline. As a result, the proposed action will **improve** water temperature conditions over the long-term."*
The proposed planting plan incorporates four distinct plant communities based on the available light and proximity to the channel at different locations in the project area. In addition to the 107 trees that will be planted during Phase I (detailed above), the project design calls for removal of invasive species within the project area and additional planting of 256 shrubs, and 196 herbs during Phase I. This is an extensive planting plan relative to the size of the project.

<u>Phase I and Phase II concerns</u>
Comment *Per the documents that we reviewed, the Phase I project is not independent of the Phase II project and should be evaluated for its potential impacts to salmonids and their habitats concurrently. Phase II is needed so that the 30th Street SE [sic] culvert can pass the 100 year flood event with 1 foot of freeboard and meet Bellevue's engineering standards and likely those standards of FEMA and other agencies. The Phase II project is also needed to meet the project's purpose "to address chronic flooding of SE 30th Street and surrounding private property". As noted in the Biological Assessment (BA, page 7), the Phase II project primary purpose is to address the flooding of properties surrounding the project area and to "optimize the flood conveyance capacity of Sunset Creek from the downstream project extents of Alternative 1 to the confluence of Sunset Creek and Richards Creek through channel modifications and construction of a flood containment berm". Also, Phase II was analyzed for sediment transport with the Phase I improvements and compared against the existing conditions in the*

technical sections of the Flood Control and Sediment Plan for this project. Finally, the Flood Control and Sediment Plan clearly notes that there will continue to be a backwater condition in the new culvert and deposition in the area of the modified channel downstream of SE 30th Street until the high point in the channel downstream is lowered, either by Phase II channel modifications or due to geomorphic response of the channel to reduced sediment delivery.

Response to Comment
The Flood Control and Sediment Management Plan for the Richards Creek, Sunset Creek, and East Creek Confluence Area recommends a range of alternatives to address recurrent flooding and sedimentation problems, channel instability, and degraded habitat conditions. Phase I includes the culvert replacement at SE 30th Street and channel modifications upstream and downstream to provide a stable streambed transition to the culvert inlet and outlet. The specific objectives of Phase I are to address the recurrent flooding at SE 30th Street and the recurrent sedimentation upstream and downstream of the existing culverts that requires annual dredging within the active channel. Satisfaction of these objectives does not require Phase II. Phase II includes approximately 400 feet of channel modifications from the downstream end of Phase I to the confluence of Sunset Creek and Richards Creek. The specific objective of Phase II is to limit the extent of flooding into neighboring properties downstream of SE 30th Street and the Phase I project extents. Channel modifications under both phases include the following project components that will improve the aquatic habitat conditions of Sunset Creek:

- Construction of a two-stage channel
- Biostabilization of stream banks
- The removal of invasive species
- Replanting with native vegetation.

Due to the limited width of the channel corridor and the distinct change in channel slope at SE 30th Street, neither Phase I or Phase II can fully meet the City of Bellevue's engineering standard stating that culverts should pass the 100-year flow with one foot of freeboard.
Under the existing conditions, flows as small as the 1-year recurrence interval event are predicted to flood SE 30th Street. These modeled conditions are supported by observations of at least six flooding events at SE 30th Street since January 1, 2005. The replacement culvert and channel modifications proposed under Phase I will improve the flow conveyance capacity and keep the 100-year flow from flooding SE 30th Street, though the City's freeboard requirement in the culvert cannot be met. Immediately following the construction of Phase I, the replacement culvert is designed to pass the 2-year flow with a free water surface at the upstream culvert inlet (i.e., with freeboard through the culvert length). Following either downstream channel responses to reduced bedload delivery rates, or the construction of Phase II channel modifications, the replacement culvert is designed to pass the 25-year flow with a free water surface at the culvert inlet. Based on extensive hydraulic modeling, sediment transport analyses, and a detailed understanding of the geomorphic processes at the project site, it is anticipated that the downstream geomorphic responses to the Phase I culvert replacement and channel modifications would include the transport of sediments that have accumulated within the channel downstream of the Phase I project extents over the last 30 years. The exact timeframe of this response is difficult to predict, but the resulting hydraulic influences of this response to the downstream

channel would likely mimic those that will result from the channel modifications proposed under Phase II. Therefore, while Phase I could be implemented to reduce the recurrent flooding at SE 30th Street and the recurrent sedimentation upstream and downstream of the existing culverts without implementing Phase II, the benefits of constructing Phase II include limiting the extent of flooding into neighboring properties downstream of the Phase I extents while also extending the length of channel with improved aquatic habitat. Although Phase II would provide some control over the timing and character of channel modifications downstream of the Phase I project extents, it is not a required component of long-term flood control at SE 30th Street and is thus considered independent of Phase I.

Comment *Concern about potential Phase IV improvements.*

Response The City of Bellevue is only pursuing Phase I improvements with this application. Phases II-IV will be evaluated separately and are dependent upon CIP priorities and funding.

V. Summary of Technical Reviews

Clearing and Grading

The Clearing and Grading Division of the Development Services Department has reviewed the proposed site development for compliance with Clearing and Grading codes and standards. The Clearing and Grading staff found no issues with the proposed development.

VI. State Environmental Policy Act (SEPA)

The environmental review indicates no probability of significant adverse environmental impacts occurring as a result of the proposal. The Environmental Checklist submitted with the application adequately discloses expected environmental impacts associated with the project. The City codes and requirements, including the Clear and Grade Code, Utility Code, Land Use Code, Noise Ordinance, Building Code and other construction codes are expected to mitigate potential environmental impacts. Therefore, issuance of a Determination of Non-Significance (DNS) is the appropriate threshold determination under the State Environmental Policy Act (SEPA) requirements.

A. Earth and Water

A grading plan that includes temporary erosion and sedimentation control best management practices is included in the project plans, and addresses all requirements for restoring the site to a condition equal to or better than its existing condition. See Section IX for a related condition of approval.

B. Animals

The project site is part of type F stream and riparian area and is adjacent to larger natural areas that contains quality habitat for birds and mammals. Fisheries resources in Sunset Creek include anadromous and resident species. Sunset Creek is identified by the WDFW as containing priority resident fish presence two aquatic species listed under the Endangered Species Act (i.e., Puget Sound Chinook salmon [*Oncorhynchus tshawytscha*] and Puget Sound steelhead [*O. mykiss*]) In addition, coho salmon (*O. kisutch*) currently listed as a species of concern, may also occur within the action area.

The existing twin culverts at SE 30th Street are not currently passable to fish at all flows. Extensive sediment deposition in Sunset Creek downstream of these culverts presents a low flow barrier to fish passage, and sediment deposition upstream of SE 30th Street has created gradient and velocity conditions that are a likely barrier to passage during high flow conditions. The proposed project would improve fish passage conditions in Sunset Creek at the SE 30th Street culvert and address barrier conditions in the channel both upstream and downstream of the structure. The new culvert would provide for full fish passage for all species and life history stages likely to occur in this system during the flow conditions in which migratory and dispersal behavior is likely to take place. In addition, the grade control structures, culvert configuration, and sediment trap would prevent aggradation at the inlet and outlet of the culvert that currently limits fish passage.

The applicant will implement WSDOT Fish Exclusion Protocols and Standards to ensure fish resources in the project reach are protected. See Section IX for related conditions of approval.

C. Plants

The proposed project will remove approximately 600 square feet of riprap from the stream banks upstream and downstream of the SE 30th Street culvert and install bank protection structures. In addition 6,800 square feet of the stream bank will be replanted with native riparian vegetation appropriate for this site. There no rare or threatened plant species identified in or near the project area. Eight trees will be removed as part of the project because of conflicts with utility relocations. Of these eight trees, only three are Douglas Fir which would be suitable for incorporation into the project. The plan calls for removal of invasive species within the project area and the planting of 107 trees 256 shrubs, and 196 herbs. The proposed restoration plan, when satisfactorily completed and maintained will result in no adverse impact. See Section IX for related conditions of approval.

D. Noise

The site is adjacent to Light Industrial uses. The proposed project will produce short-term noise effects on the surrounding terrestrial environments. Construction noise will be limited by the City's Noise Ordinance (Chapter 9.18 BCC) which regulates construction hours and noise levels. See Section X for a related condition of approval.

VII. Decision Criteria

A. Critical Areas Report Decision Criteria- General Criteria LUC 20.25H.255

The Director may approve, or approve with modifications, the proposed modification where the applicant demonstrates:

1. The modifications and performance standards included in the proposal lead to levels of protection of critical area functions and values at least as protective as application of the regulations and standards of this code;

Finding: The proposed project is not proposing the modification of any of the standards contained in the Land Use Code. The proposed project is expected to improve critical area functions and values in the segments of Sunset Creek. The expected improvements include the following:

- Reduced maintenance dredging frequency in the active channel, reducing habitat disturbance
- Simplified fish exclusion procedures and reduced need for fish capture and relocation during maintenance
- Replacement of 154 lineal feet of riprap bank protection with bioengineered structures and channel modifications and addition of 39 pieces of geomorphically functional large woody debris to the stream channel, resulting in increased hydraulic complexity and habitat diversity.
- Improved water quality.
- Improved fish passage under high and low flow conditions.
- Maintenance of desirable spawning habitat conditions.
- Restoration and enhancement of all areas disturbed by construction.
- Removal of invasive and ornamental riparian vegetation and replacement with site appropriate native species;
- Increased density and coverage of native vegetation, providing improved shade and cover, and increased recruitment of organic material and prey organisms (dense vegetation will also limit human access, reducing harrassment and disturbance of aquatic life).

These habitat improvements will be maintained over the anticipated life of the project, and will be further enhanced by the subsequent phases of the proposed comprehensive flood control and sediment management plan. This project will lead to a increased level of protection of the functions and values of this stream and riparian area.

2. Adequate resources to ensure completion of any required mitigation and monitoring efforts;

Finding: The City of Bellevue Utilities Department is initiating the project and has sufficient resources to complete the required mitigation and monitoring efforts.

3. The modifications and performance standards included in the proposal are not detrimental to the functions and values of critical area and critical area buffers off-site; and

Finding: The proposal does not include a modification of the prescribed buffers on the site. The proposed performance standards are consistent with those in the land use code. The proposed project will be beneficial to the functions and values of the critical area and critical area buffer off-site because it will increase the habitat structure by reducing flooding and sedimentation impacts.

4. The resulting development is compatible with other uses and development in the same land use district.

Finding: The proposal to replace an existing twin barrel 42-inch diameter culvert with an integrated fish-passable culvert and sediment capture structure, modification of the stream channel upstream and downstream of SE 30th and the restoration of the impacted area with native plantings is compatible with the light-industrial uses in the area.

B. Critical Areas Land Use Permit Decision Criteria 20.30P

The proposal, as conditioned below, meets the applicable regulations and decision criteria for a Critical Areas Land Use Permit pursuant to LUC Section 20.30P.

1. The proposal obtains all other permits required by the Land Use Code;

Finding: The proposed project will require a Clearing and Grading Permit from the City of Bellevue. No work on the project will be allowed to commence until the Clearing and Grading permit in addition to permits from other state and federal agencies are issued.

2. The proposal utilizes to the maximum extent possible the best available construction, design and development techniques which result in the least impact on the critical area and critical area buffer;

Finding: The culvert replacement project is designed to address chronic flooding of Sunset Creek at SE 30th Street and adjacent businesses, and provide the ability to adaptively manage habitat conditions and flood conveyance capacity. The integrated sediment trap will capture the majority of sediments transported to this reach of Sunset Creek in most years. This will allow for maintenance dredging to be conducted within the enclosed structure rather than the active channel. Sediment removal will be managed to optimize sediment delivery rates to the channel segment downstream of the structure, maintaining flood conveyance capacity and desirable habitat conditions. The applicant has provided a draft protocol for Channel Monitoring and Replacement Culvert Sedimentation Structure and shall provide a detailed plan with reporting to the Development Services Department on an annual basis for a minimum of 10 years. Construction will only occur during the allowed work windows as established by the Washington Department of Fish and Wildlife. The proposal utilizes the best available construction, design and development techniques which will result in the least impact to critical area functions.

3. The proposal incorporates the performance standards of Part 20.25H to the maximum extent applicable, and ;

Finding: As discussed above in Section II, the proposal does incorporate the applicable performance standards, which will be implemented and enforced as conditions of approval the underlying Clearing and Grading Permit.

4. The proposal will be served by adequate public facilities including street, fire protection, and utilities; and;

Finding: The property is currently served by adequate public facilities. The proposal does not change the need for, or ability to serve the property.

5. The proposal includes a mitigation or restoration plan consistent with the requirements of LUC Section 20.25H.210; and

Finding: The installation of the culvert does not require the preparation of a mitigation plan. However, the proposal includes a restoration plan consistent with LUC 20.25H.210 for the restoration of disturbed areas within and adjacent to the stream channel.

With a condition that the restoration plan meet the standards for plant spacing and sizing found in Critical Areas Handbook and include performance standards and monitoring schedules for fish passage and plant establishment for a period of five years this criteria can be met.

6. The proposal complies with other applicable requirements of this code.

Finding: As discussed in Section IV & V of this report, the proposal complies with all other applicable requirements of the Land Use Code.

VIII. Conclusion and Decision

After conducting the various administrative reviews associated with this proposal, including Land Use Code consistency, SEPA, City Code and Standard compliance reviews, the Director of Planning and Community Development does hereby **approve with conditions** the proposal replace an existing twin barrel 42-inch diameter culvert on Sunset Creek at SE 30th Street with an integrated fish-passable culvert and sediment capture structure and associated modifications of the stream channel upstream and downstream of SE 30th for the purpose of flood control and sediment management.

Note- Expiration of Approval: In accordance with LUC 20.30P.150 a Critical Areas Land Use Permit automatically expires and is void if the applicant fails to file for a Clearing and Grading Permit or other necessary development permits within one year of the effective date of the approval.

IX. Conditions of Approval

The applicant shall comply with all applicable Bellevue City Codes and Ordinances including but not limited to:

Applicable Ordinances	Contact Person
Clearing and Grading Code- BCC 23.76	Tom McFarlane, 425-452-5207
Land Use Code- BCC 20.25H	Heidi M. Bedwell , 425-452-4862
Noise Control- BCC 9.18	Heidi M. Bedwell, 425-452-4862

The following conditions are imposed under the Bellevue City Code or SEPA authority referenced:

1. Restoration for Areas of Temporary Disturbance: A detailed restoration plan for all areas of temporary disturbance is required to be submitted for review and approval by the City of Bellevue prior to the issuance of the Clearing and Grading Permit. The plan shall include the documentation of existing site conditions and shall identify the restoration planting plan and include performance standards and monitoring schedules for fish passage and plant establishment for a period of five years. The restoration plan must contain native shrubs and trees and most conform to planting details, densities outlined in the City of Bellevue Critical Area Handbook where suggested densities do not match the standard. No permits shall be issued until the associated restoration plan has been approved by the City. Any modifications to this plan must be submitted for review and approval by the City prior to commencing any work.

Authority: Land Use Code 20.25H.220.H
Reviewer: Heidi M. Bedwell, Land Use Division

2. Rainy Season restrictions: Due to the proximity to Sunset Creek, a type F stream, no clearing and grading activity may occur during the rainy season, which is defined as November 1 through April 30 without written authorization of the Development Services Department. Should approval be granted for work during the rainy season , increased erosion and sedimentation measures, representing the best available technology must be implemented prior to beginning or resuming site work.

Authority: Bellevue City Code 23.76.093.A
Reviewer: Tom McFarlane, Development Services Department

3. Culvert Monitoring and Maintenance Prior to approval of the clearing and grading permit, the applicant shall prepare a detailed protocol for Channel Monitoring and Replacement Culvert Sedimentation Structure Maintenance. The report shall detail surveying protocol of the channel cross sections up stream and downstream of the culvert replacement and streambed sediment surveying for both pebble counts and subsurface bulk sampling and sieve analysis. Surveying and sampling shall be for a period of 5 years annually and semi-annually for the following 10 years. The report shall also detail measures to address sediment delivery rates which are different from predicted outcomes including but not limited to gravel nourishment and sediment removal. Reporting of the survey findings shall be given to the Development Services Department on an annual basis.

Authority: Land Use Code 20.25H.220.H
Reviewer: Heidi M. Bedwell, Land Use Division

4. Noise Control: Noise related to construction is exempt from the provisions of BCC 9.18 between the hours of 7 am to 6 pm Monday through Friday and 9 am to 6 pm on Saturdays, except for Federal holidays and as further defined by the Bellevue City Code. Noise emanating from construction is prohibited on Sundays or legal holidays unless expanded hours of operation are specifically authorized in advance. Requests for construction hour extension must be done in advance with submittal of a construction noise expanded exempt hours permit.

Authority: Bellevue City Code 9.18
Reviewer: Heidi M. Bedwell, Land Use Division

5. Temporary Erosion and Sedimentation Control Plan: Prior to approval of the underlying clearing and grading permit and initiation of any clearing or grading activities, a Temporary Erosion and Sedimentation Control Plan must be approved as part of a Clearing and Grading permit and all clearing limits and the location of temporary erosion and sedimentation control measures shall be field staked for approval by the on-site clearing and grading inspector's approval.

Authority: Bellevue City Code 23.76
Reviewer: Tom McFarlane, Development Services Department

6. Turbidity Monitoring Plan: Prior to approval of the underlying clearing and grading permit and initiation of any clearing and grading activities, a Turbidity Monitoring Plan must be approved as part of the Clearing and Grading Permit.

Authority: Bellevue City Code 23.76
Reviewer: Tom McFarlane, Development Services Department

7. Use of removed trees: Three Douglas fir trees removed as part of the proposed project shall be incorporated into the project designs to the extent possible.

Authority: Land Use Code 20.25H.180.C.2
Reviewer: Heidi M. Bedwell, Land Use Division

8. Applicable State and Federal Permits: Prior to approval of the underlying clearing and grading permit and before work can be allowed to proceed, all applicable state and federal permits must be presented to the Development Services Department.

Authority: Land Use Code 20.25H.180.C.2
Reviewer: Heidi M. Bedwell, Land Use Division

9. Fish protection measures: The applicant shall implement WSDOT Fish Exclusion Protocols and Standards to ensure fish resources in the project reach are protected during construction.

Authority: Land Use Code 20.25H.160
Reviewer: Heidi M. Bedwell, Land Use Division

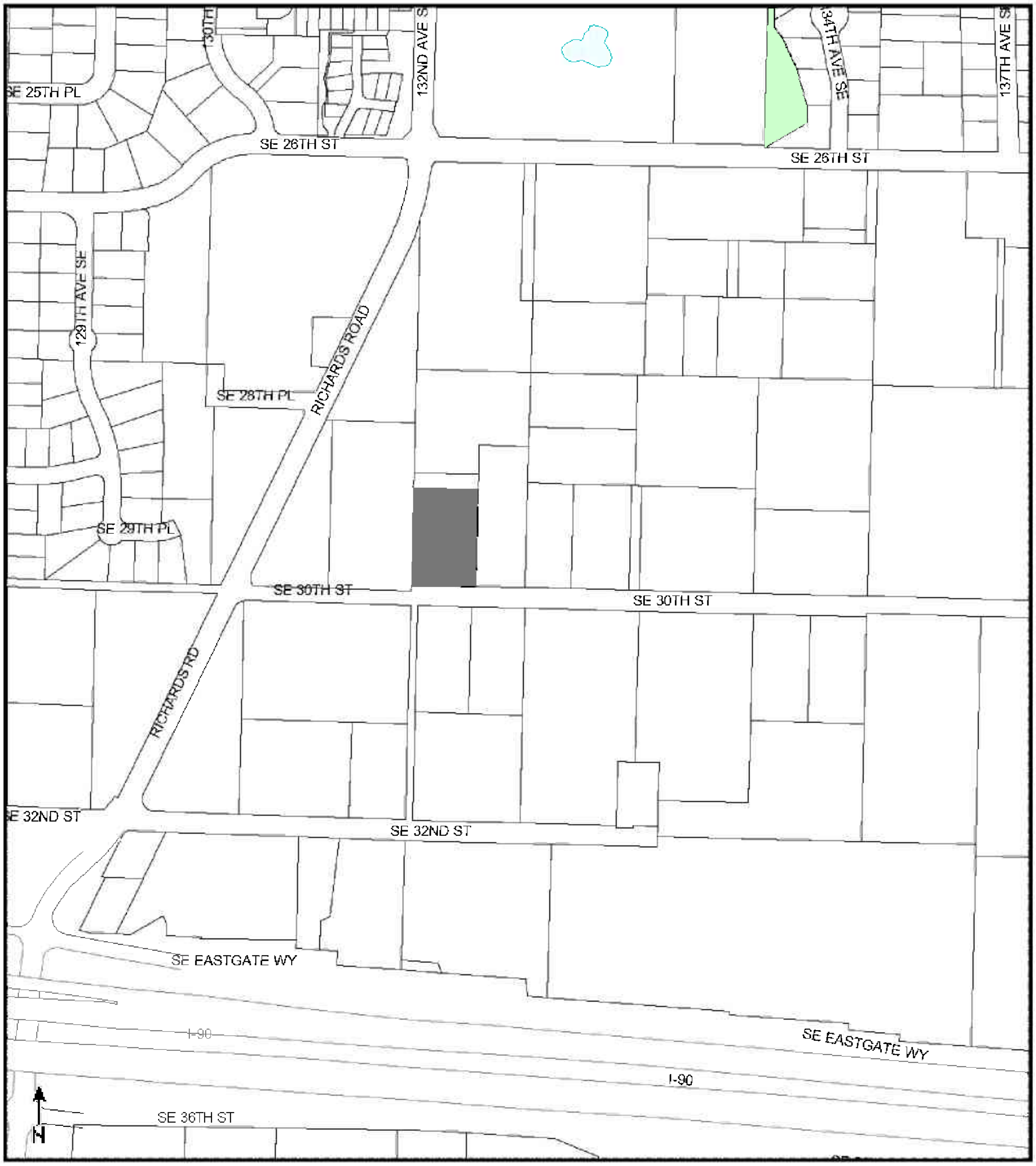
10. In-Water Work Window: Work in the active channel approved by the underlying Clearing and Grading Permit must be completed during an in-water work window of July 1 through August 31 or as allowed per the Washington Department of Fish and Wildlife, HPA conditions.

Authority: Land Use Code 20.25H.160
Reviewer: Heidi M. Bedwell, Land Use Division

Attachments

1. Vicinity Map
2. Critical Areas Report
3. Addendum to the Critical Areas Report
4. Environmental Checklist
5. Public Comment

Attachment 1
Vicinity Map



City of Bellevue
Information Technology
Geographic Information Services
August 27, 2008

Vicinity Map

08-128529 LO COB Sunset Creek Flood Improvement

This map is derived from the Bellevue Geographic Information System and designed for City staff use. It is not guaranteed accurate.

If you have specific questions regarding this map, contact the department shown.

Site
Park
School


VICINITY MAP

Attachment 2

Critical Areas Report (Includes Development Plans and supplemental material provide to the State and Federal Permitting agencies- JARPA & BE)

HERRERA
ENVIRONMENTAL
CONSULTANTS

June 27, 2008

Heidi Bedwell
City of Bellevue
Department of Planning and Community Development
450 110th Avenue NE
P.O. Box 90012
Bellevue, WA 90009

Subject: SE 30th Street/Sunset Creek Flood Improvement Project – Phase 1: Abbreviated Critical Areas Report

Dear Heidi:

On behalf of Brian Ward of the City of Bellevue Utilities Department, Herrera Environmental Consultants has prepared an abbreviated report intended to satisfy Critical Areas Report requirements for the proposed SE 30th Street/Sunset Creek Flood Improvement Project. Per agreement between you and Brian, this report specifically identifies the components of existing permitting documentation that satisfy the Critical Areas Land Use Permit reporting requirements codified under LUC 20.25H.250.B. Where necessary, the report provides additional supporting information and interpretation to fully comply with these requirements.

The technical and permitting documents referenced in this report include:

- The Joint Aquatic Resources Permitting Application (JARPA) submitted to the Washington Department of Fish and Wildlife
- The Biological Assessment (BA) prepared to satisfy Endangered Species Act Consultation in conjunction with U.S. Army Corps of Engineers permitting requirements

Copies of these documents are included as appendices to the enclosed Abbreviated Critical Areas Report.

Please do not hesitate to contact Chase Barton or me if you have any questions or require additional information.

Sincerely,

Herrera Environmental Consultants, Inc.

Eric Doyle
Fisheries Biologist/Project Scientist

Enclosure: Abbreviated Critical Areas Report

cc: Brian Ward, Utilities

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Sequim
Washington
98382

(360) 683-9109
FAX 683-3671

ABBREVIATED CRITICAL AREAS REPORT

SE 30th Street / Sunset Creek Flood Improvement Project

Prepared for

City of Bellevue
Utilities Department

June 27, 2008

Contents

1 Introduction

The City of Bellevue (the City) proposes to replace existing twin barrel 42-inch diameter culverts on Sunset Creek at SE 30th Street with an integrated fish-passable culvert and sediment capture structure. Installation of the new structure will require modification of the stream channel upstream and downstream of SE 30th Street. These modifications will include eight grade control structures upstream and two grade control structures downstream of the culvert, riprap removal and replacement with bioengineered bank protection structures, and stream and riparian habitat enhancement. Channel and riparian modifications will take place over a segment of Sunset Creek extending from approximately 110 feet upstream to approximately 60 feet downstream of SE 30th Street.

The culvert replacement project (hereafter referred to as the proposed action) is designed to address chronic flooding of Sunset Creek at SE 30th Street and adjacent businesses, and provide the ability to adaptively manage habitat conditions and flood conveyance capacity. The integrated sediment trap will capture the majority of sediments transported to this reach of Sunset Creek in most years. This will allow for maintenance dredging to be conducted within the enclosed structure rather than the active channel. Sediment removal will be managed to optimize sediment delivery rates to the channel segment downstream of the structure, maintaining flood conveyance capacity and desirable habitat conditions.

The proposed project is planned as Phase 1 of a multiple-phase Flood Control and Sediment Management Plan for Richards Creek, Sunset Creek, and East Creek that is currently in development. The intent of this multi-phase effort is to provide a comprehensive solution to ongoing sediment management and flooding challenges in these drainages, and produce a net improvement in habitat conditions. While considered part of this larger effort, Phase 1 has independent utility and is being implemented separately to address immediate needs.

Under Bellevue Land Use Code (LUC) 20.25H.250, project proponents are required to prepare a Critical Areas Report (CAR) when the action they propose might affect the ecological functions and values provided by designated critical areas. The CAR provides the information needed by the City's Department of Planning and Community Development (PCD) to evaluate consistency with these requirements and determine if proposed restoration and mitigation adequately compensate for affected critical area functions and values.

In lieu of preparing a full CAR, PCD staff indicated they will accept an abbreviated CAR supported by the other permitting documents prepared for the proposed action. An abbreviated CAR is acceptable, providing that it clearly identifies the elements of the existing technical and permitting documentation that satisfy CAR requirements detailed in LUC 20.25H.250.B. This report has been prepared in accordance with this agreement. It identifies the pertinent elements of permitting documents that address CAR requirements, and provides additional supporting information where necessary.

The existing technical and permitting documents referenced in this report include:

- The Joint Aquatic Resources Permit Application (JARPA) (Appendix A)
- The Biological Assessment (BA) prepared to satisfy Endangered Species Act Consultation in conjunction with U.S. Army Corps of Engineers permitting requirements (Appendix B)

The general location of the proposed action is shown on Figure 1 of the BA (see BA page 2). The construction limits for the proposed action are shown generally in BA Figure 2 (see BA page 15), and more specifically in the project plans (see BA, Appendix B and/or the JARPA). The extent of anticipated direct and indirect impacts associated with the proposed action are best represented by the aquatic component of the action area, as shown on BA Figure 3 (see BA page 39), and the clearing limits shown in plan sheet C-10 (see BA Appendix B). For the purpose of this report, these combined effect limits are referred to hereafter as the impact area. (The remaining component of the action area outlined in red represents short-term construction noise impacts which are not a CAR reporting requirement.) The majority of the impact area downstream of SE 30th Street represents anticipated gradual and long-term changes in habitat conditions expected to result from adaptive management of sediment delivery rates. The design of the proposed action, construction methods, impact avoidance and minimization measures, best management practices (BMPs), and mitigation and monitoring are described in detail in the BA.

2 Critical Areas Report

Consistent with LUC 20.25H.245, the supporting information upon which this report is based was developed by qualified professionals in the areas of hydrologic and hydraulic modeling, geomorphology, engineering and fisheries biology, using the best available science and guidance. This report relates the pertinent elements in existing documentation to CAR information needs specified in LUC 20.25H.250. For ease of reference, this information is presented following the stepwise listing of CAR reporting requirements provided in LUC 20.25H.250.B.

2.1 Identification and Classification of Critical Areas and Critical Area Buffers

This subsection addresses LUC 20.25H.250.B. subsections 1 and 2. Identified critical areas and critical area buffers within and adjacent to the impact area include the following:

Streams and stream buffers: The proposed action will be constructed in and/or have direct and indirect effects on the lower Sunset Creek and upper Richards Creek stream channels identified in BA Figures 2 and 3 (see BA pages 12 and 37). Under the definitions provided in LUC 20.25H.075.B, subsection 2, both stream systems are classified as Type F (fish bearing) waterbodies. Under LUC 20.25H.075.C, subsection 1.a.ii, streams of this class have a designated buffer width of 50 feet. Historic development of the area prior to institution of critical areas protections has encroached upon the stream buffer. Buildings, roadways, and paved parking lots limit the existing and potential riparian zone to an average width of 10 to 30 feet.

Vegetation and channel conditions within these critical areas are described in the BA (see BA pages 5-8).

Habitats associated with species of local importance: Richards Creek and Sunset Creek are known and/or presumed habitat for Chinook and coho salmon, both of which are identified as species of local importance under LUC 20.25H.150.A. Chinook salmon are currently listed as threatened under the Endangered Species Act (ESA) (64 CFR 14308-14328). The buffers defined for fish bearing streams also apply to this critical area type. Additional detail on habitat use by these species, as well as other species of importance, is provided in Section 2.3.2 of this report.

No amphibian, avian, or mammal species of local importance were observed in the impact area during site surveys. Habitat conditions are generally not suitable for these species due to natural characteristics or the degraded condition of the stream buffer. Large trees that could serve as perch areas for raptors and woodpeckers are a possible exception, but these habitat elements will remain protected. There are no wetlands (LUC 20.25H.095) or geologic hazard areas (LUC

20.25H.120) within the impact area, or on adjacent properties. Neither Richards nor Sunset Creek are designated as shoreline critical areas under LUC 20.25H.115. Critical areas adjacent to the site include the Richards Creek stream channel and associated buffer upstream of the Sunset Creek confluence (existing buffer conditions are similar to those described above for Sunset Creek).

2.2 Regulations and Codes Proposed for Modification

The proposed action is classified as an allowable use under LUC 20.25H.055.B (new or expanded culverts and bridges). Under LUC 20.25H.055.C, subsection 2, this type of use is allowed providing certain performance standards are met. Consistent with the CAR guidance, relevant performance standards are discussed in detail in Section 7 of this report.

2.3 Habitat Assessment Report

This subsection identifies the elements of existing documentation that satisfy Habitat Assessment Report (HAR) requirements specified under LUC 20.25H.165.A.

2.3.1 Vegetation on and Adjacent to the Site

Vegetation conditions in the stream's buffer are described in the BA, under Vegetation and Wetlands (see BA page 5).

2.3.2 Species of Local Importance with Primary Habitat Association

Chinook salmon use of the impact area is described in detail in the BA (see BA page 40). Coho spawning and rearing has been documented in the Richards and Sunset Creek channels up to and immediately upstream of SE 30th Street (Paulsen 2007; WDFW 2004, 2007a, 2007b). Neither species has been documented in the impact area in recent years, as a result of two factors: depressed population abundance; and partial barriers to fish passage created by beaver activity in downstream areas of Richards Creek (Paulsen 2007).

While not currently considered a species of local importance, steelhead trout are listed as threatened under the ESA (72 FR 26722-26735) and are of special concern from a state and federal permitting perspective. This species has been historically documented in the Kelsey Creek system and could potentially occur in the impact area. Potential habitat use is described in the BA (see BA page 42).

The streams and associated stream buffers within the impact area described in the previous subsections comprise the primary habitats utilized by these species of local importance.

2.3.3 Federal, State, or Local Management Recommendations

No specific federal or state level management recommendations have been developed for Sunset Creek and Richards Creek. However, area biologists with WDFW and the Muckleshoot Tribe have both expressed a strong sentiment toward the maintenance and improvement of riparian functions and the protection of spawning habitat provided by Sunset Creek within the impact area (Fisher 2007; Walter 2007). Lead City of Bellevue biologists have expressed similar concerns (Paulsen 2007).

Sediment accumulation and chronic flooding in this area have been ongoing management concerns at the local level for several years. The City has invested considerably in infrastructure to address sediment delivery from upstream source areas (i.e., the high-flow bypass system in upper Sunset Creek), and in comprehensive planning to address these issues (e.g., the Richards Creek Basin Plan [Entranco 1999], and the ongoing comprehensive flooding and sediment management planning effort discussed in Section 1 of this report). The proposed action is consistent with these other city efforts.

2.3.4 Direct and Indirect Impacts

The anticipated direct and indirect impacts of the proposed action are described in detail in the BA (see BA pages 27-34). The discussion includes consideration of the indirect effects of ongoing sediment management activities in the impact area on channel conditions, and the habitat benefits expected to result from the proposed action.

2.3.5 Impact Avoidance, Minimization, and Mitigation Measures

The proposed action incorporates two general categories of impact avoidance and minimization measures:

1. Conceptual planning for the project based on the best available science and appropriate guidance

2. Standard BMPs employed to avoid and minimize short-term, construction related direct effects.

The conceptual planning element is discussed under Applicable Performance Standards (Section 2.6). Construction BMPs and long-term maintenance related measures are discussed in the BA (see BA pages 20-22).

With regard to mitigation requirements, the proposed project is considered to be self-mitigating because it will result in a net-increase in critical area functions and values. Supporting information for this position is provided in Section 2.7.

2.3.6 Ongoing Management Practices for Habitat Protection

The proposed project includes a long-term monitoring and adaptive management plan to ensure that desired habitat conditions in the project impact area are maintained. This component, which is critical to achieving the desired net improvement in critical areas functions and values, is detailed in the BA (see BA pages 22-24).

2.4 Probable Cumulative Impacts

With regard to cumulative impacts, the long-term indirect effects, effects of interrelated and interdependent actions, and project benefits described in the BA (see BA pages 29-34) provide the best measure of long-term anticipated project effects. As noted in the introduction, the proposed action is considered to be Phase 1 of a broader plan to comprehensively address sediment loading, chronic flooding, and habitat conditions in the Sunset Creek/Richards Creek/East Creek confluence area. The intent of the broader plan is to develop a comprehensive solution to sediment accumulation and flooding problems in this area while enhancing aquatic and riparian habitat conditions. The combined cumulative effects of these actions are expected to be beneficial on balance, as they will: 1) reduce the need for routine maintenance dredging of the active channel; 2) decrease the frequency of flooding of adjacent impervious surfaces that contribute pulses of non-point source pollution during storm events, and 3) incorporate extensive channel and riparian habitat enhancements. These combined elements should result in a net improvement in chronic flooding, a reduction in maintenance-related habitat disturbance, and improved habitat conditions.

The proposed action is not expected to lead to additional cumulative effects. It will not increase the traffic capacity of SE 30th Street, nor will it facilitate future development. Therefore, there are no effects associated with land use changes that can be ascribed to the action.

2.5 Critical Areas Functions and Values Protection Assessment

This component of the CAR requires a pre- and post-project assessment of the level of protection afforded to critical area functions and values by the regulations and standards in the LUC. This assessment must include the following components:

- Existing functions and values provided by critical areas and critical area buffers
- Projected future functions and values should the project be permitted
- Projected future functions and values should the project not be permitted.

These assessment elements are addressed in the following sections.

2.5.1 Existing Functions and Values Provided by Affected Critical Areas

Existing conditions in the Sunset Creek/Richards Creek impact area are degraded. The surrounding area was developed for commercial and light industrial uses during the 1960s and 1970s, prior to the establishment of critical areas protections. To accommodate this development, much of the existing channel network was relocated, straightened, and contained within riprap armored channels. Property development was allowed to encroach upon the streams, limiting the effective riparian buffer to less than 20 feet on either side of the stream in most circumstances. The remaining riparian buffer is composed of a sparse mix of ornamental, invasive, and native vegetation.

Before historic hydromodification, stream channels within the project area would have naturally aggraded and shifted location across an alluvial fan, occupying the course of least resistance. Development related hydromodification halted the natural process of channel migration and restricted the natural process of sediment deposition to the established channel corridors. Concurrent development of headwater areas of the drainage proceeded without adequate stormwater detention, resulting in an increased sediment supply rate that has proven difficult to mitigate. Sediment aggradation in the project vicinity currently exceeds transport capacity, resulting in chronic sediment deposition that reduces channel capacity and promotes flooding. As a consequence, the City must dredge the active channel annually to maintain flood conveyance. While considered an allowable use under LUC 20.25H.055.B, this activity nonetheless contributes to chronic disturbance of the channel and channel buffer.

The functions and values provided by the area proposed for modification are mixed. Under natural conditions, this alluvial fan reach likely provided prime spawning habitat for resident and migratory fish, including salmon and steelhead. Even in its current degraded state, the aggraded stream reach immediately downstream of SE 30th Street continues to provide important spawning habitat. However, the inability of the channel to migrate in response to sediment deposition has created an overly wide and shallow channel condition that limits the quality and quantity of useable spawning habitat and presents a low flow passage barrier.

Protecting and enhancing remaining spawning habitat in the Kelsey Creek watershed is considered a central objective of critical areas management by the City. This system is spawning habitat limited (Paulsen 2007), meaning that salmonid productivity in the system is constrained by the amount of available habitat suitable for spawning. Preserving existing spawning habitat and increasing its function will directly benefit species of local interest.

2.5.2 Projected Future Conditions: Proposed Action Permitted

The proposed action is expected to improve critical area functions and values in the segments of Sunset Creek and Richards Creek within the impact area. The expected improvements include the following, by critical area and critical area buffer category:

- Streams and habitats used by species of local interest:

- ☐ Reduced maintenance dredging frequency in the active channel, reducing habitat disturbance

- ☐ Simplified fish exclusion procedures and reduced need for fish capture and relocation during maintenance

- ☐ Replacement of 154 lineal feet of riprap bank protection with bioengineered structures and channel modifications and addition of 39 pieces of geomorphically functional large woody debris to the stream channel, resulting in increased hydraulic complexity and habitat diversity (see BA page 32)

- ☐ Improved water quality (see BA pages 34, 43-53)

- ☐ Improved fish passage under high and low flow conditions (see BA pages 33-34)

- ☐ Maintenance of desirable spawning habitat conditions (see BA pages 43-53).

- ▪ Stream buffers, and buffers for habitats used by species of local interest (see BA, Appendix B, Drawings P1-P3):

  - ☐ Restoration and enhancement of all areas disturbed by construction;

  - ☐ Removal of invasive and ornamental riparian vegetation and replacement with site appropriate native species;

  - ☐ Increased density and coverage of native vegetation, providing improved shade and cover, and increased recruitment of organic material and prey organisms (dense vegetation will also limit human access, reducing harrassment and disturbance of aquatic life).

These habitat improvements will be maintained over the anticipated life of the project, and will be further enhanced by the subsequent phases of the proposed comprehensive flood control and sediment management plan for this portion of the Richards Creek drainage discussed elsewhere in this report.

2.5.3 Projected Future Conditions: Proposed Action Denied

Should the proposed action not go forward, the protections afforded by existing critical areas regulations would be expected to maintain habitat conditions in a degraded state. Routine annual maintenance dredging of the active channel would continue, resulting in episodic habitat disturbance, including fish capture and handling during work area dewatering. Chronic sediment aggradation upstream and downstream of the SE 30th Street culvert would continue to pose high flow and low flow barriers to fish passage. Periodic water quality degradation associated with overland flooding of adjacent impervious surfaces would continue unabated. Riparian vegetation would likely remain in its current degraded state, dominated by sparse ornamental and invasive species.

2.6 Applicable Performance Standards

Pertinent performance standards for culvert replacement are specified under LUC 20.25H.055.C. These standards require demonstration that the proposed action is the most technically feasible and appropriate solution to the problem at hand, and that the solution is designed consistent with applicable best available science and guidance.

The proposed action presents the most technically feasible solution to sediment accumulation and flooding issues that characterize the SE 30th Street crossing of Sunset Creek. As described in the BA summary of hydraulic and geomorphic characteristics (see BA pages 6-8), historic hydromodification of this channel segment has created a condition in which sediment deposition rates exceed transport capacity. This causes chronic aggradation inside the culvert and immediately upstream and downstream that in turn contributes to chronic flooding. The City has invested considerable resources in infrastructure to address sediment delivery from upstream source areas. However, a detailed analysis of current and projected future conditions (currently in preparation) has indicated that sediment delivery rates will exceed transport capacity for the foreseeable future even if additional source control measures are implemented. This will contribute to ongoing sediment deposition in the SE 30th Street vicinity, poor culvert performance, and continued chronic flooding. Annual maintenance dredging required to minimize this flooding will maintain aquatic habitat conditions in a degraded state (LUC 20.25H.055.C, subsection 2.a.v.).

The proposed action will address these issues by increasing the hydraulic capacity of the culvert and adjacent channel and improving sediment management capability. In combination with the improved habitat conditions provided by riparian enhancement and addition of instream wood structures, the ability to adaptively manage sediment delivery rates to the downstream channel will result in improved habitat conditions. The channel will be allowed to gradually erode the existing sediment deposit until a more suitable width/depth ratio is reached. Substrate conditions will be monitored to ensure desirable spawning habitat attributes are maintained. As such, the long-term impacts of the proposed action are anticipated to be beneficial. While short-term construction related impacts will occur, the BMPs and impact avoidance and minimization measures incorporated into the design will limit their duration and extent. The site will be fully restored following project completion and riparian vegetation in stream buffer areas will be enhanced relative to current conditions (LUC 20.25H.055.C, subsections 2.b.i, ii, and viii).

Per the requirements of LUC 20.25H.055.C, subsection 3, the culvert replacement structure and related stream modifications have been designed by qualified professionals consistent with the best available science and the appropriate guidance. As stated in the BA (see BA pages 24-25) the entire design is based on a comprehensive assessment of watershed, reach, and site specific hydrologic, hydraulic, and geomorphic conditions. This approach is consistent with the Integrated Streambank Protection Guidelines prepared by the Washington State Aquatic Habitat Guidelines Program (WSAHGP 2003). As discussed in the JARPA (see JARPA page 10), the culvert replacement structure has been designed in accordance with WDFW culvert design guidance (WDFW 2003), using the stream simulation method. The culvert replacement is strictly intended to address flood control and sediment management issues at the existing road crossing. It will not change the traffic capacity of the existing roadway or otherwise facilitate new development.

2.7 Restoration and Mitigation Requirements

Mitigation and restoration requirements associated with this type of project are defined based on the type of critical area affected. As discussed, the proposed project will result in two categories of functional effects: short-term construction related effects on the stream buffer; and long-term beneficial effects on the stream buffer and stream habitat conditions, including habitats used by species of local importance.

With regard to short-term effects, all areas disturbed during construction of the proposed action will be fully restored and enhanced. The construction plans incorporate measures to protect existing trees, avoid native vegetation, and concentrate disturbance in areas dominated by invasive or ornamental vegetation. All disturbed areas will be replanted with site appropriate native species. Existing invasive and ornamental vegetation will be removed. The site revegetation plan, prepared in accordance with City requirements, is provided in Appendix B of the BA (see Drawings P1-P3).

Per LUC 20.25H.085.A, mitigation is specifically intended to replace loss or degradation of critical area and buffer values and functions caused by a proposed action. Mitigation requirements specific to streams and stream buffers include the following in the stated order of preference:

1. On-site, through replacement of lost critical area buffer

2. On-site, through enhancement of the functions and values of remaining critical area buffer

3. Off-site, through replacement or enhancement, in the same sub-drainage basin

4. Off-site, through replacement or enhancement, out of the sub-drainage basin but in the same drainage basin.

Per LUC 20.25H.085.B, lost values and functions shall be mitigated with a one-to-one ratio.

Based on these requirements, the proposed action is considered to be self-mitigating. No further mitigation should be required because: 1) the project will result in an immediate and long-term net-improvement in critical area values and functions, and 2) the project incorporates long-term monitoring and adaptive management to ensure that desirable conditions are maintained overtime. Because no loss of critical area functions and values will result from the proposed action, no further mitigation measures should be required.

3 References

Entranco. 1999. Richards Creek Basin Plan. Prepared for the City of Bellevue by Entranco, Bellevue, Washington. July 26, 1999.

Fisher, Larry. 2007. Personal communication (field meeting with Eric Doyle, Herrera Environmental Consultants, Inc., Seattle, Washington, regarding proposed SE 30th Street/Sunset Creek Culvert Replacement Project). Regional biologist, Washington Department of Fish and Wildlife. August 20, 2007.

Paulsen, Kit. 2007. Personal communication (field meeting with Eric Doyle, Herrera Environmental Consultants, Inc., Seattle, Washington, regarding proposed SE 30th Street/Sunset Creek Culvert Replacement Project). City of Bellevue habitat biologist. August 20, 2007.

Walter, Karen. 2007. Personal communication (comment made during field meeting with Eric Doyle, Herrera Environmental Consultants, Inc., Seattle, Washington, regarding proposed SE 30th Street/Sunset Creek Culvert Replacement Project). Regional biologist, Muckleshoot Indian Tribe. August 20, 2007.

WDFW. 2003. Design of Road Culverts for Fish Passage. Washington Department of Fish and Wildlife, Habitat Program, Environmental Engineering Subsection, Olympia, Washington.

WDFW. 2004. Salmonid Stock Inventory, WRIA 8. Washington Department of Fish and Wildlife. Obtained on November 12, 2007 from agency website: <http://wdfw.wa.gov/cgi-bin/database/sasi_search_new_db.cgi?keyword=08&field=4&search_sort=sort&srchtype=within&job=search&wria=wria>.

WDFW. 2007a. Salmonscape Database. Washington Department of Fish and Wildlife. Obtained August 10, 2007 from agency website: <http://wdfw.wa.gov/mapping/salmonscape/index.html>.

WDFW. 2007b. Priority Habitats and Species database information for S9/S10T24NR05E. Data request dated August 9, 2007; data received September 1, 2007.

WSAHGP. 2003. Integrated Streambank Protection Guidelines. Washington State Aquatic Habitat Guidelines Program, Washington Department of Fish and Wildlife, Washington Department of Ecology, Washington State Department of Transportation. April 2003.

APPENDIX A

Joint Aquatic Resources Permit Application

AGENCY USE ONLY	JARPA FORM LAST UPDATED: March 19, 2007
Agency Reference #:	Date Received:
Circulated by:	(local govt. or agency)
Project Tracking Number:	

Washington State **JOINT AQUATIC RESOURCES PERMIT APPLICATION (JARPA)** Form

Step 1: Get Ready	Step 2: Complete Form		Step 3: Check Work	Step 4: Copy and Send In
Go to www.epermitting.org for **correct form** and **instructions**.	Use **black ink**. Check correct permit boxes.	Use internet **"Help" buttons** to answer questions completely.	Use final review checklist at www.epermitting.org .	See **JARPA Contacts** at www.epermitting.org for correct mailing addresses.

☐ Fish Habitat Enhancement Projects per RCW 77.55.181. You must submit copy of completed JARPA form and Fish Habitat Enhancement JARPA Addition to your Local Government Planning Dep't and WA Dep't of Fish and Wildlife (WDFW) Area Habitat Biologist on same day. Note for Local Governments: You must submit comments to WDFW within 15 working days.

Based on instructions at www.epermitting.org, I am sending copies of this application to the following: *(check all that apply)*

☒ Local Government for Shoreline: ☐ Substantial Development ☐ Conditional Use ☐ Variance ☐ Exemption ☐ Revision
☒ Floodplain Management ☒ Critical Areas Ordinance

☒ Washington Department of Fish and Wildlife for Hydraulic Project Approval (Submit 2 copies to WDFW Region)

☒ Washington Department of Ecology for 401 Water Quality Certification (to Regional Office-Federal Permit Unit)

☐ Washington Department of Natural Resources for Aquatic Resources Use Authorization Notification

☒ Corps of Engineers for: ☒ Section 404 permit ☐ Section 10 permit

☐ Coast Guard for: ☐ General Bridge Act Permit ☐ Private Aids to Navigation (for non-bridge projects)

☐ For Department of Transportation projects only: This project will be designed to meet conditions of the most current Ecology/Department of Transportation Water Quality Implementing Agreement

PROJECT TITLE: SE 30th Street / Sunset Creek Culvert Replacement

PROJECT DESCRIPTION:

The City of Bellevue proposes to replace existing twin 42-inch diameter corrugated metal pipe culverts on Sunset Creek at SE 30th Street with a stream simulation and sedimentation structure, and modify the Sunset Creek channel upstream and downstream to match the culvert replacement structure invert elevations. Proposed channel modifications include removing existing riprap along the channel banks and culvert headwalls, modifying the streambed grade, installing grade control and bank stabilization structures made primarily of boulders and large woody debris, and revegetating disturbed streambanks. The culvert replacement project is designed to reduce ongoing flooding of SE 30th Street and adjacent properties and manage sediment transported in Sunset Creek to eliminate the need for annual dredging in the active channel upstream and downstream of the culvert openings. The replacement culvert project is designed to transmit the 100-year flood without allowing flow to overtop SE 30th Street, store approximately 50 cubic yards of sediment within the culvert structure, and provide improved aquatic habitat and fish passage conditions.

SECTION A - Use for all permits covered by this application. Be sure to ALSO complete Section C (Signature Block) for all permit applications.

help 1. APPLICANT
City of Bellevue Utilities, Brian Ward (Project Manager)

MAILING ADDRESS
450 110th Ave NE, 5th Floor, Bellevue, WA 98004

WORK PHONE	E-MAIL ADDRESS	HOME PHONE	FAX #
425-452-5206	**bward@bellevuewa.gov**	**206-334-1500**	**425-452-5286**

If an agent is acting for the applicant during the permit process, complete #2. Be sure agent signs Section C (Signature Block) for all permit applications

help 2. AUTHORIZED AGENT
Herrera Environmental Consultants, Inc. (Chase Barton, Project Manager)

MAILING ADDRESS
2200 Sixth Avenue, Suite 1100, Seattle, Washington 98121

WORK PHONE	E-MAIL ADDRESS	HOME PHONE	FAX #
206-441-9080	**cbarton@herrerainc.com**	**206-910-4403**	**206-441-9108**

help 3. Relationship of applicant to property: ☒ OWNER ☐ PURCHASER ☐ LESSEE ☐ ______

help 4. Name, address and phone number of property owner(s) if other than applicant:
E.S. Harrington, 13120 SE 30th Street, Bellevue, Washington 98005
Stead Building Partnership, 13200 SE 30th Street, Bellevue, Washington 98005
SLC Investment LLC, 13201 SE 30th Street, Bellevue, Washington 98005
SCC Property Holdings, 13111 SE 30th Street, Bellevue, Washington 98005

help 5. Location (street address, including city, county and zip code, where proposed activity exists or will occur)
SE 30th Street, approximately 500 feet east of Richards Road SE, Bellevue, King County, Washington 98005

help Local government with jurisdiction (city or county) **City of Bellevue**

help Waterbody you are working in		**Sunset Creek**		help Tributary of **Richards Creek**		help WRIA # **8**
help Is this waterbody on the 303(d) List ☐ YES ☒ NO If **YES**, what parameter(s)?				help Shoreline designation	**N/A**	
				help Zoning designation	**Light Industrial**	
¼ Section	Section **9 and 10**	Township **24 North**	Range **5 East**	Government Lot	help DNR stream type if known	**Type F**
help Latitude and Longitude:		**47^{0}35'01"N, 122^{0}09'52"W**		Tax Parcel Number	**5453300194, 5453300183, 5453300244, 5458300291**	

help 6. Describe (a) the current use of the property, (b) structures existing on the property, and (c) existing environmental conditions.
Have you completed any portion of the proposed activity on this property? ☐ YES ☒ NO
For any portion of the proposed activity already completed on this property, indicate month and year of completion.

a & b) The project improvements are proposed to occur within existing city street right-of-way and adjacent privately owned parcels. The culvert replacement site is located within the right-of-way of SE 30th Street along the same alignment as the existing twin 42-inch diameter culverts. Upstream channel modifications are to occur primarily within an existing city right-of-way for 132nd Avenue SE, which was never completed in this location. Some channel modification, site access and revegetation activities associated with upstream channel modifications may also occur on private parcels (tax parcel numbers 5453300244, 5453300291). Downstream channel modifications are proposed on private parcels (tax parcel numbers 5453300194 and 5453300183). The taxpayers, property name, property type and present use of the private parcels associated with the proposed project activities are presented in Table 1. Initial discussions have been initiated with private parcel owners by the City of Bellevue, and there is no indication of any opposition to the proposed project activities.

Table 1. Property characteristics for private parcels associated with proposed project activities.

Tax Parcel Number	Taxpayer	Property Name	Property Type	Present Use
5453300244	SCC Property Holdings	Shurgard Mini Storage	Commercial	Mini Warehouse
5453300291	SLC Investment LLC	Printed Circuits Assembly Corp.	Commercial	Industrial Park
5453300194	Emmett S. Harrington	Shurgard Mini Storage	Commercial	Mini Warehouse
5453300183	Stead Building Partnership	Stead Building	Commercial	Warehouse

c) Sunset Creek is located in the Kelsey Creek subarea of WRIA 8. Approximately 400 feet downstream of the proposed culvert replacement location, Sunset Creek joins Richards Creek. Approximately 850 feet downstream of the confluence of Sunset Creek and Richards Creek, Richards Creek is joined by East Creek. From this confluence, Richards Creek flows north towards Kelsey Creek. Upstream of the proposed project site, Sunset Creek originates from a highly developed watershed approximately one square mile in area that lies primarily to the south of Interstate 90 and east of Interstate 405. Single family residential parcels dominate the watershed land use south of Interstate 90 and commercial properties are predominant in the vicinity of the proposed project site. Significant watershed development began prior to 1961. Presently, the effective impervious area of the Sunset Creek watershed is approximately 44 percent. Sheet 1 shows the project vicinity map.

The physical changes made to a watershed during urbanization can significantly alter its hydrologic regime and sediment supply characteristics. In the Sunset Creek watershed, as has occurred in many other watersheds in the Puget Sound area, the addition of impervious surfaces associated with development resulted in increased peak flow magnitudes that in turn caused widespread adjustments in stream channel form, primarily in the form of channel incision and enlargement. Locally, these changes destabilized the toes of steep hillslopes and increased the rate of sediment supply to the channel from bank erosion and landslides. Although streambanks in many parts of the Sunset Creek channel network have been stabilized, bank erosion and slope instability continues in some reaches upstream of Interstate 90.

The Sunset Creek ravine located immediately upstream of Interstate 90 has been the most highly productive sediment supply reach in the Sunset Creek channel network. The City of Bellevue has completed multiple projects to address widespread landsliding within this reach. Channel spanning grade control structures were installed in the mid to late 1980s and a flow bypass, routing peak flow discharges around the most unstable and highly sediment productive portion of the reach, was completed in 1998. Although it is apparent that these projects have reduced the rate that sediment is delivered to the channel and transported downstream, considerable sediment is stored within the active channel network in the upper watershed. This mobile sediment continues to be routed downstream of Interstate 90 where steep and largely confined channel segments route the sediment to the proposed culvert replacement location at SE 30th Street.

Historical and recent channel survey data indicate that the bed elevation of Sunset Creek and Richards creeks has aggraded between three and four and a half feet within 1,000 feet of channel length downstream of SE 30th Street over the last 30 years. It is estimated that an average of approximately 40 cubic yards of gravel (with some sand) have accumulated annually in this reach of Sunset and Richards creeks in that 30-year period. It is likely that peak rates of sediment delivery to the SE 30th Street culverts and the channel network downstream occurred soon after widespread watershed development, and before efforts to reduce sediment production and transport from the upper watershed. However, ongoing sedimentation in the twin culverts beneath SE 30th Street and in the stream channel downstream requires regular dredging activity to maintain culvert openings and provide flow conveyance. Records of recent maintenance dredging completed by the City of Bellevue show that between 10 and 22 cubic yards of sediment have been removed annually between 2004 and 2007 (Table 2). Dredged areas typically aggrade following the first few storm events of the winter. The volume of accumulated and dredged sediment represents a

reasonable estimate of the bedload sediment volume that is delivered annually to Sunset Creek at and below SE 30th Street. The total sediment in transport past SE 30th Street, including suspended sediment in storm flows, is likely an order of magnitude higher.

Table 2. Records of recent maintenance dredging in Sunset Creek at SE 30th Street.

Year of Dredging	Volume of Sediment Removed Downstream of SE 30th Street Culverts (yds^3)	Volume of Sediment Removed Upstream of SE 30th Street Culverts (yds^3)
2004	15-20	–[a]
2005	20	1.5
2006	10	0.75
2007	15-20	–[a]

[a] **Volume of sediment removal upstream of culverts not reported.**

Ongoing aggradation at the proposed culvert replacement location at SE 30th Street, and within the Sunset, Richards, and East Creek channel network downstream, is a result of the site's position on a historical alluvial fan where steep confined channels from the upper watershed transition to less confined, lower gradient channels. Within this context, the proposed culvert replacement location at SE 30th Street coincides with a marked change in gradient. Upstream of SE 30th Street to Interstate 90 the average channel gradient of Sunset Creek exceeds 2.5 percent. Downstream of SE 30th Street the channel gradient decreases to 1.2 percent; with the gradient decreasing to less than 0.9 percent at the confluence with Richards Creek and approximately 0.3 percent north of Kamber Road. The significant decrease in channel gradient at the proposed culvert replacement location and within the channel network further downstream results in similar decreases in sediment transport capacity and drives the ongoing sediment aggradation that exacerbates flooding at SE 30th Street.

Between 1963 and 1970, Sunset Creek was relocated to its present day alignment at SE 30th Street as part of the development in the area. The current conditions of the Sunset Creek channel immediately upstream and downstream of SE 30th Street are largely controlled by the confined, channelized alignment, insufficient flow conveyance of the existing culverts, and high rates of sediment delivery. Downstream of SE 30th Street, abundant deposits of gravel and sand occupy the entire channel width between vertical riprap banks that were constructed when the stream was relocated from its historic location and channelized at the edge of developing properties. The relatively wide, shallow channel presents a fish passage barrier during low flow conditions in this area. Upstream of SE 30th Street, the channel is confined within constructed banks armored with riprap and protected with riprap toes. The substrate of the channel upstream of SE 30th Street is coarse and armored beyond the extent of backwater deposits associated with limited flow conveyance during moderate and high flow events. Both upstream and downstream of SE 30th Street, within the extent of proposed channel modifications associated with the proposed culvert replacement structure, the straight, plane-bed channel pattern provides little hydraulic or habitat complexity. A private habitat improvement project was completed in 2005 in Sunset Creek just upstream of the limits of the proposed channel modifications. That project included addition of large woody debris and modifications to the channel cross-section in an effort to provide a two-stage channel. The proposed upstream channel modifications associated with the culvert replacement project will transition into this previously completed project reach.

Despite the comprehensive channel modifications, limited riparian corridor and high rates of sediment delivery, resident and adfluvial trout (cutthroat) have been observed spawning in Sunset Creek downstream of the proposed culvert replacement location, and evidence of spring spawning was observed in April of this year. Chinook salmon and steelhead are also known to have used the Sunset Creek and Richards Creek systems with distribution of these species extending into Sunset Creek up to and possibly beyond SE 30th Street. These species have not been observed in Sunset Creek in recent years, potentially due to passage barriers imposed by extensive beaver dam complexes in downstream reaches.

help Is the property agricultural land? ☐ YES ☒ NO help Are you a USDA program participant? ☐ YES ☒ NO

help 7a. Describe the proposed work that needs aquatic permits: Complete plans and specifications should be provided for all work waterward of the ordinary high water mark or line, including types of equipment to be used. If applying for a shoreline permit, describe all work within and beyond 200 feet of the ordinary high water mark. If you have provided attached materials to describe your project, you still must summarize the proposed work here. Attach a separate sheet if additional space is needed.

The proposed project includes replacing existing twin 42-inch diameter corrugated metal pipe culverts with a box culvert designed to simulate natural streamflow conditions to the highest degree possible. The proposed box culvert design includes a sedimentation structure. Channel modifications will be necessary upstream and downstream of the replacement structure to create a stable transition of the existing streambed to the replacement culvert inlet and outlet invert elevations. Sheet 1 shows the project vicinity map. The principal work activities associated with the culvert replacement and channel modifications include:

1. **Site preparation**
2. **Preliminary excavation of roadway**
3. **Install temporary flow bypass**
4. **Conduct fish removal**
5. **Dewater construction area**
6. **Remove riprap from culvert inlet and outlet headwalls**
7. **Remove and replace existing culverts**
8. **Remove riprap from channel banks**

9. Channel grading, excavation and sediment removal
10. Install grade control structures and bank protection
11. Revegetate streambanks
12. Reintroduce flow to channel
13. Construct high flow and maintenance bypass culvert.

A detailed description of each of these work activities follows. Sheet 2 presents a schematic drawing of the proposed work area.

1. Site preparation

Site preparation activities include the contractor mobilizing to the project site, developing a staging area, establishing site access routes and traffic control, marking the work and clearing limits, and installing temporary erosion and sediment control (TESC) best management practices (BMPs). Space at the project site is limited and it is anticipated that the contractor will establish staging in the parking lot of a nearby business. The City of Bellevue is currently evaluating staging area alternatives. A staging area of approximately 100 feet by 100 feet is anticipated to be sufficient for the proposed project activities. Access to the project site will be along SE 30th Street.

2. Preliminary excavation of roadway

Preliminary excavation of SE 30th Street will include removal of the road surfacing and sidewalks in the area where the culvert will be replaced and excavation of the trench where the temporary flow bypass will be routed under SE 30th Street. The temporary flow bypass alignment is anticipated to be located immediately to the west of the replacement culvert adjacent to the future alignment of the maintenance bypass pipe. Preliminary excavation may also include temporary relocations or realignments of utilities at the project site.

3. Conduct fish removal

Fish removal will be conducted by isolating the work area, removing as many fish as possible, then gradually dewatering the work area while continuing to remove any fish observed. The work area will be isolated by installing block nets upstream and downstream of all work activities including the intake and discharge location for the temporary flow bypass. If conditions allow, the upstream block net shall be placed first. The downstream block net will then be used as a seine to herd fish from the upstream block net location downstream to the point selected for the downstream block net installation. The site will be then be dewatered slowly enough to allow for continued removal of all fish species to avoid strandings. Fish removal methods during dewatering will likely include dip netting and hand removal. Fish handling will be kept to the minimum necessary to remove fish from the work site. All fish and aquatic life removed from the project site will be released downstream of the downstream block net.

4. Install temporary flow bypass

In conjunction with fish removal activities, Sunset Creek will be diverted into a flow bypass pipe and routed past the work area for the duration of culvert replacement and channel modification work. A coffer dam will be constructed approximately 250 feet upstream of SE 30th Street and stream flow will be routed into a flexible pipe to be secured to the west of the channel. The bypass pipe will be 36 inches in diameter and capable of conveying flows up to 95 cubic feet per second (cfs). This bypass conveyance capacity exceeds the 2-year recurrence interval flow in Sunset Creek (79 cfs). The temporary bypass pipe will be routed beneath SE 30th Street and will extend for a distance of approximately 150 feet downstream of SE 30th Street where flows will be discharged to a temporary energy dissipater. All coffer dam and energy dissipater materials will be completely removed from the site when the flow bypass is removed.

5. Dewater construction area

Following the installation of the temporary flow bypass any water remaining in the active channel or existing culverts will be pumped from the work area in accordance with permit requirements for discharge water quality. Turbidity control BMPs will be implemented as necessary before this pumped water is released to Sunset Creek and/or its riparian corridor. The culvert excavation will be dewatered as necessary based on the groundwater conditions encountered at the time of construction. Groundwater was encountered from 5 to 8 feet below the road surface during geotechnical borings advanced in April 2007.

6. Remove riprap from culvert inlet and outlet headwalls and channel banks

Riprap will be removed from the culvert inlet and outlet headwalls to facilitate further excavation and culvert replacement. Riprap will also be removed from the banks of Sunset Creek within 110 feet upstream and 60 feet downstream of the replacement culvert. Riprap will be removed using an excavator and will be hauled from the site to a licensed disposal or material reuse facility. Quantities and linear extents of riprap removal are presented in Table 3.

Table 3. Riprap removal quantities.

Location	Bank Length (ft)	Bank Area (ft^2)
Upstream		
Left Bank	10	30
Above Culvert	14	42
Downstream		
Left Bank	60	240
Right Bank	60	240
Above Culvert	10	50
Totals	154	602

7. Remove and replace existing culverts

Removal of the existing twin 42-inch diameter corrugated metal pipe culverts and installation of the replacement culvert structure will require additional excavation in the SE 30th Street corridor. Excavation, culvert removal, and replacement will require traffic control, as only one lane of SE 30th Street will typically be closed at any given time. All excavated material will be hauled from the project site to a licensed disposal or material reuse facility, or stockpiled onsite for use as backfill following installation of the replacement culvert structure. The replacement culvert structure will be installed in approximately the same location as the existing culverts. The replacement culvert will be constructed using precast concrete structures. All replacement culvert construction activities will be constructed in the dry to minimize water quality impacts. Construction of the replacement culvert will be coordinated with utility relocation in the SE 30th Street right-of-way. Sheet 3 shows a profile of the existing and replacement culverts. Sheet 5 shows plan and profile views of the replacement culvert design. Sheet 6 presents cross section views of the proposed culvert design in the upper stream simulation section and in the lower sediment trap section.

8. Channel grading, excavation and sediment removal

The Sunset Creek channel will be modified to provide smooth and stable transitions from the existing streambed to the inlet and outlet invert elevations of the replacement culvert. Upstream of the replacement culvert, the finished channel bed will be lowered an average of approximately 1.4 feet, and up to 2.5 feet locally, over a length of 110 feet and an average channel width of 7 feet. The streambed will be overexcavated an additional 2 feet for the placement of streambed material, boulders, and large woody debris. Sheet 3 shows the extents of proposed channel grading upstream of SE 30th Street. Streambed and bank material will be removed from the channel using an excavator. Streambed material from the channel upstream of the replacement culvert may be reused as stable channel bed material after grade control structures are constructed if deemed suitable by the project engineer. Bank materials and any streambed material deemed unsuitable for reuse by the project engineer will be hauled from the site to a licensed disposal or material reuse facility.

Downstream of the replacement culvert, the full width of the channel bed, at an average width of 10 feet, will be lowered up to 2.5 feet for a distance of 60 feet downstream of the replacement culvert. Sheet 3 shows the extents of proposed channel grading downstream of SE 30th Street. As upstream, the streambed will be overexcavated an additional 2 feet for the placement of streambed material, boulders, and large woody debris. Bed material from this part of the channel will be removed with an excavator. A portion of this material may be suitable for use as stable channel bed material if deemed so by the project engineer during construction. Additional streambed material will be removed from the channel between 60 and 100 feet downstream of the replacement culvert. This material will be removed from the center 4 to 5 feet of the channel using a suction dredge without disturbing existing streambanks or riparian vegetation.

Stream channel bank and bed material removal and fill quantities within the ordinary high water line associated with channel modifications during construction are presented in Table 4. Sheet 4 shows a typical cross section of the proposed channel modifications as well as the plan view extents of grade control structures on the upstream side of SE 30th Street. Sheet 7 shows a typical cross section of the proposed channel modifications as well as the plan view extents of grade control structures on the downstream side of SE 30th Street.

Table 4. Sediment removal and fill quantities within the ordinary high water line.

Impact	Upstream of Culvert	Downstream of Culvert
Volume of excavation within existing OHWM (cy) [a]	111	145
Volume of fill within existing OHWM (cy) [b]	58	47
Area of fill within existing OHWM (arce)	0.02	0.02

[a] Includes streambed material and riprap.
[b] Includes streambed material and boulders.

9. Install grade control structures, bank protection, and substrate material

Grade control and bank protection structures will be constructed in order to create a stable transition of the existing streambed to the replacement culvert inlet and outlet invert elevations. Grade control and bank protection structures will be primarily constructed using large woody debris and rounded to subrounded river boulders; large woody debris will be imbedded in the streambed and banks and surcharged with boulders as necessary to resist lateral drag and buoyant forces and provide a high factor of safety for channel stability. One structure, the large woody debris grade control structure downstream of the replacement culvert outlet, will incorporate ecology blocks buried within the streambanks. Here, where the channel corridor is narrow relative to the channel width, the large woody debris will be attached to the ecology blocks buried within the banks and located outside of the OHWM. Typical dimensions for large woody debris are diameters of 18 to 24-inches and lengths of 15 to 25-feet. Typical boulder diameters are 12 to 18-inches.

Eight grade control structures will be installed upstream of the replacement culvert. The average gradient of Sunset Creek upstream of SE 30th Street is 2.5 percent. Within 15 feet of SE 30th Street on the upstream side, however, the existing channel gradient is up to 30 percent. The design grade of the channel for a distance of 110 feet upstream of the replacement culvert is 4 percent, with no sections to exceed 5 percent between grade control structures and no vertical drops in excess of 4 inches to promote fish passage. Sheet 8 shows plan and section design details of the proposed grade control structures upstream of SE 30th Street.

Downstream of the replacement culvert one large woody debris grade control structure and one boulder grade control structure will be constructed. The large woody debris grade control structure will be constructed 20 feet downstream of the replacement culvert and the boulder grade control structure will be located another 20 feet further downstream. Sheet 9 shows plan and section design details of the proposed grade control structures downstream of SE 30th Street.

Two types of streambed material will be placed in areas where the channel is modified upstream and downstream of the replacement culvert. The streambed surface will be composed of a 12-inch thick layer of streambed habitat gravel. Below this layer, a 12-inch thick layer of cobble and gravel sized to resist scour and downstream transport will be used to maintain design channel elevations between grade control structures. These materials will likely be placed by excavator with finish placement requiring hand grading.

10. Revegetate streambanks

All streambanks disturbed during channel modification will be revegetated with an appropriate range of native species. Typical species that may be used to revegetated streambanks are presented in Table 5. Replanting plans will be consistent with planting guidelines presented in the City of Bellevue's Critical Areas Handbook (2007).

Table 5. Typical species that may be used to revegetated Sunset Creek streambanks following channel modification.

Vegetation Type	Common Name	Latin Name
Trees		
	Oregon ash	***Fraxinus latifolia***
	Pacific Willow	***Salix lasiandra***
	Paper birch	***Betula papyifera***
	Red alder	***Alnus rubra***
Shrubs		
	Vine maple	***Acer circinatum***
	Red-osier dogwood	***Cornus sericea***
	Salmonberry	***Rubus spectablis***
	Pacific ninebark	***Physocarpus capitatus***
Groundcover		
	Lady fern	***Athyrium filix-femina***
	Sword fern	***Polystichum munitum***
Emergent		
	Small-fruited bulrush	***Scirpus microcarpus***

11. Reintroduce flow to channel

Following completion of the culvert replacement and channel bed modifications, Sunset Creek flows will be reintroduced to the channel. The timing of reintroduction will be coordinated with construction of the high flow and maintenance bypass culvert and outfall and completion of bank protection in the outfall location at the downstream end of the replacement culvert.

12. Construct maintenance bypass culvert

A 24-inch diameter maintenance bypass culvert will be constructed to the west of the replacement culvert structure. The maintenance bypass culvert will provide a means to bypass streamflows during maintenance of the sedimentation structure. The inlet of the maintenance bypass culvert at the upstream end will be in the wall of the replacement culvert. The outlet of the high flow and maintenance bypass culvert will discharge to an energy dissipation structure composed of large woody debris built into the left bank of the stream channel downstream of the replacement culvert. Both the inlet and outlet of the culvert will be screened to preclude fish passage.

PREPARATION OF DRAWINGS: See sample drawings and guidance for completing the drawings. ***ONE SET OF ORIGINAL OR GOOD QUALITY REPRODUCIBLE DRAWINGS MUST BE ATTACHED.*** NOTE: Applicants are encouraged to submit photographs of the project site, but these DO NOT substitute for drawings. ***THE CORPS OF ENGINEERS AND COAST GUARD REQUIRE DRAWINGS ON 8-1/2 X 11 INCH SHEETS. LARGER DRAWINGS MAY BE REQUIRED BY OTHER AGENCIES.***

help 7b. Describe the purpose of the proposed work and why you want or need to perform it at the site. Please explain any specific needs that have influenced the design.

The purpose of the proposed culvert replacement project is to improve flow conveyance and reduce flooding at SE 30th Street, manage sediment delivery to Sunset Creek north of SE 30th Street, and improve fish passage conditions at the culvert location. Flood control and sediment management alternatives at the project site are limited both by the highly confined channel corridor and the site's location at a natural deposition zone in a watershed that generates and transports considerable sediment from upstream. The proposed culvert replacement project is designed to address immediate, ongoing, and future conditions at the project location as well as complement flooding, sedimentation, and aquatic habitat resource management objectives in channels downstream.

Since January 1, 2006 Sunset Creek has flooded at SE 30th Street at least six times, most recently on December 3, 2007. Flooding at SE 30th Street directly impacts neighboring businesses and restricts neighborhood access. Sediment deposition at the project site reduces the conveyance capacity of the twin culverts beneath SE 30th Street, further exacerbating flooding. Recurring sediment deposition requires regular dredging of the active channel by the city. Deposition of sediment that is transmitted downstream of SE 30th Street contributes to channel aggradation and aggravates flooding in other locations of the Sunset, Richards, and East Creek channel networks. Under existing conditions, the sediment that accumulates upstream, downstream, and within the twin 42-inch diameter culverts at SE 30th Street inhibits fish passage by contributing to pressure flow conditions during flows as low as 10 cfs (equivalent to the 10 percent exceedance flow for January).

Design of the proposed culvert replacement structure incorporates an understanding of the geomorphic, hydraulic, and

ecological conditions at the watershed and project-site scales. Design of the replacement culvert followed a watershed and project reach assessment of geomorphic conditions, including a thorough evaluation of sediment delivery and transport at the project site, and was supported by a detailed hydraulic analysis of the Sunset Creek, Richards Creek, and East Creek system from SE 32nd Street to downstream of Kamber Road (SE 26th Street). The design of the proposed culvert replacement structure and channel modifications considers the natural variability in sediment delivery to the project site and the potential channel responses to changes in sediment transport downstream of SE 30th Street. The proposed culvert replacement structure will be supported by a monitoring and adaptive operations and maintenance plan that will be implemented by the City of Bellevue following project construction. Detailed descriptions of replacement culvert design components and the monitoring and adaptive operations and maintenance plan are provided below.

1. Replacement Culvert and Channel Modification Design

The replacement culvert structure is designed to transmit the 100-year flood flow without allowing flow to overtop SE 30th Street, provide improved aquatic habitat and fish passage conditions compared to exiting conditions, and store approximately 50 cubic yards of sediment in a structure that can be maintained with minimal detrimental impacts to aquatic habitat. Performance criteria for flow conveyance, fish passage, and sediment transport conditions were used to evaluate replacement structure designs.

City of Bellevue design standards require culverts to pass the 100-year flood with an additional foot of freeboard. Due to physical constraints at the project site, including the downstream channel width and road surface elevation, these design criteria could not be met. The proposed geometry of the structure maximizes flow conveyance beneath SE 30th Street given the physical constraints of the downstream channel and the sediment transport and fish passage performance criteria discussed below. The hydraulic opening of the replacement culvert is designed to be 13 feet wide and approximately 4.5 feet high.

Fish passage criteria for the proposed replacement culvert are met by using a combination backwater and stream simulation culvert. The dimensions of the main culvert opening maintain the width of the bank-full channel upstream of the culvert, consistent with design parameters for stream simulation culverts in confined channels (WDFW 2003). The design slope of the stream simulation portion of the culvert is 3 percent, which is 1.2 times the average upstream channel gradient. This satisfies part of the stream simulation culvert design criteria (WDFW 2003). The bed of the stream simulation structure will be composed of a layer of streambed sediment that will likely be in flux over time from the upstream channel towards the sediment structure. Stable boulders will protrude through the design streambed surface to provide hydraulic complexity.

The sedimentation structure was designed to accommodate storage of 50 cubic yards of sediment. This volume was derived based on analysis of sediment delivery to the project site and ongoing dredging that the city has performed in recent years to maintain flow conveyance. Sediment has accumulated in the channel downstream of SE 30th Street at an average rate of approximately 40 cubic yards annually in the past 30 years. The current average annual accumulation rate is likely less than what it was 10 or 20 years ago due to upstream efforts to reduce sediment production and delivery. Still, regular dredging of 10 to 20 cubic yards of sediment is required on an almost annual basis to maintain flow conveyance. The design sediment storage volume is intended to capture the majority of bedload sediment that is delivered to the project site in an average year with additional storage capacity for infrequent storms during which a greater volume of sediment is transported.

The performance of the replacement culvert will be influenced by the streambed elevation of the downstream channel. It is anticipated that some channel bed lowering will naturally occur downstream of SE 30th Street once bedload delivery is reduced by up to 50 cubic yards per year. As a result, the replacement culvert is designed to achieve performance criteria in terms of flow conveyance, sedimentation, and fish passage under not only as-built conditions but anticipated future conditions as well.

Following construction, the replacement culvert will be backwatered by the relatively high channel bed elevation downstream of the project area. If the downstream channel degrades sufficiently to no longer backwater the replacement culvert, the fish passable conditions will be maintained by backwater through the sedimentation structure caused by the large woody debris grade control structure downstream of the culvert outlet and the stream simulation culvert design in the upstream half of the replacement culvert. The channel modifications downstream of the replacement culvert are further designed to accommodate potential channel responses by incorporating a deformable porous boulder weir downstream of the large woody debris grade control structure. Should the downstream channel degrade, the boulder weir will deform somewhat but will maintain fish passage to and past the large woody debris grade control structure and through the replacement culvert structure.

2. Monitoring and Adaptive Operations and Maintenance Plan

Installing a sedimentation structure into Sunset Creek at SE 30th Street will require active monitoring of the channel downstream of SE 30th Street and a commitment to operation and maintenance of the sedimentation structure. The City of Bellevue will lead these activities to ensure proper function of the sedimentation structure and avoid impacts to aquatic habitat downstream of SE 30th Street.

The following monitoring protocols will be implemented to identify the onset of geomorphic changes to the Sunset and Richards Creek channels downstream of SE 30th Street resulting from the altered dynamics of sediment delivery resulting from the sedimentation structure. These protocols are intended to document geomorphic characteristics of the downstream channels and inform the City of Bellevue if modifications to the operations and maintenance schedule or more aggressive actions, such as gravel supplementation, are necessary to maintain substrate conditions that are beneficial for aquatic habitat.

A channel monitoring protocol will be initiated by establishing four to five permanent monitoring locations approximately every 200 to 250 feet beginning 100 feet downstream of the replacement culvert. At each monitoring section:

1. Channel cross-sectional geometry will be surveyed.
2. The composition of streambed sediment will be monitored at established locations downstream of SE 30th Street using

a combination of surface pebble counts and subsurface bulk sampling and sieve analysis.

Channel surveying and streambed sediment sampling will be performed annually for a period of 5 years and semi-annually for the following 10 years. At that time future monitoring needs can be reevaluated.

Baseline sedimentation structure monitoring protocols will consist of the following:

1. **Scheduled visual inspections of sedimentation structure capacity and additional inspections following significant storm events.**
2. **Documentation of the timing and quantity of all sediment removed from the structure.**
3. **Bulk sieve analysis of sediment removed to document grain size distribution of captured sediment.**

Based on the patterns and rates of sediment delivery to the site and the channel response downstream of SE 30th Street an adaptive policy for determining when sediment removal is necessary can be developed. Current rates of deposition at SE 30th Street indicate that annual to semi-annual sediment removal should be expected in the near future. As sediment production and delivery from the upstream watershed decrease as a result of additional channel stabilization and sediment reduction measures the frequency of sediment removal may decrease. Should sediment production in the upper watershed reduce to a level such that maintenance of the sedimentation structure is no longer necessary, the sedimentation structure is designed to function as a stream simulation culvert without need for modifications.

Removal of sediment from the sedimentation structure will be conducted so as to minimize impacts to aquatic species and downstream water quality. During maintenance activities flow will be diverted through the maintenance bypass pipe by use of an adjustable gate at the upstream end of the sedimentation structure. Sheet 2 shows the alignment of the bypass pipe on the west side of the replacement culvert structure. Once flows are completely routed into the bypass pipe, fish will be excluded from the sedimentation structure using a seine that will then be installed as a downstream block net at the downstream end of the replacement culvert. Dip netting will likely be used to complement the seining fish removal. Once fish have been removed from the sedimentation cell to the downstream block net, sediment will be removed from the structure through use of a suction dredge operated from the street above and disposed of at an appropriate upland location. Upon completion of sediment removal activities, the downstream block net will be removed and the gate at the upstream end of the culvert will be reopened to allow Sunset Creek to once again flow through the replacement culvert structure. Sediment removal will not require heavy equipment operations within the stream channel.

help 7c. Describe the potential impacts to characteristic uses of the water body. These uses may include fish and aquatic life, water quality, water supply, recreation and aesthetics. Identify proposed actions to avoid, minimize, and mitigate detrimental impacts and provide proper protection of fish and aquatic life. Identify which guidance documents you have used. Attach a separate sheet if additional space is needed.

The proposed project involves the replacement of an existing culvert structure with an improved culvert structure combined with an integrated sediment trap. Placement of this structure will require modification of the stream channel bed and bank modifications for grade control purposes.

Primary impacts of concern associated with the proposed project include the following:

- **Construction related impacts on aquatic species and water quality**
- **Culvert management effects on aquatic species and water quality**
- **Effects on stream habitat conditions**
- **Effects on fish passage.**

The proposed project has been planned and designed to avoid, minimize and mitigate these potential impacts to the greatest extent possible, and will result in a net improvement in existing habitat and water quality conditions. Discussion of methods and guidance used to avoid and minimize impacts are described below.

1. Construction related impacts on aquatic species and water quality

The proposed project has the potential to cause construction-related impacts on water quality, principally in the form of increased suspended sediment loading from channel bed and bank disturbance. The project plans include several BMPs and construction monitoring protocols designed to limit sediment loading and water quality impacts to the greatest extent possible. All channel and bank work will be conducted within a dewatered exclusion area, during the mid to late summer months when streamflow should be at its lowest. Groundwater and stormwater pumped from the construction site will be filtered prior to discharge back to surface waters, or delivered to the sanitary sewer system for treatment. Once construction is completed, the exclusion area will be rewatered slowly to limit the suspension of sediments from disturbed areas. Turbidity levels will be monitored in Sunset Creek downstream of SE 30th Street throughout construction to ensure BMP effectiveness.

Dewatering of the exclusion area will require the capture and relocation of fish and other aquatic organisms. These activities will be conducted consistent with current Washington State Department of Transportation protocols for this practice, which are designed to minimize adverse effects.

All machinery operating within the stream channel will utilize hydraulic fluid that is certified as non-toxic to aquatic life. Throughout construction a spill control and prevention plan will be in place to avoid and manage any spills of potentially hazardous materials.

2. Post-construction related effects on aquatic species and water quality

The proposed project design includes a sediment trap integrated into the replacement culvert structure. Several long-term benefits for aquatic life and water quality are anticipated with the replacement culvert. The primary benefit provided by the sediment trap within the culvert structure is that it will allow for the majority of sediment removal activities to take place inside an enclosed structure, versus dredging of the active channel. Second, the trap will provide increased sediment storage capacity, which is expected to decrease the frequency and/or the extent of sediment removal activities. Currently, dredging of the active channel takes place on an annual basis, causing considerable habitat disturbance and related water quality impacts. While some dredging of the active channel may be required in the future, this will be limited to infrequent occasions when large sediment delivery events overwhelm trap capacity.

The proposed replacement culvert structure design incorporates several design features that will simplify fish exclusion and relocation during sediment removal activities. These features will promote the removal of fish from the sediment management area with less disturbance and handling, reducing stress and injury potential. Because the sediment trap within the culvert is designed to be smaller in areal extent than the segment of channel that is currently dredged, the amount of habitat that fish are denied access to during maintenance activities will be reduced.

Finally, the existing twin culverts that convey Sunset Creek across SE 30th Street provide insufficient flood conveyance capacity, contributing to routine flooding of adjacent roadways and parking lots. These floodwaters commonly overwhelm storm drains and flow overland back into the stream system. Because some of those local storm drains do not drain directly back to the stream system, this suggests that current flooding conditions contribute to elevated delivery of stormwater pollutants to Sunset Creek. By reducing the frequency of flooding that overtops the street, the proposed project is likely to result in a slight incremental improvement in local water quality conditions during and following flood events.

3. Effects on habitat conditions

The proposed project will result in improved habitat conditions in the project area. These improvements will occur because of increased habitat complexity provided by bioengineered grade control and bank stabilization structures, reduced frequency of sediment management activities in the active channel, and adaptive management of sediment delivery rates to downstream channels. These three factors that are expected to positively influence habitat are described in more detail below.

The bioengineered grade control and bank stabilization structures are necessary components of channel reconfiguration needed to support the culvert design. The current channel gradient conditions have been imposed by backwater conditions induced by the existing culvert and sediment deposition in the channel downstream of SE 30th Street that occurs because elevated sediment delivery rates in the Sunset Creek watershed are out of equilibrium with sediment transport capacity in the channel. The channel upstream and downstream of SE 30th Street must be returned to a more natural gradient to support fish passage and enhance sediment capture in the replacement culvert structure. The channel profile modification work will involve excavation of accumulated sediment from the channel bed and the installation of grade control structures, removal of riprap, and bank contouring and stabilization. Riprap will be removed from approximately 74 lineal feet of streambank and replaced with bioengineered bank protection structures composed primarily of LWD. The grade control structures will also be constructed using LWD.

The channel modification design is based on a comprehensive assessment of watershed, reach, and site specific hydrologic, hydraulic, and geomorphic conditions, and is consistent with WDFW Integrated Streambank Protection Guidelines. The grade control and bank stabilization structures are specifically designed to mimic the habitat forming processes and functions provided by LWD in natural stream environments, and will significantly increase habitat complexity and improve fish passage in the project reach of Sunset Creek. The proposed project is considered to be self-mitigating for these reasons.

The Sunset Creek channel accumulates more sediment than it can effectively transport in its current hydromodified state. This promotes an overly wide and shallow channel environment with limited habitat complexity. These channel conditions provide poor flow conveyance, contributing to frequent flooding problems on SE 30th Street and adjacent businesses, and also contribute to low flow passage barrier conditions for adult salmonids and potentially for juvenile salmonids.

Sediment management to maintain flood flow conveyance capacity in this reach of Sunset Creek is accomplished by routine annual dredging of the active channel downstream of the SE 30th Street culvert. This requires regular disturbance of the active channel, interfering with the formation of beneficial habitat features. A key advantage of the integrated sediment trap in the replacement culvert structure is that it will allow for the majority of sediment removal activities to be conducted within the structure using equipment parked on the roadway atop the culvert, avoiding streambank and channel disturbance. Dredging of the active channel will only be required in rare circumstances when large sediment delivery events overwhelm sediment trap capacity.

The integrated sediment trap in the replacement culvert structure will allow for more flexible and adaptive management of sediment flux through the lower reach of Sunset Creek downstream of the culvert, which should produce habitat benefits over the long-term. The proposed project incorporates monitoring of bed elevations and substrate conditions in and downstream of the project reach in Sunset Creek, and an adaptive approach for metering sediment delivery rates to promote the formation of beneficial channel conditions. Specifically, controlled sediment delivery downstream of SE 30th Street will allow for the existing sediment plug in the channel between SE 30th Street and the confluence of Sunset Creek with Richards Creek to gradually erode. This in turn will increase flow conveyance capacity, and allow for the formation of a greater diversity of habitat features. The channel will be routinely monitored to ensure that substrate conditions desirable for salmonid spawning are maintained.

Collectively, these project elements should produce improved habitat conditions within the project reach that are beneficial to a range of aquatic species.

4. Effects on fish passage

The proposed project will result in improved conditions for fish passage in the project reach. Currently, fish passage conditions in Sunset Creek are impaired by sediment deposition upstream and downstream of the SE 30th Street twin culverts. The flatter gradient in the channel downstream of the culverts promotes the accumulation of a large plug of sediment that creates a low flow barrier to adult salmonid passage. This sediment plug may also hinder the movement of juvenile salmonids under certain flow conditions. This sediment plug extends beyond the limits of current dredging activities, meaning that this barrier condition will remain permanent without additional intervention. By allowing for greater control of sediment delivery rates to the downstream channel, it is expected that the sediment trap will permit the evolution of channel conditions that are beneficial to fish passage.

The existing twin culverts also limit fish passage upstream of SE 30th Street. The culverts lack sufficient hydraulic capacity to convey flood flows that transport large sediments. This creates a backwater effect upstream of the structure that promotes the accumulation of coarse bedload, increasing the channel gradient abruptly from approximately 2.5 percent to 10 percent approaching the upstream culvert entrance. During high flow conditions, the high flow velocity in the culvert barrels in combination with shallow, high velocity flow conditions in this over-steepened segment may create a partial barrier condition.

The proposed culvert integrates two fish passage components, a backwatered sediment trap at the downstream end, and a streambed simulation component at the upstream end. The streambed simulation segment has been designed in accordance with current WDFW culvert design guidance (WDFW 2003). This segment will mimic natural channel bed conditions at a more natural 2.5 percent channel slope. The backwatered sediment trap component will provide quiescent flow conditions that will allow for unhindered fish passage. The streambed simulation segment will provide for full fish passage for all species and life history stages likely to occur in this system during the flow conditions during which migratory and dispersal behavior is likely to take place.

Collectively, the proposed culvert design and stream channel modifications address high flow and low flow passage barriers, and are expected to provide improved fish passage conditions throughout this reach of Sunset Creek.

help 7d. For in-water construction work, will your project be in compliance with the State of Washington water quality standards for turbidity (WAC 173-201A-410)? ☒ YES ☐ NO

help 8. Will the project be constructed in stages? ☒ YES ☐ NO

Proposed starting date: **Summer of 2009**

Estimated duration of activity: **50 to 70 working days for construction with up to 10 additional days for mobilization and setup of temporary erosion and sediment control measures.**

help 9. Check if any temporary or permanent structures will be placed:

☒ Waterward of the ordinary high water mark or line for fresh or tidal waters AND/OR

☐ Waterward of the mean higher high water for tidal waters?

help 10. Will fill material (rock, fill, bulkhead, or other material) be placed:

☒ Waterward of the ordinary high water mark or line for fresh waters?

If **YES**, VOLUME (cubic yards) **105** / AREA **0.04** (acres)

☐ Waterward of the mean higher high water for tidal waters?

If **YES**, VOLUME (cubic yards) / AREA (acres)

help 11. Will material be placed in wetlands? ☐ YES ☒ NO

If **YES**:

help A. Impacted area in acres:

help B. Has a delineation been completed? **If YES**, please submit with application. ☐ YES ☐ NO

help C. Has a wetland report been prepared? **If YES**, please submit with application ☐ YES ☐ NO

help D. Type and composition of fill material (e.g., sand, etc.)

help E. Material source:

help F. List all soil series (type of soil) located at the project site, and indicate if they are on the county's list of hydric soils. Soils information can be obtained from the natural Resources Conservation Service (NRCS).

help G. WILL PROPOSED ACTIVITY CAUSE FLOODING OR DRAINING OF WETLANDS? ☐ YES ☒ NO

If **YES**, IMPACTED AREA IS ACRES OF DRAINED WETLANDS.

NOTE: If your project will impact greater than 1/10 of an acre of wetland, submit a mitigation plan to the Corps and Ecology for approval along with the JARPA form.
NOTE: A 401 water quality certification may be required from Ecology in addition to an approved mitigation plan if your project wetland impacts are greater than 1/10 acre in size. Please submit the JARPA form and mitigation plan to Ecology for 401 certification review.

help 12. Stormwater Compliance: This project is (or will be) designed to meet ecology's most current stormwater manual, or an Ecology approved local stormwater manual. ☒ YES ☐ NO

If **YES** – Which manual will your project be designed to meet? **2005 Stormwater Management Manual for Western Washington** help If **NO** – For Clean Water Act Section 401 and 404 permits only – Please submit to Ecology for approval, along with this JARPA application, documentation that demonstrates the stormwater runoff from your project or activity will comply with the water quality standards, WAC 173-201(A)

help 13. Will excavation or dredging be required in water or wetlands? [X] YES [ ] NO

If **YES**:

A. Volume: **256** (cubic yards) /area **0.04** (acre)

B. Composition of material to be removed: **Riprap and streambed material**

C. Disposal site for excavated material: **licensed disposal or reuse facility**

D. Method of dredging: **Excavator and suction dredge (sediment to be removed in the dry)**

help 14. Has the State Environmental Policy Act (SEPA) been completed [ ] YES [X] NO

SEPA Lead Agency: **City of Bellevue**

SEPA Decision: DNS, MDNS, EIS, Adoption, Exemption Decision Date (end of comment period)

SUBMIT A **COPY OF YOUR SEPA DECISION LETTER** TO WDFW AS REQUIRED FOR A COMPLETE APPLICATION

help 15. List other Applications, approvals or certifications from other federal, state or local agencies for any structures, construction discharges or other activities described in the application (i.e. preliminary plat approval, health district approval, building permit, SEPA review, federal energy regulatory commission license (FERC), Forest practices application, etc.). Also, indicate whether work has been completed and indicate all existing work on drawings. NOTE: For use with Corps Nationwide Permits, identify whether your project has or will need an NPDES permit for discharging wastewater and/or stormwater.

– Project does not require an NPDES permit.

TYPE OF APPROVAL	ISSUING AGENCY	IDENTIFICATION NO.	DATE OF APPLICATION	DATE APPROVED	COMPLETED?
Hydraulic Project Approval	**Washington Department of Fish and Wildlife**				
Clean Water Act Section 404	**U.S. Army Corps of Engineers**				
Section 401 Water Quality Certification	**Washington State Department of Ecology**				
SEPA review	**City of Bellevue**				
Critical Areas	**City of Bellevue**				

help 16. Has any agency denied approval for the activity you're applying for or for any activity directly related to the activity described herein?

[ ] YES [X] NO

If **YES**, explain:

SECTION B - Use for Shoreline and Corps of Engineers permits only:

help 17a. Total cost of project. This means the fair market value of the project, including materials, labor, machine rentals, etc.

$995,000

help 17b. If a project or any portion of a project receives funding from a federal agency, that agency is responsible for ESA consultation. Please indicate if you will receive federal funds and what federal agency is providing those funds.

FEDERAL FUNDING [ ] YES [X] NO If **YES**, please list the federal agency.

help 18. Local government with jurisdiction: **City of Bellevue**

help 19. Provide names, addresses and telephone numbers of adjoining property owners, lessees, etc. *Please note: Shoreline Management Compliance may require additional notice – consult your local government.*

NAME	ADDRESS	PHONE NUMBER
E.S. Harrington	**13120 SE 30th Street, Bellevue, WA 98005**	
Stead Building Partnership	**13200 SE 30th Street, Bellevue, WA 98005**	
SLC Investment LLC	**13201 SE 30th Street, Bellevue, WA 98005**	
SCC Property Holdings	**13111 SE 30th Street, Bellevue, WA 98005**	

SECTION C - This section MUST be completed for any permit covered by this application

help 20. Application is hereby made for a permit or permits to authorize the activities described herein. I certify that I am familiar with the information contained in this application, and that to the best of my knowledge and belief, such information is true, complete, and accurate. I further certify that I possess the authority to undertake the proposed activities. I hereby grant to the agencies to which this application is made, the right to enter the above-described location to inspect the proposed, in-progress or completed work. I agree to start work **ONLY** after all necessary permits have been received.

Brian Ward SIGNATURE OF APPLICANT	DATE 6/26/08
SIGNATURE OF AUTHORIZED AGENT	DATE

I HEREBY DESIGNATE Chase Barton TO ACT AS MY AGENT IN MATTERS RELATED TO THIS APPLICATION FOR PERMIT(S). I UNDERSTAND THAT IF A FEDERAL PERMIT IS ISSUED, I MUST SIGN THE PERMIT.

Brian Ward 6/26/08

SIGNATURE OF APPLICANT DATE

SIGNATURE OF LANDOWNER (EXCEPT PUBLIC ENTITY LANDOWNERS, E.G. DNR)

THIS APPLICATION MUST BE SIGNED BY THE APPLICANT AND THE AGENT, IF AN AUTHORIZED AGENT IS DESIGNATED.

18 U.S.C §1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of the United States knowingly falsifies, conceals, or covers up by any trick, scheme, or device a material fact or makes any false, fictitious, or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false, fictitious, or fraudulent statement or entry, shall be fined not more than $10,000 or imprisoned not more than 5 years or both.

COMPLETED BY LOCAL OFFICIAL

A. Nature of the existing shoreline. (Describe type of shoreline, such as marine, stream, lake, lagoon, marsh, bog, swamp, flood plain, floodway, delta; type of beach, such as accretion, erosion, high bank, low bank, or dike; material such as sand, gravel, mud, clay, rock, riprap; and extent and type of bulkheading, if any)

B. In the event that any of the proposed buildings or structures will exceed a height of thirty-five feet above the average grade level, indicate the approximate location of and number of residential units, existing and potential, that will have an obstructed view:

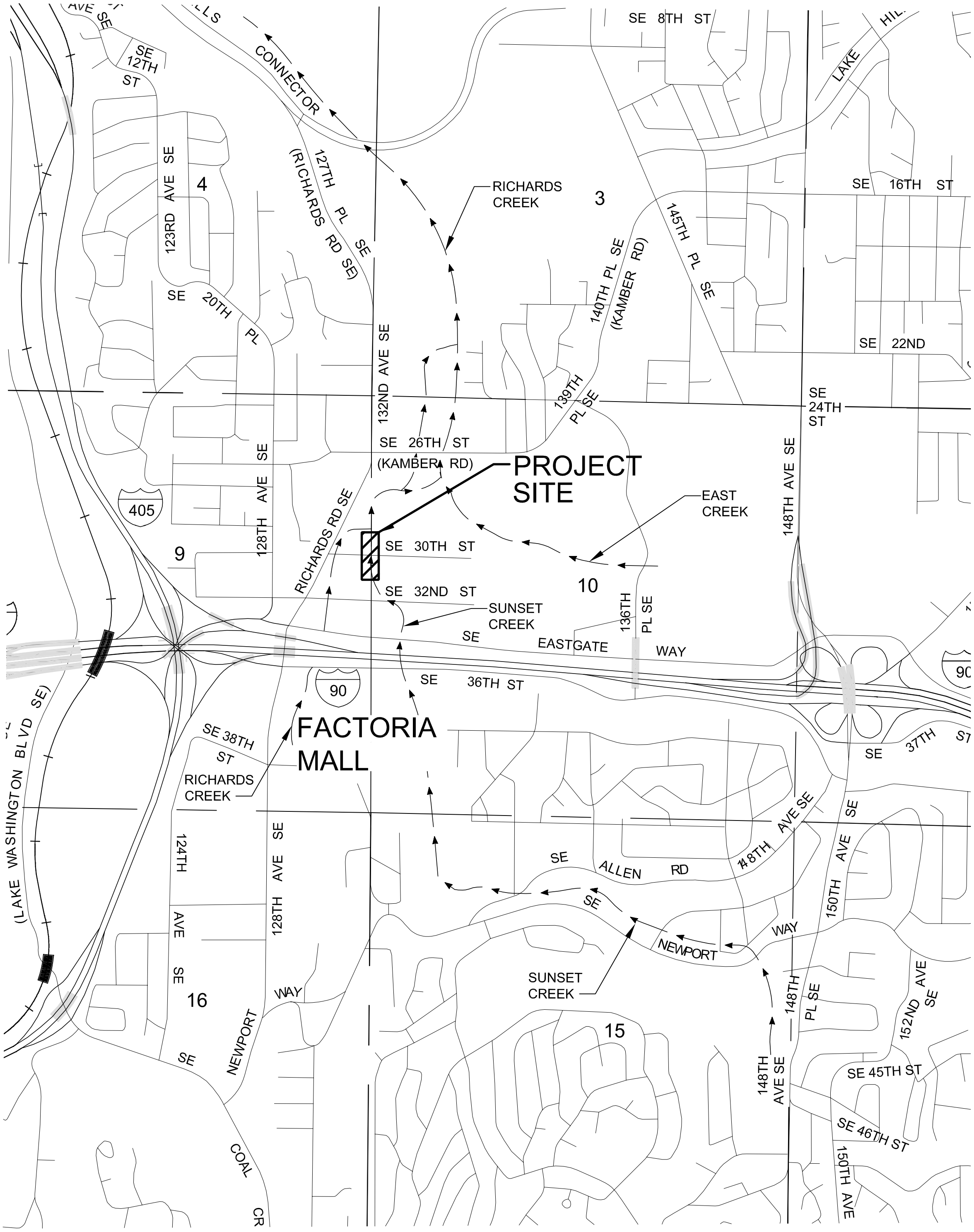
C. If the application involves a conditional use or variance, set forth in full that portion of the master program which provides that the proposed use may be a conditional use, or, in the case of a variance, from which the variance is being sought:

These Agencies are Equal Opportunity and Affirmative Action employers.
For special accommodation needs, please contact the appropriate agency in the instructions

1000 0 1000 2000

SCALE 1" = 2000'

N



NOTE:
RICHARDS CREEK IS TRIBUTARY
TO KELSEY CREEK.

PROJECT SITE COORDINATES:
NORTH 1/2, SEC. 10, TWP. 24 N., RGE 5 E., W.M.
LATITUDE: 47°35'01.91"N
LONGITUDE: 122°10'21.95"W

Prepared by: C. BARTON	VICINITY MAP	Applicant: CITY OF BELLEVUE
HERRERA ENVIRONMENTAL CONSULTANTS 2200 Sixth Avenue Suite 1100 Seattle, Washington 98121-1820 206-441-9080 206-441-9108 FAX http://www.herrerainc.com	Application for: SE 30th / SUNSET CREEK CULVERT REPLACEMENT	Project Location: BELLEVUE, KING COUNTY, WASHINGTON
	Purpose: FLOW CONVEYANCE	SCALE AS NOTED
Date: JUNE 2008	Waterbody: SUNSET CREEK	SHEET 1 of 9

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Jarpa\J-1.dwg
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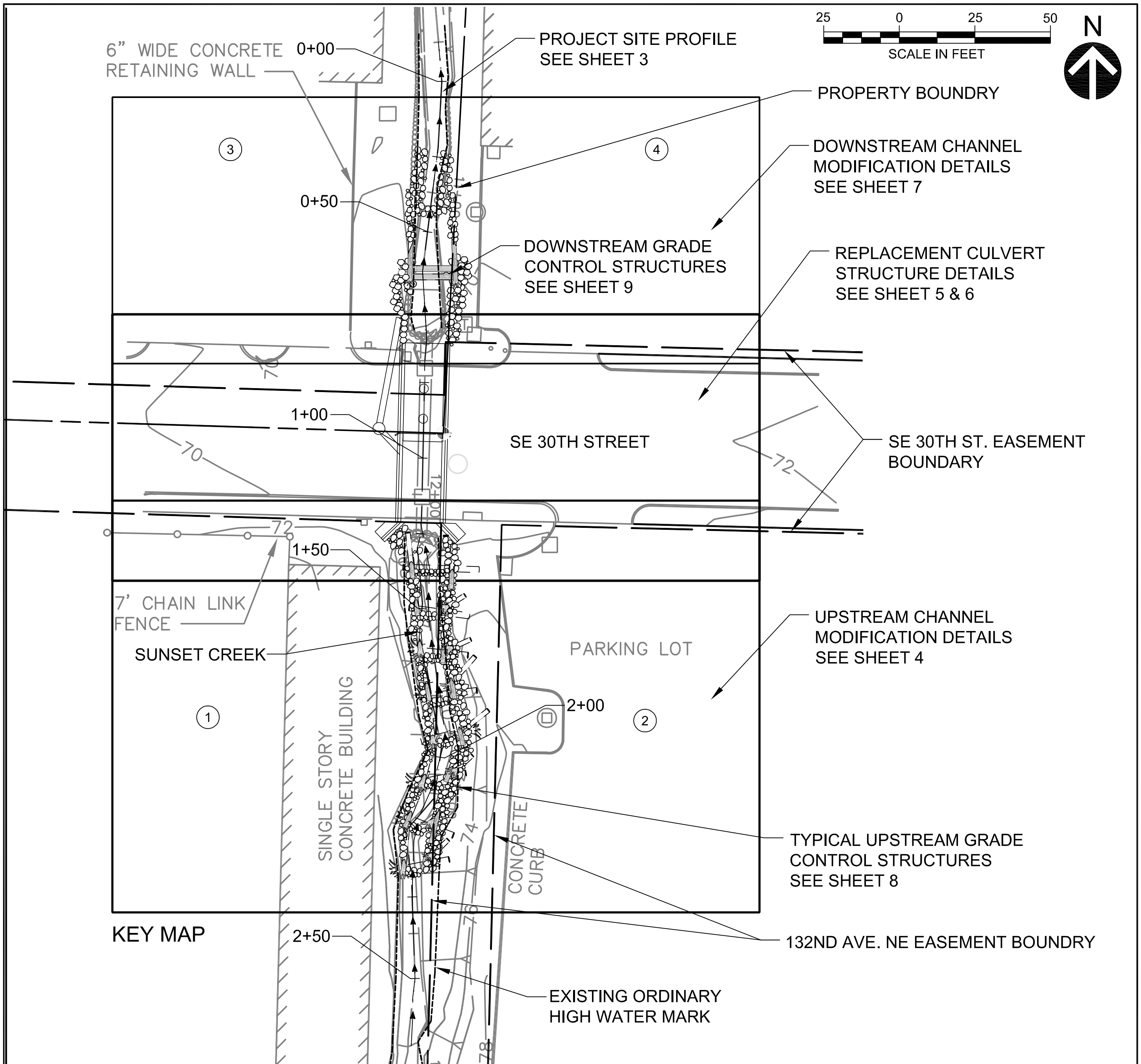


ADJACENT PROPERTY OWNERS:

1. SHURGARD MINI STORAGE (PARCEL #5453300244)
2. PRINTED CIRCUITS ASSEMBLY CORP. (PARCEL #5453300291)
3. SHURGARD MINI STORAGE (PARCEL #5453300194)
4. STEAD BUILDING (PARCEL #5453300183)

NOTE: BOUNDARIES FOR PROPERTIES ADJACENT TO PROJECT AREA DEFINED BY SE 30TH STREET ROAD RIGHT OF WAY. PROPERTIES 1 AND 2 SEPARATED BY 20' EASEMENT PARALLEL TO STREAM CORRIDOR. PROPERTIES 3 AND 4 SEPARATED BY PROPERTY BOUNDARY.

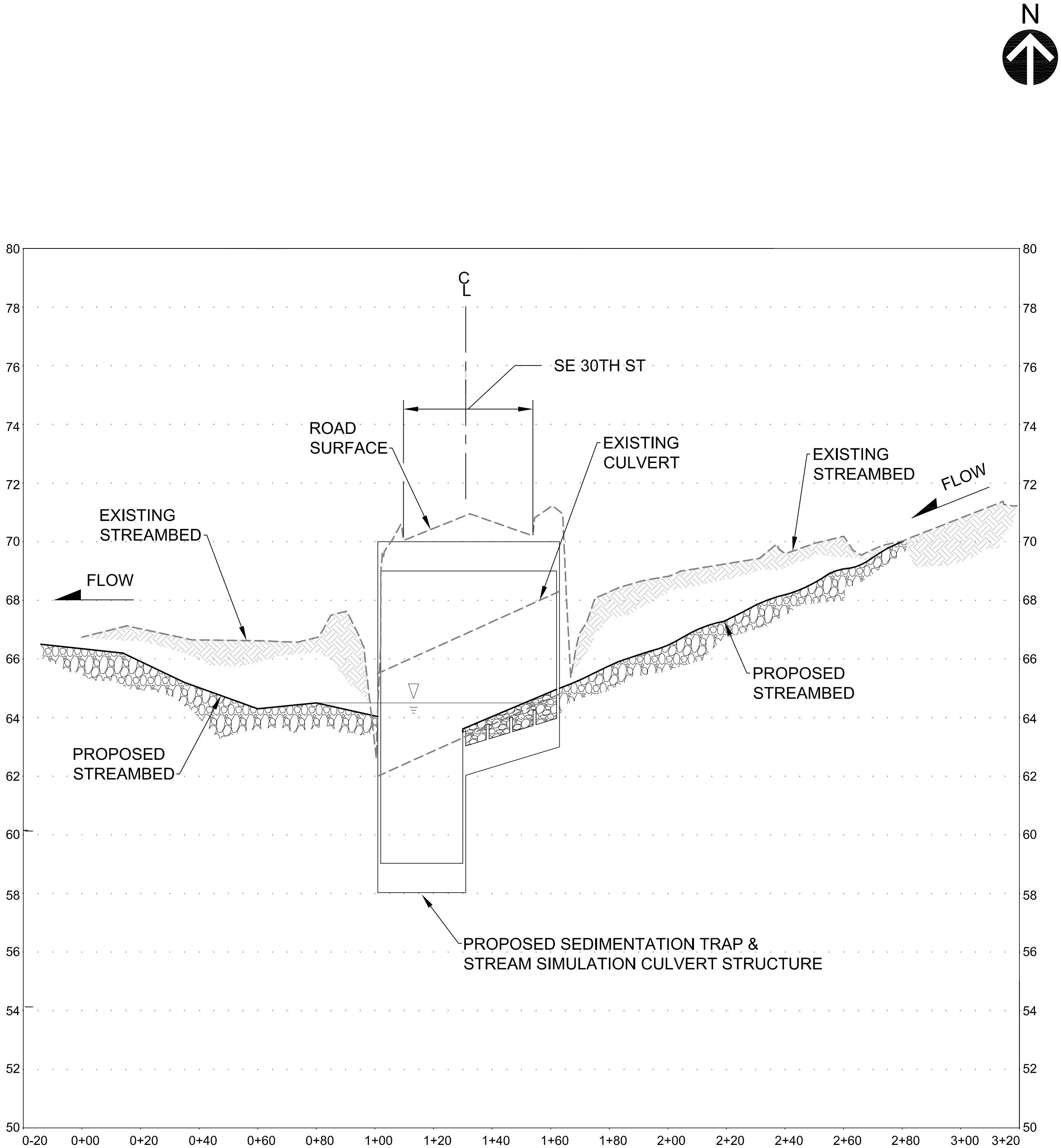
EXCAVATION AND FILL WITHIN EXISTING ORDINARY HIGH WATER MARK

QTY. OF EXCAVATION (CY)	256
QTY. OF FILL (CY)	104
AREA OF FILL (ACRE)	0.04

NOTE: EXCAVATED MATERIAL INCLUDES RIPRAP, NATIVE SOIL, AND STREAMBED SEDIMENT. TO BE DISPOSED OF AT LICENSED DISPOSAL OR REUSE FACILITY. FILL MATERIAL INCLUDES STREAMBED SEDIMENT AND BOULDERS.

Path: O:\projY2006\06-03501-001\CAD\Dwgs\Jarpa\J-2.dwg
Plot Date: 6/25/2008 3:45 PM Cad User: Wojciech Wieszczecinski

Prepared by: C. BARTON	DETAILED SITE SCHEMATIC	Applicant: CITY OF BELLEVUE
HERRERA ENVIRONMENTAL CONSULTANTS, 2200 Sixth Avenue, Suite 1100, Seattle, Washington 98121-1820, 206-441-9080, 206-441-9108 FAX, http://www.herrerainc.com	Application for: SE 30th / SUNSET CREEK CULVERT REPLACEMENT	Project Location: BELLEVUE, KING COUNTY, WASHINGTON
	Purpose: FLOW CONVEYANCE	SCALE AS NOTED
Date: JUNE 2008	Waterbody: SUNSET CREEK	SHEET 2 of 9



PROJECT PROFILE

HORIZ SCALE: 1"=50'
VERT SCALE: 1"=5'

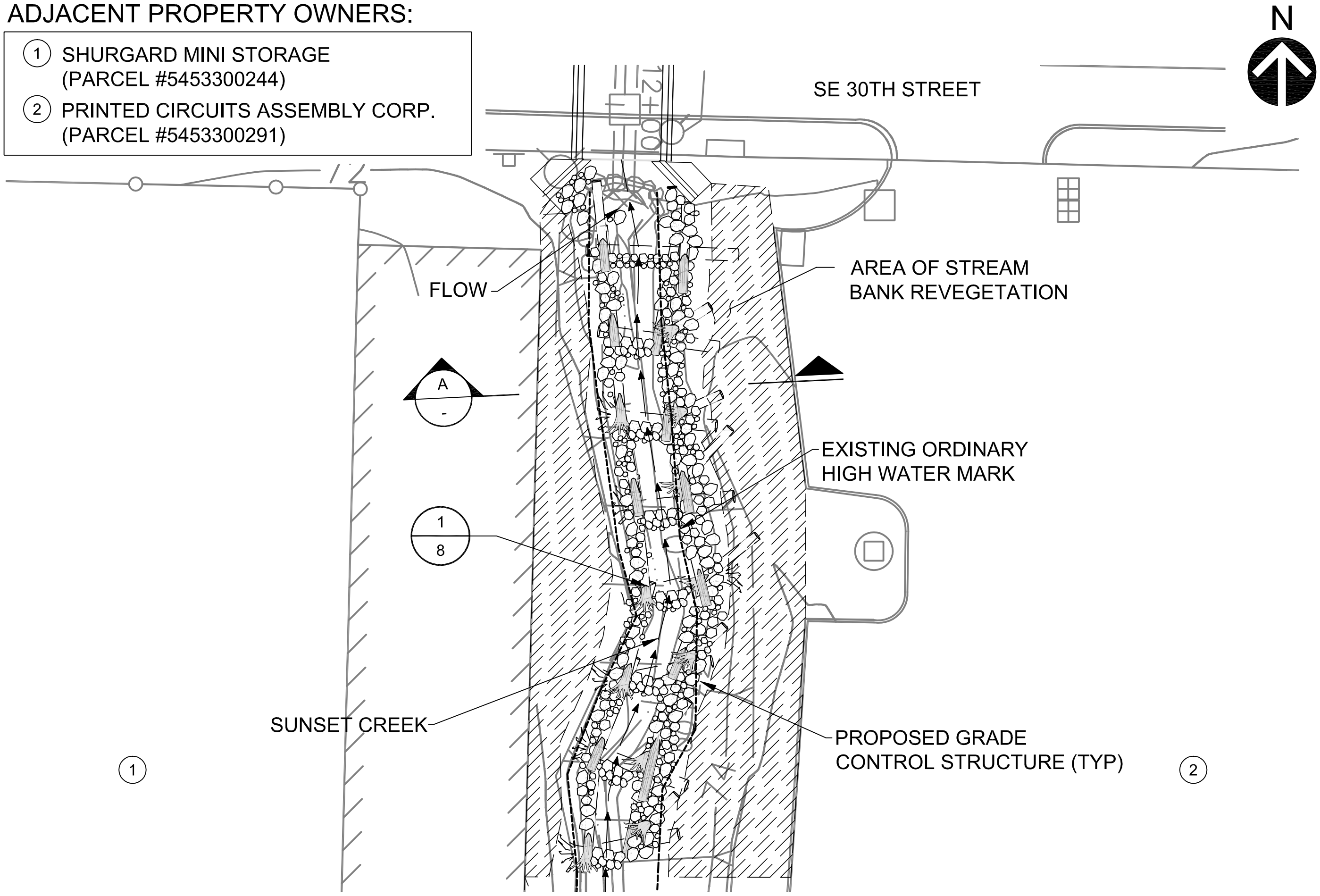
NOTE:
VERTICAL DATUM NAVD 88

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Jarpa\J-3.dwg
Plot Date: 6/25/2008 3:46 PM Cad User: Wojciech Wieszczecinski

Prepared by: C. BARTON	PROJECT PROFILE	Applicant: CITY OF BELLEVUE
HERRERA ENVIRONMENTAL CONSULTANTS 2200 Sixth Avenue Suite 1100 Seattle, Washington 98121-1820 206-441-9080 206-441-9108 FAX http://www.herrerainc.com	Application for: SE 30th / SUNSET CREEK CULVERT REPLACEMENT	Project Location: BELLEVUE, KING COUNTY, WASHINGTON
	Purpose: FLOW CONVEYANCE	SCALE AS NOTED
Date: JUNE 2008	Waterbody: SUNSET CREEK	SHEET 3 of 9

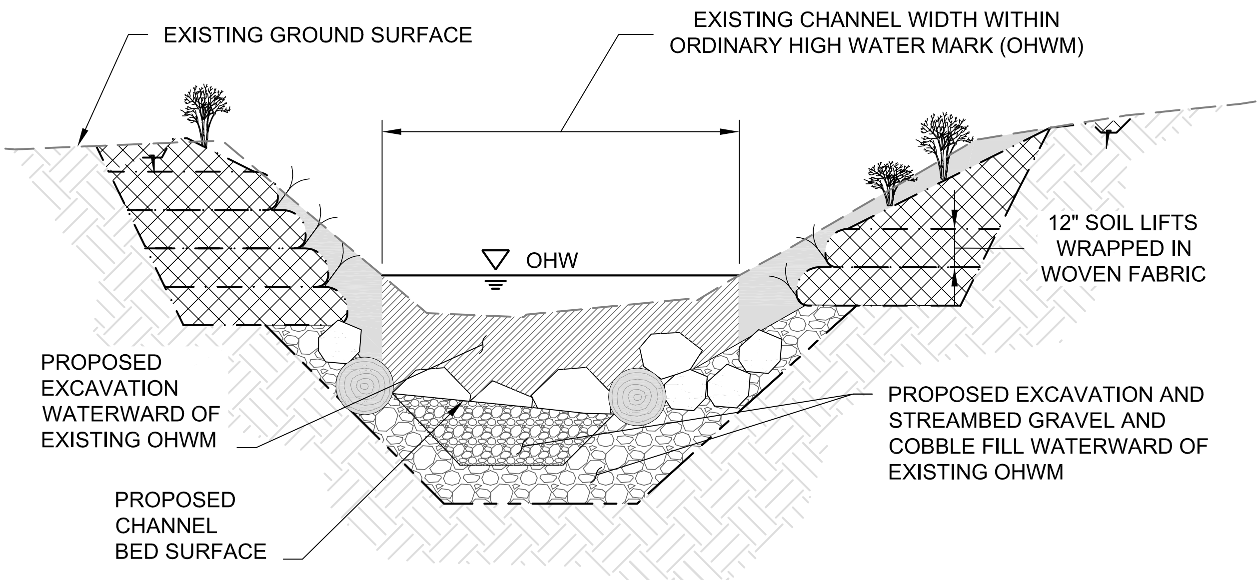
ADJACENT PROPERTY OWNERS:

1. SHURGARD MINI STORAGE (PARCEL #5453300244)
2. PRINTED CIRCUITS ASSEMBLY CORP. (PARCEL #5453300291)



PLAN VIEW - UPSTREAM CHANNEL MODIFICATION (- / 2)

SCALE: 1"=30'

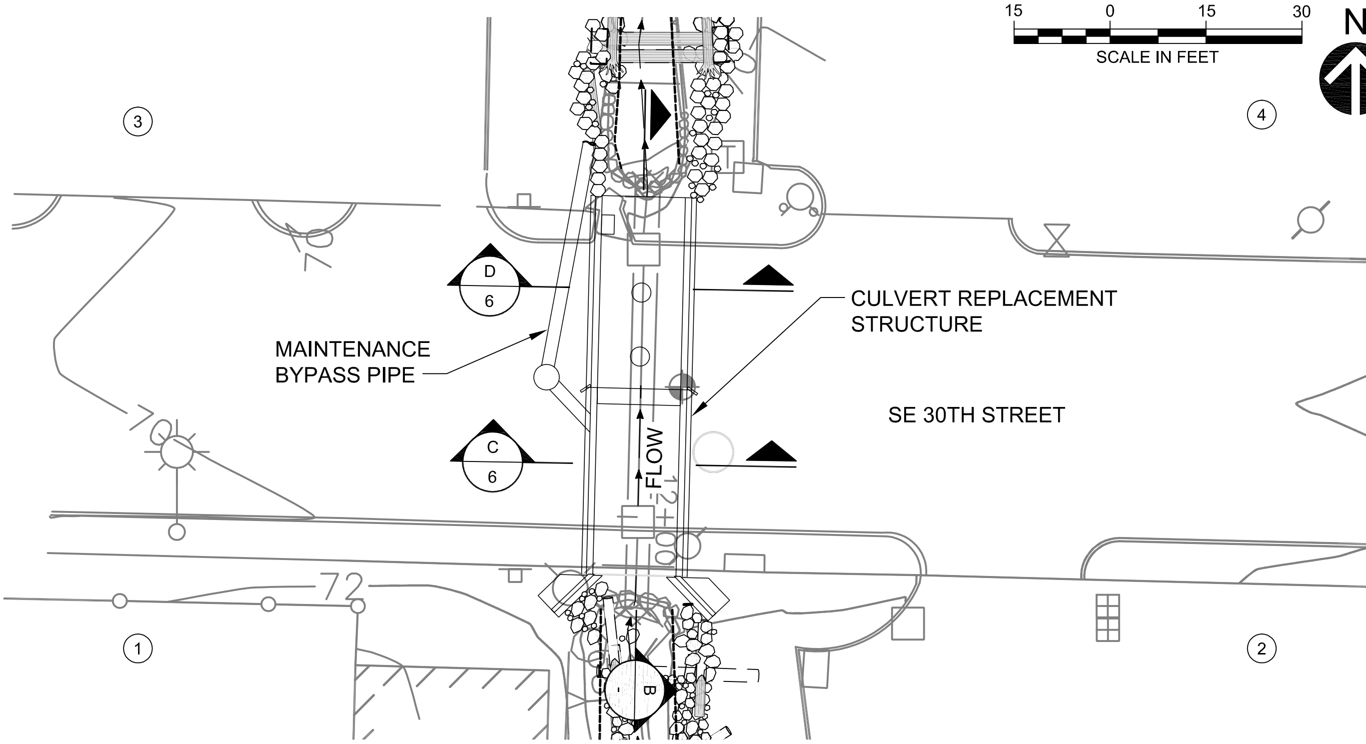


SECTION - TYPICAL STREAM CHANNEL SECTION (A / -)

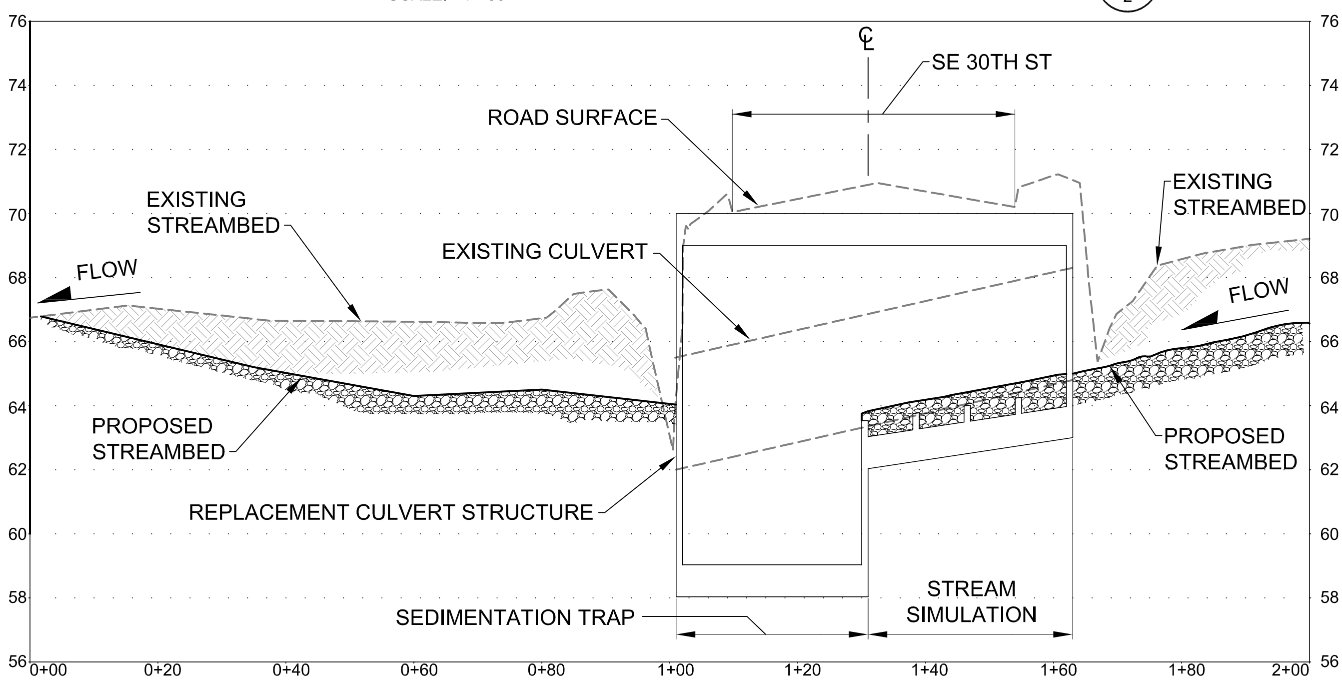
SCALE: 1"=5'

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Jarpa\J-4.dwg
Plot Date: 6/25/2008 3:46 PM Cad User: Wojciech Wieszczecinski

Prepared by: C. BARTON	UPSTREAM CHANNEL MODIFICATION PLAN AND SECTION	Applicant: CITY OF BELLEVUE
HERRERA ENVIRONMENTAL CONSULTANTS 2200 Sixth Avenue Suite 1100 Seattle, Washington 98121-1820 206-441-9080 206-441-9108 FAX http://www.herrerainc.com	Application for: SE 30th / SUNSET CREEK CULVERT REPLACEMENT	Project Location: BELLEVUE, KING COUNTY, WASHINGTON
	Purpose: FLOW CONVEYANCE	SCALE AS NOTED
Date: JUNE 2008	Waterbody: SUNSET CREEK	SHEET 4 of 9



PLAN VIEW - REPLACEMENT CULVERT STRUCTURE
SCALE: 1"=30'



REPLACEMENT CULVERT STRUCTURE PROFILE
HORIZ SCALE: 1"=30'
VERT SCALE: 1"=6'

ADJACENT PROPERTY OWNERS:

1. SHURGARD MINI STORAGE (PARCEL #5453300244)
2. PRINTED CIRCUITS ASSEMBLY CORP. (PARCEL #5453300291)
3. SHURGARD MINI STORAGE (PARCEL #5453300194)
4. STEAD BUILDING (PARCEL #5453300183)

NOTE:
VERTICAL DATUM NAVD 88

Prepared by: C. BARTON	REPLACEMENT CULVERT STRUCTURE PLAN AND PROFILE VIEW	Applicant: CITY OF BELLEVUE
HERRERA ENVIRONMENTAL CONSULTANTS, 2200 Sixth Avenue, Suite 1100, Seattle, Washington 98121-1820, 206-441-9080, 206-441-9108 FAX, http://www.herrerainc.com	Application for: SE 30th / SUNSET CREEK CULVERT REPLACEMENT	Project Location: BELLEVUE, KING COUNTY, WASHINGTON
	Purpose: FLOW CONVEYANCE	SCALE AS NOTED
Date: JUNE 2008	Waterbody: SUNSET CREEK	SHEET 5 of 9

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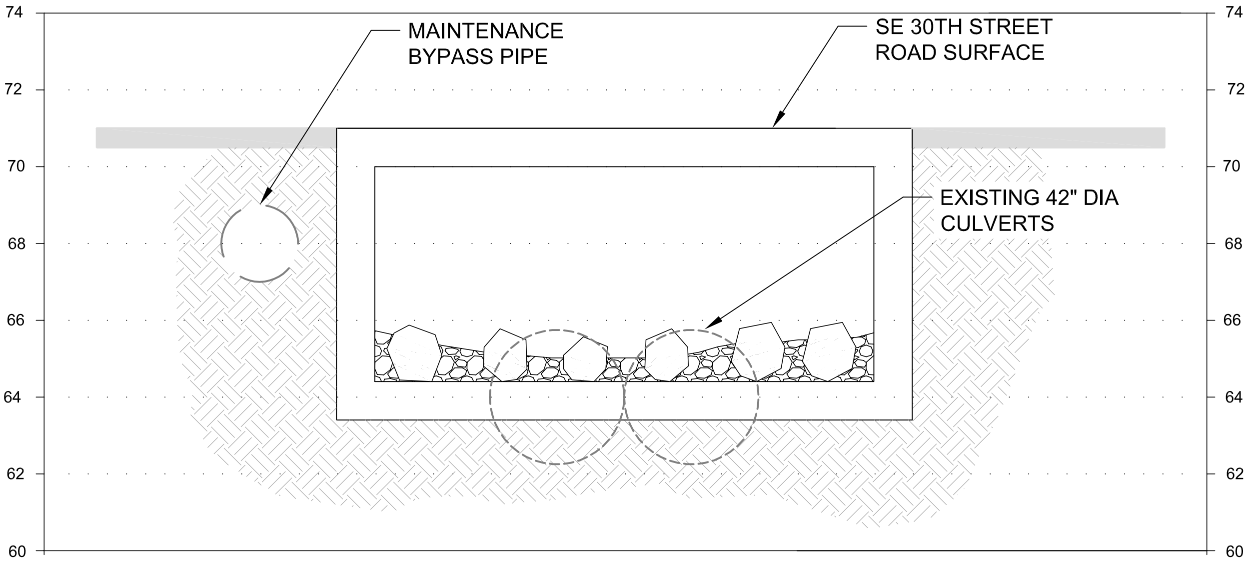
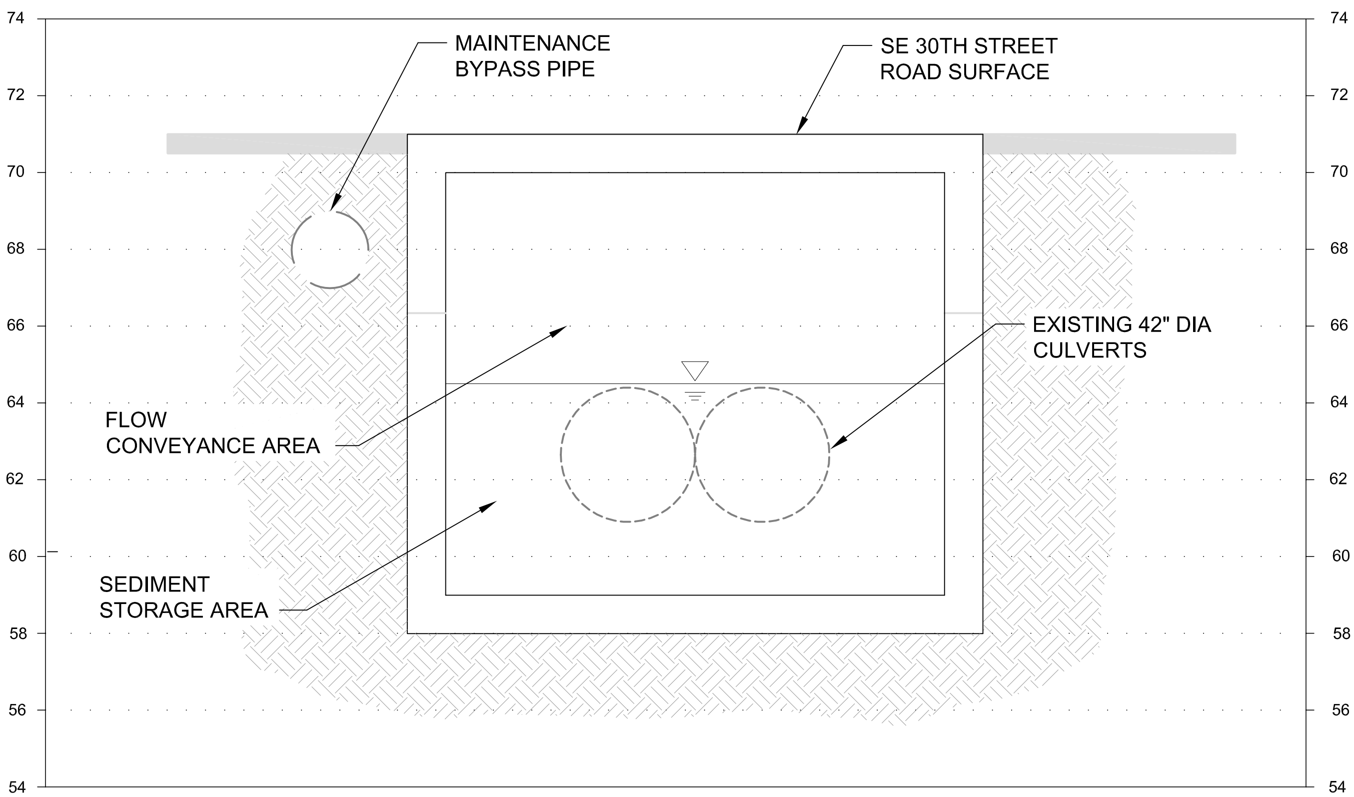


STREAM SIMULATION SECTION C/5

SCALE: 1"=5'



SEDIMENT TRAP SECTION D/5

SCALE: 1"=5'

NOTE:
VERTICAL DATUM NAVD 88

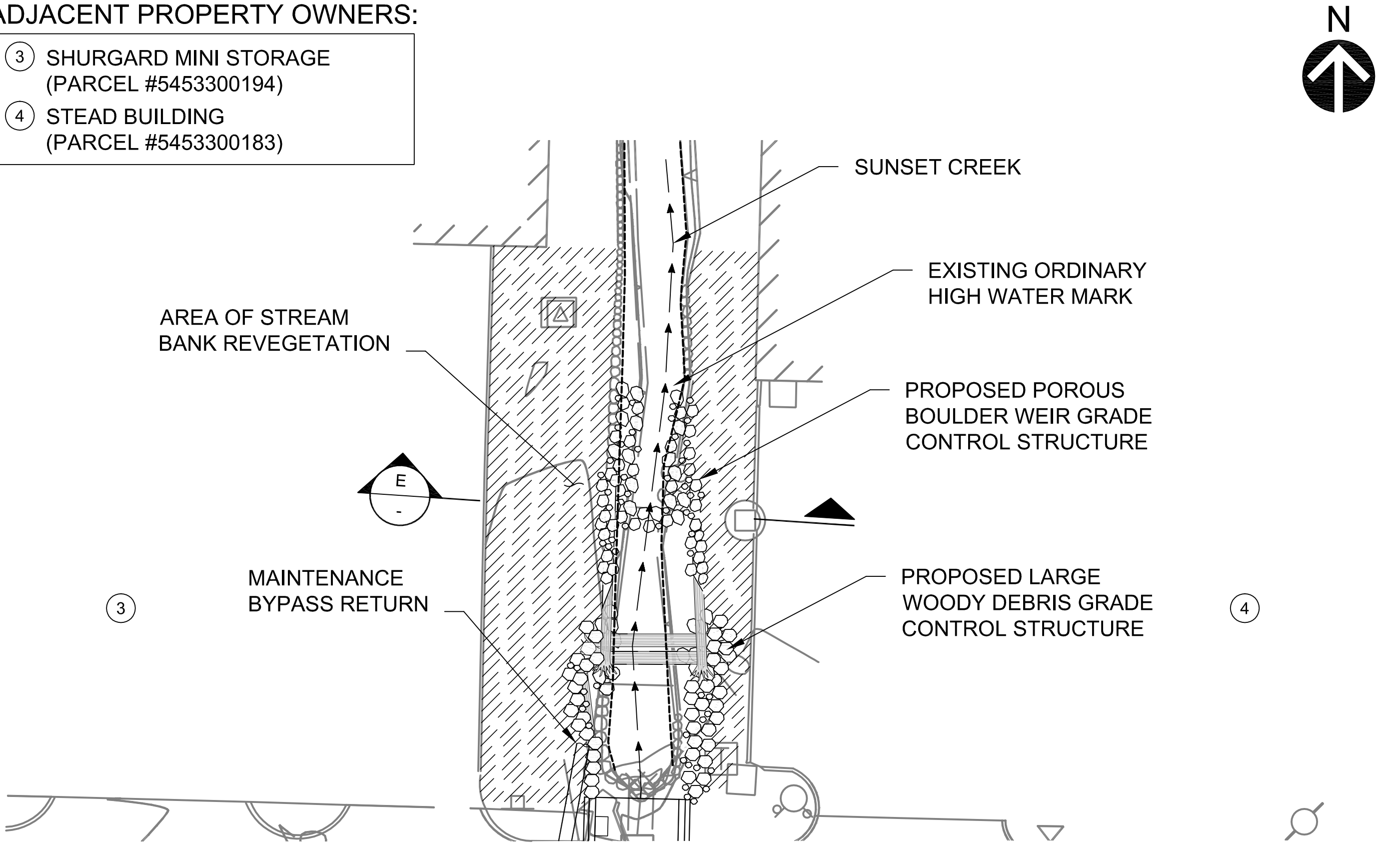
Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Jarpa\J-6.dwg
Plot Date: 6/25/2008 3:48 PM Cad User: Wojciech Wieszczecinski

Prepared by: C. BARTON	REPLACEMENT CULVERT STRUCTURE SECTIONS VIEW	Applicant: CITY OF BELLEVUE
HERRERA ENVIRONMENTAL CONSULTANTS, 2200 Sixth Avenue, Suite 1100, Seattle, Washington 98121-1820, 206-441-9080, 206-441-9108 FAX, http://www.herrerainc.com	Application for: SE 30th / SUNSET CREEK CULVERT REPLACEMENT	Project Location: BELLEVUE, KING COUNTY, WASHINGTON
	Purpose: FLOW CONVEYANCE	SCALE AS NOTED
Date: JUNE 2008	Waterbody: SUNSET CREEK	SHEET 6 of 9

ADJACENT PROPERTY OWNERS:

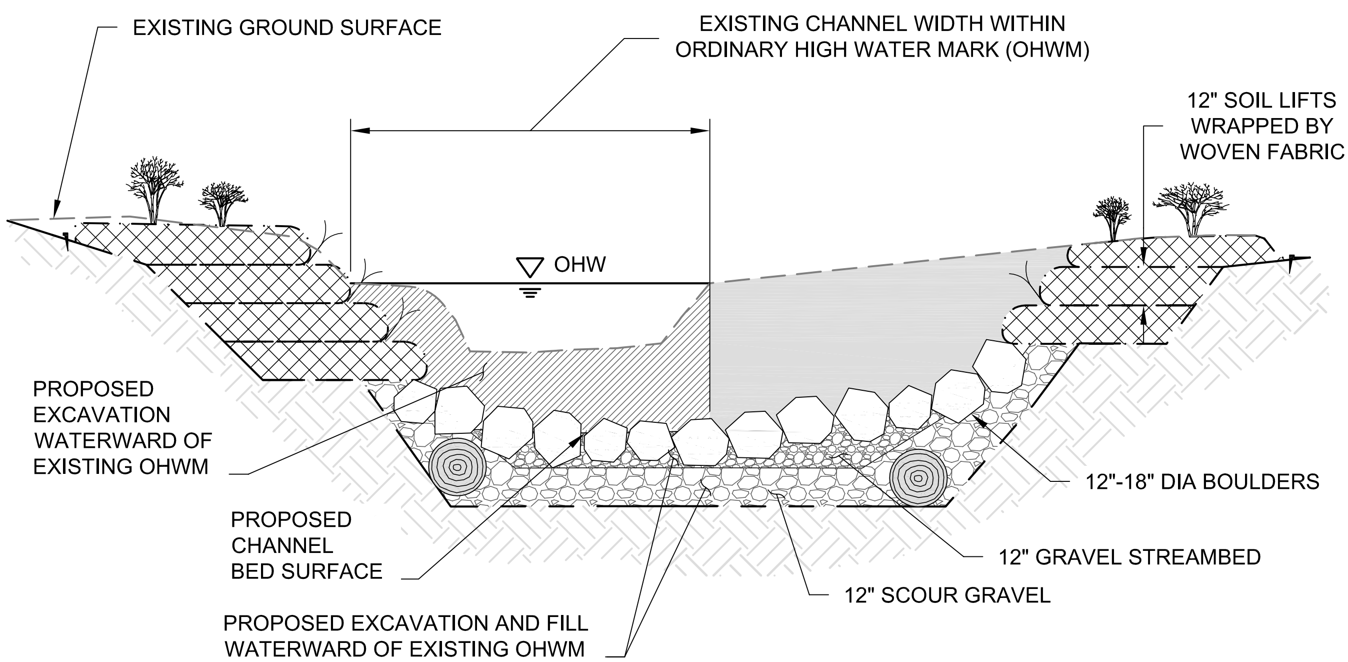
3 SHURGARD MINI STORAGE (PARCEL #5453300194)

4 STEAD BUILDING (PARCEL #5453300183)



PLAN VIEW - DOWNSTREAM CHANNEL MODIFICATION (- / 2)

SCALE: 1"=30'



TYPICAL SECTION - DOWNSTREAM CHANNEL MODIFICATION (E / -)

SCALE: 1"=5'

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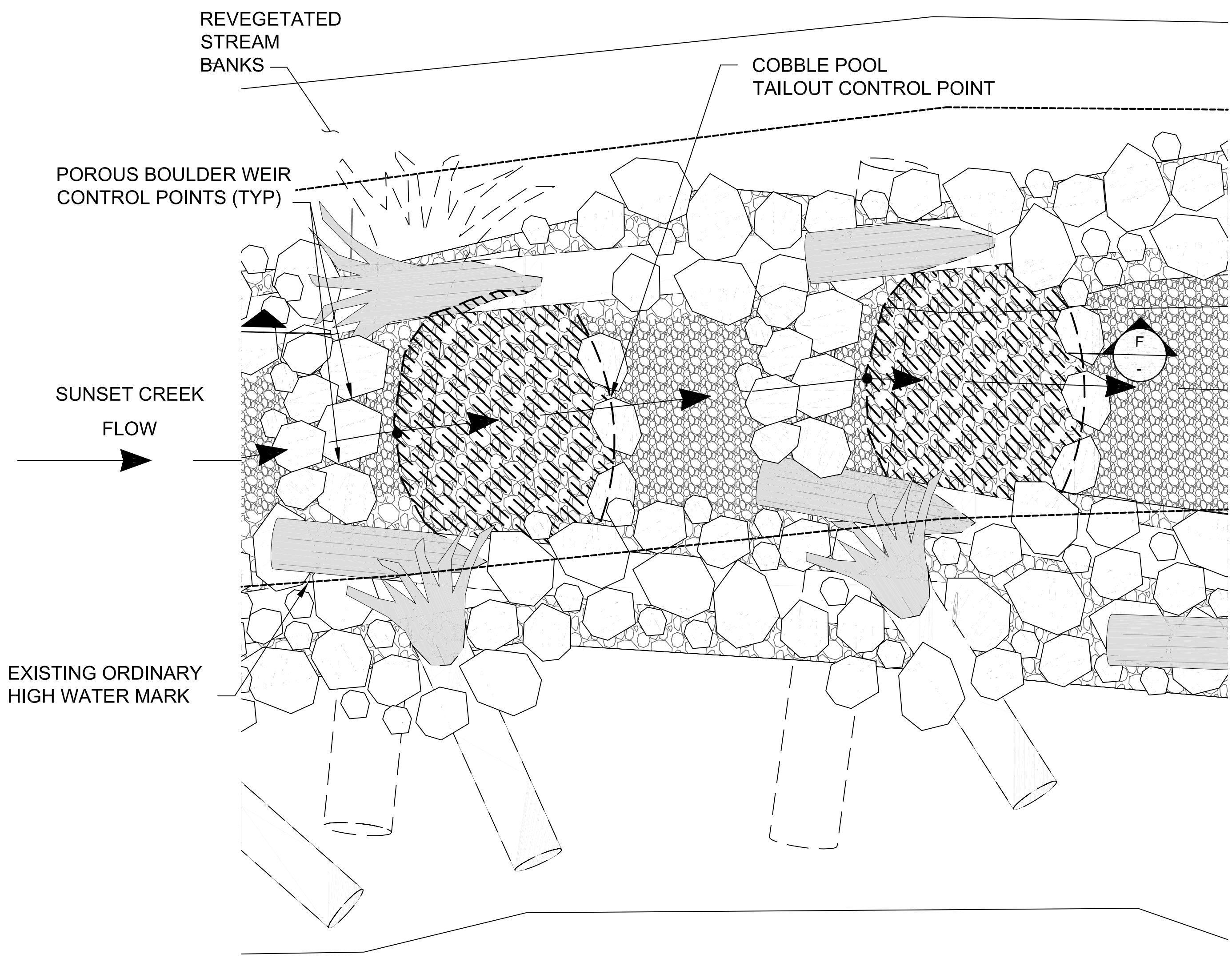
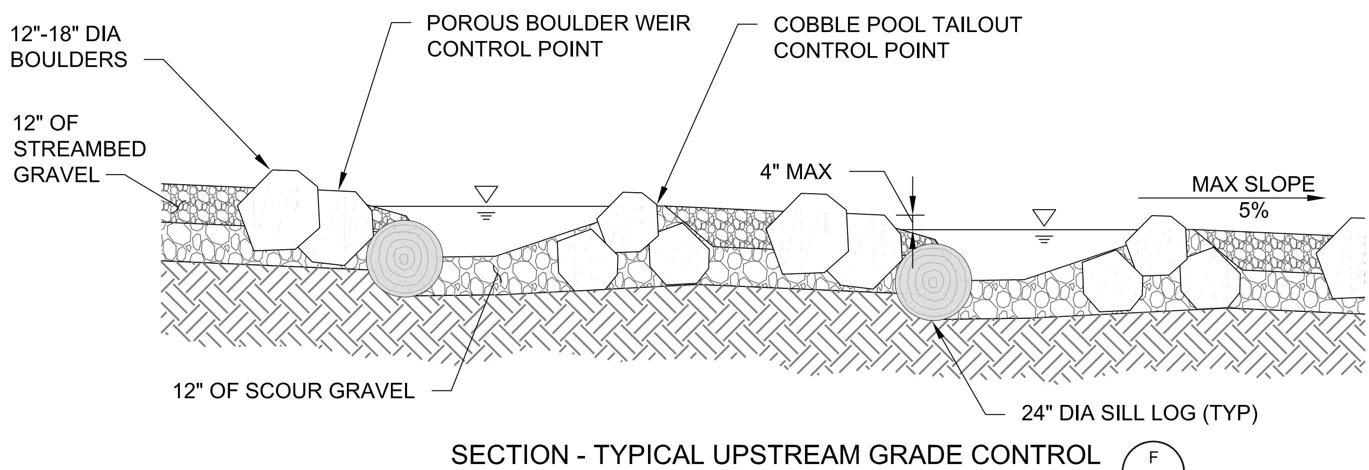
Plot Date: 6/25/2008 3:48 PM Cad User: Wojciech Wieszczecinski

Prepared by: C. BARTON	DOWNSTREAM CHANNEL MODIFICATION PLAN AND SECTION	Applicant: CITY OF BELLEVUE
HERRERA ENVIRONMENTAL CONSULTANTS, 2200 Sixth Avenue, Suite 1100, Seattle, Washington 98121-1820, 206-441-9080, 206-441-9108 FAX, http://www.herrerainc.com	Application for: SE 30th / SUNSET CREEK CULVERT REPLACEMENT	Project Location: BELLEVUE, KING COUNTY, WASHINGTON
	Purpose: FLOW CONVEYANCE	SCALE AS NOTED
Date: JUNE 2008	Waterbody: SUNSET CREEK	SHEET 7 of 9



PLAN - TYPICAL UPSTREAM GRADE CONTROL (1/-)

SCALE: 1"=5'



SECTION - TYPICAL UPSTREAM GRADE CONTROL (F/-)

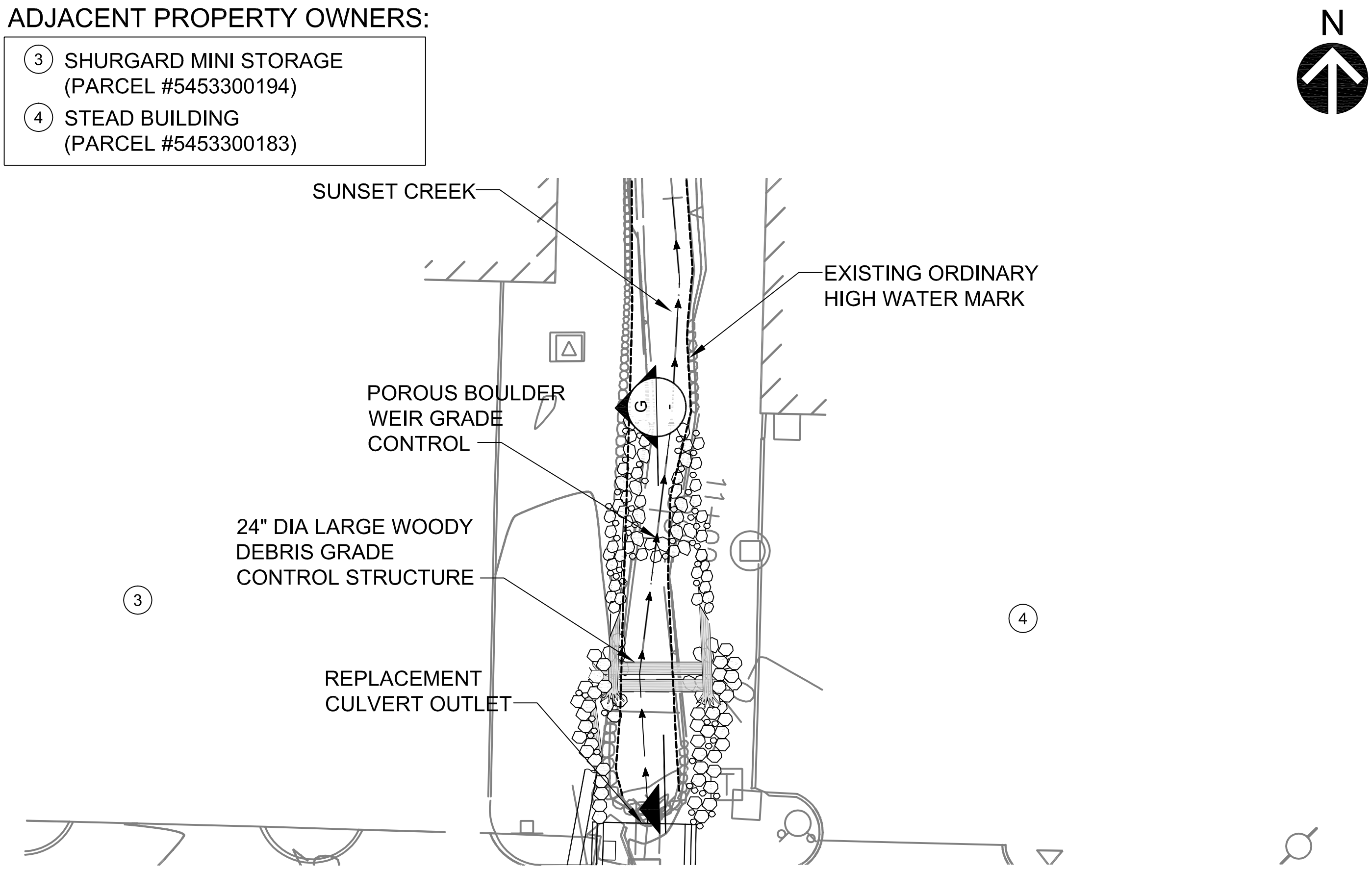
SCALE: 1"=5'

Prepared by: C. BARTON	UPSTREAM GRADE CONTROL DETAILS PLAN AND SECTION	Applicant: CITY OF BELLEVUE
HERRERA ENVIRONMENTAL CONSULTANTS 2200 Sixth Avenue Suite 1100 Seattle, Washington 98121-1820 206-441-9080 206-441-9108 FAX http://www.herrerainc.com	Application for: SE 30th / SUNSET CREEK CULVERT REPLACEMENT	Project Location: BELLEVUE, KING COUNTY, WASHINGTON
	Purpose: FLOW CONVEYANCE	SCALE AS NOTED
Date: JUNE 2008	Waterbody: SUNSET CREEK	SHEET 8 of 9

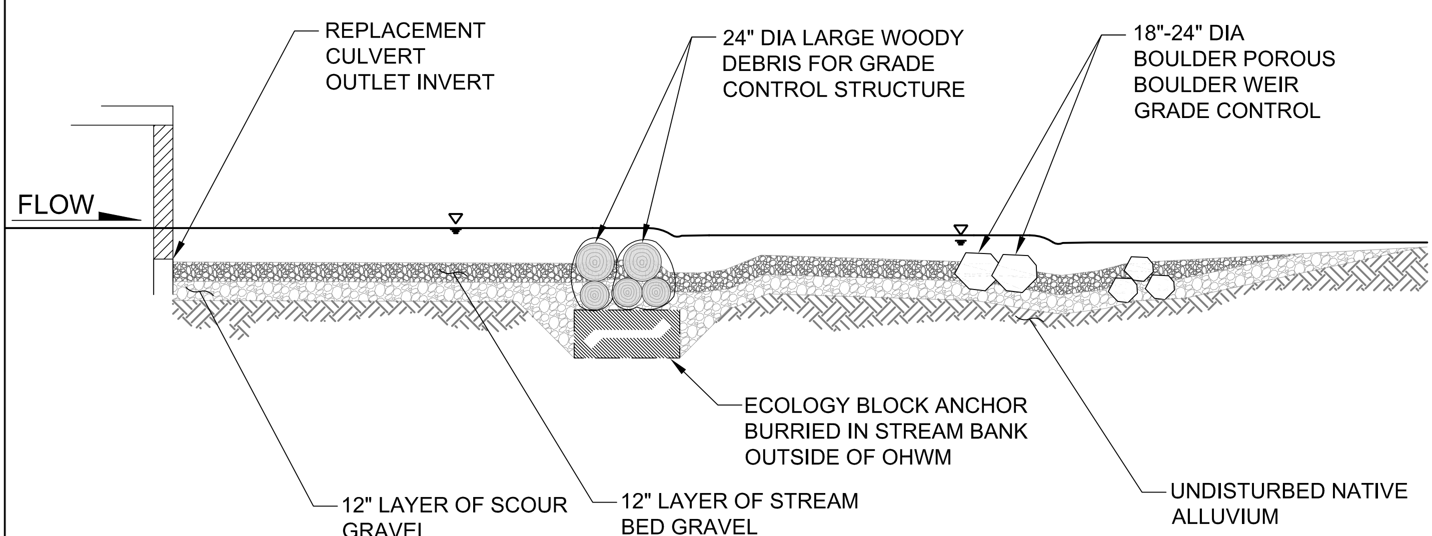
ADJACENT PROPERTY OWNERS:

3 SHURGARD MINI STORAGE
(PARCEL #5453300194)

4 STEAD BUILDING
(PARCEL #5453300183)



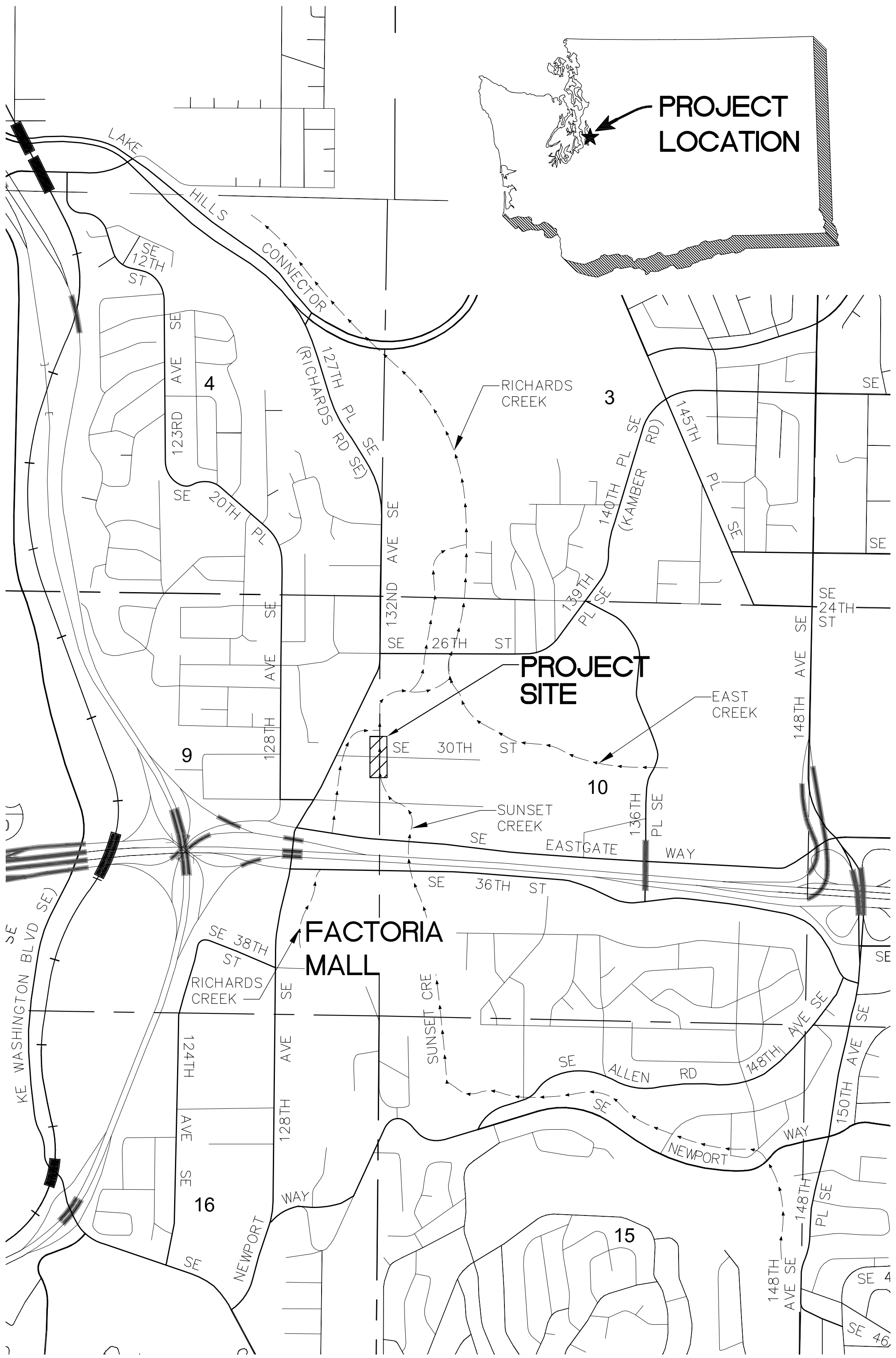
PLAN - DOWNSTREAM GRADE CONTROL STRUCTURES
SCALE: 1"=30'
- / 2



PROFILE - DOWNSTREAM GRADE CONTROL STRUCTURES
SCALE: 1"=10'
G / -

Path: O:\projY2006\06-03501-001\CAD\Dwgs\Jarpa\J-9.dwg
Plot Date: 6/26/2008 7:15 AM Cad User: Wojciech Wieszczecinski

Prepared by: C. BARTON	DOWNSTREAM CHANNEL MODIFICATION PLAN AND PROFILE	Applicant: CITY OF BELLEVUE
HERRERA ENVIRONMENTAL CONSULTANTS, 2200 Sixth Avenue, Suite 1100, Seattle, Washington 98121-1820, 206-441-9080, 206-441-9108 FAX, http://www.herrerainc.com	Application for: SE 30th / SUNSET CREEK CULVERT REPLACEMENT	Project Location: BELLEVUE, KING COUNTY, WASHINGTON
	Purpose: FLOW CONVEYANCE	SCALE AS NOTED
Date: JUNE 2008	Waterbody: SUNSET CREEK	SHEET 9 of 9



VICINITY MAP
SCALE: 1"=1000'

CITY OF BELLEVUE
SE 30TH STREET/SUNSET CREEK
CULVERT REPLACEMENT PROJECT

BELLEVUE, WASHINGTON

SHEET INDEX		
SHT NO.	DWG NO.	SHEET DESCRIPTION
1	G-1	TITLE SHEET, INDEX, AND VICINITY MAP
2	G-2	GENERAL NOTES
3	G-3	ABBREVIATIONS AND LEGEND
4	G-4	SITE PLAN
5	C-1	ROADWAY CORRIDOR DEMOLITION PLAN
6	C-2	ROADWAY PHASING PLAN AND NOTES
7	C-3	UTILITIES PLAN
8	C-4	UTILITIES DETAILS
9	C-5	ROADWAY PLAN AND SECTION
10	C-6	ROADWAY PLAN AND SECTION
11	C-7	CULVERT REPLACEMENT PLAN AND NOTES
12	C-8	CULVERT REPLACEMENT PROFILE AND NOTES
13	C-9	CULVERT REPLACEMENT DETAILS
14	C-10	STREAM CORRIDOR SITE PREPARATION PLAN
15	C-11	UPPER STREAM CHANNEL MODIFICATIONS PLAN AND PROFILE
16	C-12	LOWER STREAM CHANNEL MODIFICATIONS PLAN AND PROFILE
17	C-13	STREAM CHANNEL MODIFICATIONS DETAILS
18	ESC-1	TEMPORARY EROSION AND SEDIMENT CONTROL PLAN
19	ESC-2	TESC DETAILS
20	WM-1	FLOW DIVERSION AND FISH EXCLUSION DETAILS
21	P-1	PLANTING PLAN
22	P-2	PLANTING DETAILS
23	P-3	PLANT MATERIAL LIST

1 / C-3 — DETAIL REFERENCE NUMBER / DRAWING ON WHICH DETAIL IS SHOWN

DETAIL
SCALE: NTS
1 / C-1 — DETAIL REFERENCE NUMBER / DRAWING FROM WHICH DETAIL WAS TAKEN

A / C-4 — SECTION REFERENCE LETTER / DRAWING ON WHICH SECTION IS SHOWN

SECTION
SCALE: NTS
A / C-2 — SECTION REFERENCE LETTER / DRAWING FROM WHICH SECTION WAS TAKEN

"–" INDICATES THAT THE DETAIL/SECTION IS SHOWN ON THE SAME SHEET

"TYP" INDICATES THAT THE DETAIL/SECTION IS UNIFORMLY TYPICAL THROUGHOUT PROJECT EXCEPT WHERE OTHERWISE NOTED

"VAR" SPECIFIES THAT DETAIL/SECTION WAS TAKEN FROM SEVERAL DRAWINGS

NOTE AND DETAIL/SECTION REFERENCING

60% DESIGN - NOT FOR CONSTRUCTION

811 Know what's below. Call before you dig.

MARK EWBANK STATE OF WASHINGTON 29434 CIVIL ENGINEER PROFESSIONAL ENGINEER

ONE INCH — AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase I\G-1.dwg
Plot Date: 6/11/2008 11:50 AM Cad User: Wojciech Wieszczecinski

NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
Suite 1100
Seattle, Washington
98121-1820
206-441-9080
206-441-9108 FAX
http://www.herrerainc.com

SE 30TH STREET / SUNSET CREEK
CULVERT REPLACEMENT PROJECT

Approved By
DESIGN MANAGER — DATE
PROJECT MANAGER — DATE

C. BARTON	05/2008
DESIGNED BY	DATE
W. WIESZCZECINSKI	06/2008
DRAWN BY	DATE
M. EWBANK	06/2008
CHECKED BY	DATE

City of Bellevue
UTILITIES

TITLE SHEET, INDEX, AND VICINITY MAP
DRAWING G-1
SHT 1 OF 23

GENERAL NOTES:

1. MATERIAL SHALL NOT BE STORED OUTSIDE OF IDENTIFIED STAGING AREAS, UNLESS APPROVED BY OWNER OR ENGINEER.
2. ALL EQUIPMENT SHALL USE ONLY BIODEGRADABLE HYDRAULIC FLUIDS.
3. CONTRACTOR SHALL LIMIT MACHINERY MOVEMENT TO PROJECT LIMITS DEFINED ON SITE PLAN OR IDENTIFIED AS ACCEPTABLE BY ENGINEER.
4. CLEARING LIMITS FOR TEMPORARY ACCESS ROAD AND PROPOSED STRUCTURES SHALL BE LIMITED TO THE AREA REQUIRED FOR SAFE EQUIPMENT OPERATION. CLEARING LIMITS SHALL BE STAKED BY CONTRACTOR AND APPROVED BY ENGINEER AT LEAST 3 DAYS PRIOR TO CLEARING ACTIVITIES. CLEARING LIMITS SHALL BE STAKED TO MINIMIZE THE AREA OF DISTURBANCE.
5. SEE SPECIFICATIONS FOR LOG TYPE (SPECIES), DIAMETER AND LENGTH. EXCAVATIONS SHALL BE INSPECTED BY ENGINEER PRIOR TO PLACEMENT OF ANY WOOD.
6. LOG PLACEMENTS SHALL BE INSPECTED BY ENGINEER PRIOR TO BACKFILLING.
7. CONTRACTOR SHALL PROVIDE 24 HOURS ADVANCE NOTICE TO THE ENGINEER PRIOR TO ANY REQUIRED INSPECTION. CONTRACTOR SHALL SUBMIT A CONSTRUCTION SEQUENCE PLAN FOR APPROVAL AT LEAST 5 DAYS PRIOR TO SITE WORK.
8. APPROVED CONSTRUCTION SEQUENCE PLAN SHALL NOT BE ALTERED UNLESS APPROVED BY ENGINEER.
9. EQUIPMENT USED FOR THIS PROJECT SHALL BE FREE OF EXTERNAL PETROLEUM-BASED PRODUCTS WHILE WORKING AROUND THE STREAM. ACCUMULATION OF SOILS OR DEBRIS SHALL BE REMOVED FROM THE DRIVE MECHANISMS (WHEELS, TRACKS, TIRES, ETC.) AND UNDERCARRIAGE OF EQUIPMENT PRIOR TO ITS WORKING WITHIN THE CHANNEL.
10. EQUIPMENT SHALL BE CHECKED DAILY FOR LEAKS, AND ANY NECESSARY REPAIRS SHALL BE COMPLETED PRIOR TO COMMENCING WORK ACTIVITIES.
11. THE CONTRACTOR IS RESPONSIBLE TO ENSURE THAT NO PETROLEUM PRODUCTS, HYDRAULIC FLUID, SEDIMENTS, SEDIMENT-LADEN WATER, CHEMICALS, OR ANY OTHER TOXIC OR DELETERIOUS MATERIALS ARE ALLOWED TO ENTER OR LEACH INTO THE STREAM.
12. IF AT ANY TIME, AS A RESULT OF PROJECT ACTIVITIES, FISH ARE OBSERVED IN DISTRESS, A FISH KILL OCCURS, OR WATER QUALITY PROBLEMS DEVELOP (INCLUDING EQUIPMENT LEAKS OR SPILLS), OPERATIONS SHALL CEASE AND THE ENGINEER SHALL BE NOTIFIED IMMEDIATELY. WASHINGTON DEPARTMENT OF FISH AND WILDLIFE AND WASHINGTON DEPARTMENT OF ECOLOGY SHALL BE CONTACTED IMMEDIATELY BY THE ENGINEER OR BY HIS/HER DESIGNEE. WORK SHALL NOT RESUME UNTIL FURTHER APPROVAL BY OWNER'S REPRESENTATIVE.
13. EROSION CONTROL METHODS SHALL BE USED TO PREVENT SILT-LADEN WATER FROM ENTERING THE CREEK. INITIAL EROSION CONTROL MEASURES ARE SHOWN ON DRAWINGS ESC-1 AND ESC-2. THE CONTRACTOR SHALL SUBMIT A TEMPORARY EROSION AND SEDIMENT CONTROL PLAN SHOWING ADDITIONAL SITE SPECIFIC EROSION AND SEDIMENT CONTROL TECHNIQUES AND METHODS.
14. IF HIGH FLOW CONDITIONS THAT MAY CAUSE SILTATION OR EROSION ARE ENCOUNTERED DURING CONSTRUCTION, WORK SHALL STOP UNTIL THE FLOW SUBSIDES.
15. CONTRACTOR IS RESPONSIBLE FOR CALLING "ONE CALL" FOR UTILITY LOCATES PRIOR TO CONSTRUCTION. 1(800)424-5555 OR 811
16. THE EXISTING FEATURES AS SHOWN ON THE EXISTING CONDITIONS PLAN WERE PROVIDED BY THE CITY OF BELLEVUE AND FROM SUPPLEMENTAL FIELD WORK PERFORMED BY APS.

LOG NOTES:

1. DECKED LOGS SHALL BE ACCESSIBLE FOR INSPECTION.
2. LOG TYPE IDENTIFICATION SHALL BE PAINTED ON ALL LOGS IN A PLACE VISIBLE FOR INSPECTION PRIOR TO PLACEMENT WITH LEAD-FREE, BLAZE-ORANGE SURVEY MARKING PAINT.

UTILITIES AND AGENCIES

CITY OF BELLEVUE

BRIAN WARD – PROJECT MANAGER

450 110TH AVENUE NE
BELLEVUE, WA 98004
(425) 452-5206
(425) 452-7856

EMAIL: BWARD@BELLEVUEWA.GOV

KING COUNTY DEPARTMENT OF NATURAL RESOURCES, WTD

ERIC DAVISON

201 S. JACKSON ST, MAIL STOP
KSC-NR-0508
SEATTLE, WA 98104-3855

(206) 684-1707
FAX: (206) 684-1710
ERIC.DAVISON@KINGCOUNTY.GOV

BELLEVUE WATER DISTRICT #1

KIPP FOCKLER – OPERATING & WATER MAINTENANCE
(425) 452-2923

GREG KNIGHT
(425) 452-4493

BELLEVUE FIRE DEPARTMENT

NON-EMERGENCY GENERAL
(425) 452-6892

FIRE PREVENTION PLAN REVIEW DESK
(425) 452-4122

BELLEVUE POLICE DEPARTMENT

(425) 452-6917

CITY OF BELLEVUE – TRANSPORTATION DEPARTMENT

JON REGALIA

450 110TH AVENUE NE
BELLEVUE, WA 98004
(425) 452-4599

EMAIL: JREGALIA@BELLEVUEWA.GOV

CITY OF BELLEVUE – PERMIT CENTER

TRAVIS RIPLEY
(425) 452-6042

PUGET SOUND ENERGY (PSE CONSTRUCTION)

JEANNE COLEMAN – MUNICIPAL CONSTRUCTION PLANNER

P.O. BOX 97034
MAIL STOP: EST-11W
BELLEVUE, WA 98009-9734

(425) 462-3488
EMAIL: JEANNE.COLEMAN@PSE.COM

COMCAST (FORMERLY AT&T BROADBAND)

JILL LOOK

1525 75TH ST. SW, SUITE 200
EVERETT, WA 98203

(425) 263-5346
FAX: (425) 263-5352
MOBILE: (206) 396-6032
EMAIL: JILL_LOOK@CABLE.COMCAST.COM

QWEST (US WEST COMMUNICATIONS)

DAN RESSLER

1550 NEWPORT WAY NW, ROOM #2
ISSAQUAH, WA 98027

(206) 345-3809
EMAIL: JOSEPH.RESSLER@QWEST.COM

ONE CALL

UTILITY LOCATION
(800) 424-5555 OR 811

60% DESIGN - NOT FOR CONSTRUCTION

MARK EWBANK, STATE OF WASHINGTON, 29434, CIVIL ENGINEER, PROFESSIONAL ENGINEER

ONE INCH — AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
Suite 1100
Seattle, Washington
98121-1820
206-441-9080
206-441-9108 FAX
http://www.herrerainc.com

SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER — DATE
PROJECT MANAGER — DATE

C. BARTON 05/2008 — DESIGNED BY DATE
W. WIESZCZECINSKI 06/2008 — DRAWN BY DATE
M. EWBANK 06/2008 — CHECKED BY DATE

City of Bellevue UTILITIES

GENERAL NOTES

DRAWING G-2 — SHT 2 OF 23

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase I\G-2.dwg Cad User: Wojciech Wieszczecinski
Plot Date: 6/11/2008 11:51 AM

ABBREVIATIONS:

APPROX	APPROXIMATE(LY)
CB	CATCH BASIN
DBH	DIAMETER BREAST HEIGHT
DIA	DIAMETER
DWG	DRAWING
ESC	EROSION AND SEDIMENT CONTROL
EX	EXISTING
FAC	FACULTATIVE
FACU	FACULTATIVE UPLAND
FACW	FACULTATIVE WETLAND
FT	FEET
IN	INCHES
LWD	LARGE WOODY DEBRIS
MIN	MINIMUM
NI	NO INDICATOR
OHP	OVERHEAD POWER LINE
OHWM	ORDINARY HIGH WATER MARK
PSE	PUGET SOUND ENERGY
SDMH	STORM DRAIN MANHOLE
TEL	TELEPHONE
TYP	TYPICAL
UGP	UNDERGROUND POWER LINE
UGT	UNDERGROUND TELEPHONE LINE
UPL	OBLIGATE UPLAND

LEGEND:

- EXISTING BUILDING
- EXISTING CURB
- 72 — EXISTING CONTOURS
- EXISTING BANK SLOPE
- OHP — EXISTING OVERHEAD POWER LINE
- UGP — EXISTING UNDERGROUND POWER LINE
- W — EXISTING WATER LINE
- G — EXISTING GAS LINE
- EXISTING MANHOLE
- EXISTING CATCH BASIN
- EXISTING STORM DRAIN MANHOLE
- T — EXISTING TELEPHONE J-BOX
- P — EXISTING POWER VAULT
- EXISTING FIRE DEPT CONNECTION
- EXISTING POWER POLE
- EXISTING POWER TRANSFORMER
- CREEK FLOW LINE
- HIGH VISIBILITY FENCE
- SILT FENCE
- EXCAVATION LIMITS
- EXISTING GRADE
- DIVERTED FLOW LINE
- PROPOSED AVERAGE GRADE
- LIMITED DISTURBANCE AREA
- CLEAR AND GRUB AREA
- STREAMBED GRAVEL
- PLUNGE POOL
- SCOUR COBBLE
- EXISTING GROUND
- TEMPORARY STREAM ACCESS
- EXCAVATED ALLUVIUM
- STAGING AREA
- ECOLOGY BLOCKS
- BULK BAGS
- BOULDERS
- LOGS WITH ROOTWAD
- LOGS WITHOUT ROOTWAD
- LOGS WITH ROOTWAD BURIED
- LOGS WITHOUT ROOTWAD BURIED
- LOG SECTION
- VEGETATION
- # — LOG IDENTIFICATION #
- LOG CONTROL POINT
- 1+00 — STREAM PROFILE STATIONING (FT)

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase I\G-3.dwg
Cad User: Wojciech Wieszczecinski
Plot Date: 6/11/2008 11:52 AM

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C. BARTON	05/2008
DESIGNED BY	DATE
W. WIESZCZECINSKI	06/2008
DRAWN BY	DATE
M. EWBANK	06/2008
CHECKED BY	DATE

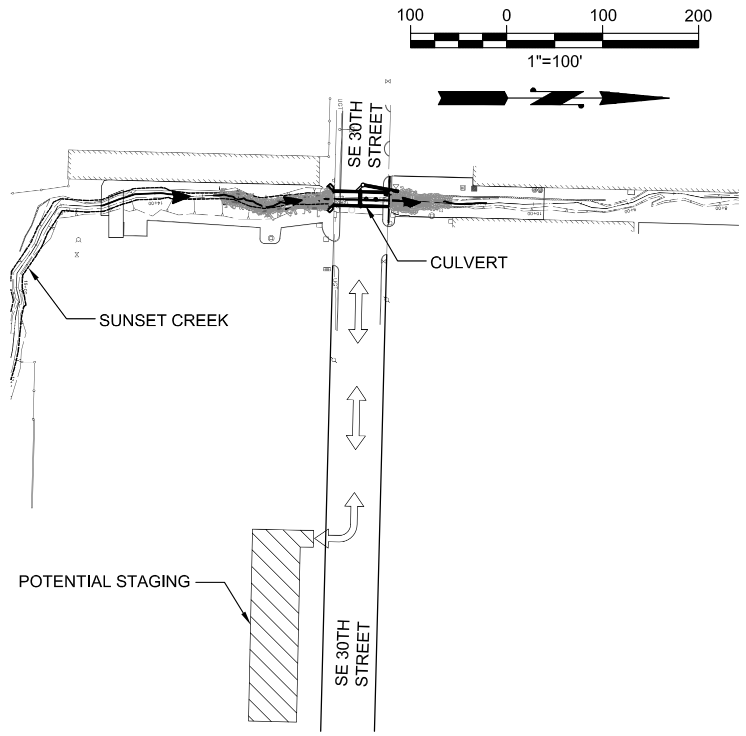
City of Bellevue UTILITIES

ABBREVIATIONS AND LEGEND

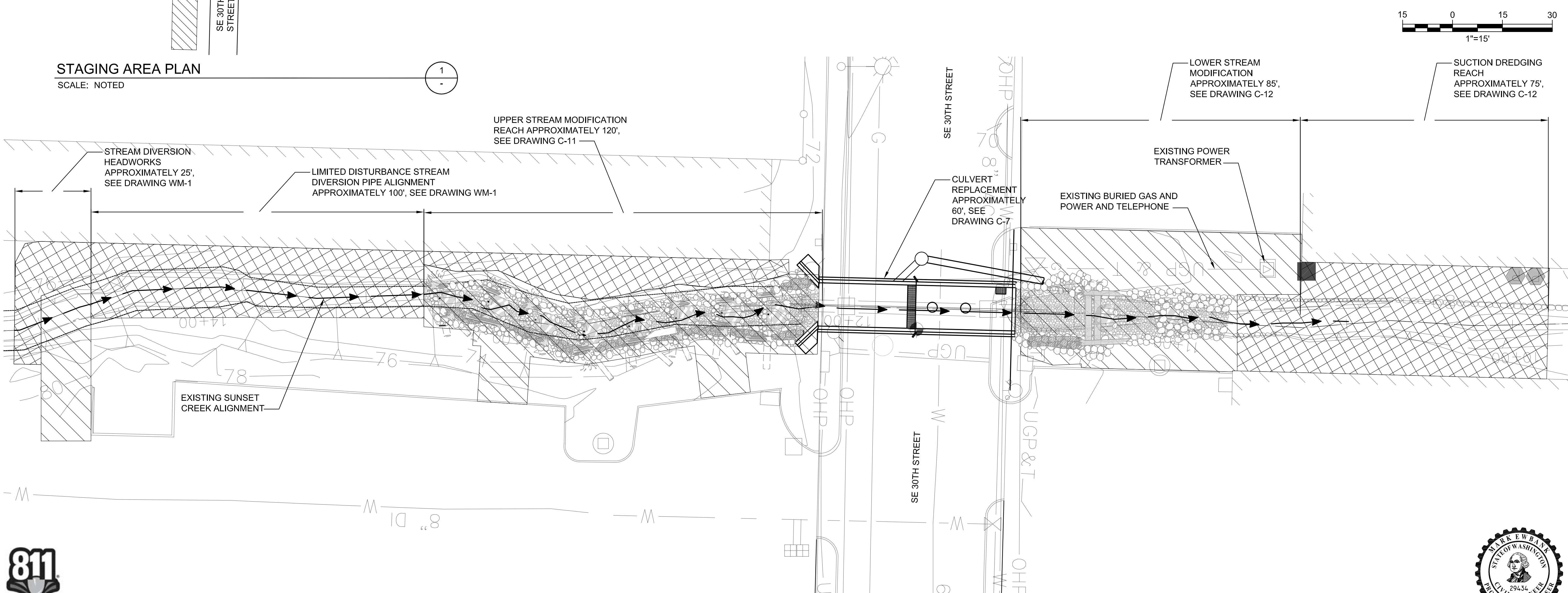
DRAWING G-3 — SHT 3 OF 23

GENERAL NOTES:

1. FOR STREAM CORRIDOR SITE PREP DETAILS SEE DRAWING C-10
2. FOR SITE STAGING AREA SEE DETAIL 1 ON THIS SHEET



STAGING AREA PLAN 1
SCALE: NOTED



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Cad User: Wojciech Wieszczecinski

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CIVILTECH ENGINEERING
10800 NE 8th Street Suite 820
Bellevue, WA 98004
Phone: 425.453.6488
Fax: 425.453.5848

SE 30TH STREET / SUNSET CREEK
CULVERT REPLACEMENT PROJECT

Approved By

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W. WIESZCZECINSKI	06/2008
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M. EWBANK	06/2008
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City of Bellevue
UTILITIES

SITE PLAN

DRAWING G-4 SHT 4 OF 23

MARK EWBANK, STATE OF WASHINGTON, 29434, CIVIL ENGINEER, PROFESSIONAL ENGINEER

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REMOVAL NOTES:

1. REMOVE CONC CURB AND SIDEWALK
2. SAW CUTTING PAVEMENT
3. REMOVE ASPHALT CONC PAVEMENT
4. REMOVE CATCH BASIN
5. EXCAVATE AND REMOVE CMP CULVERTS
6. REMOVE SAFETY RAILING
7. REMOVE ROCKERY WALL AS NECESSARY TO FACILITATE CULVERT INSTALLATION. KEEP ROCK FOR CHANNEL MODIFICATIONS.

GENERAL NOTES:

1.) FOR REMOVAL, RELOCATION, AND ADJUSTMENT OF WATER VALVES, FIRE HYDRANTS, WATER METERS, AND OTHER FEATURES RELATED TO WATER MAIN, SEE UTILITY PLAN, SHEETS C3 AND C4.

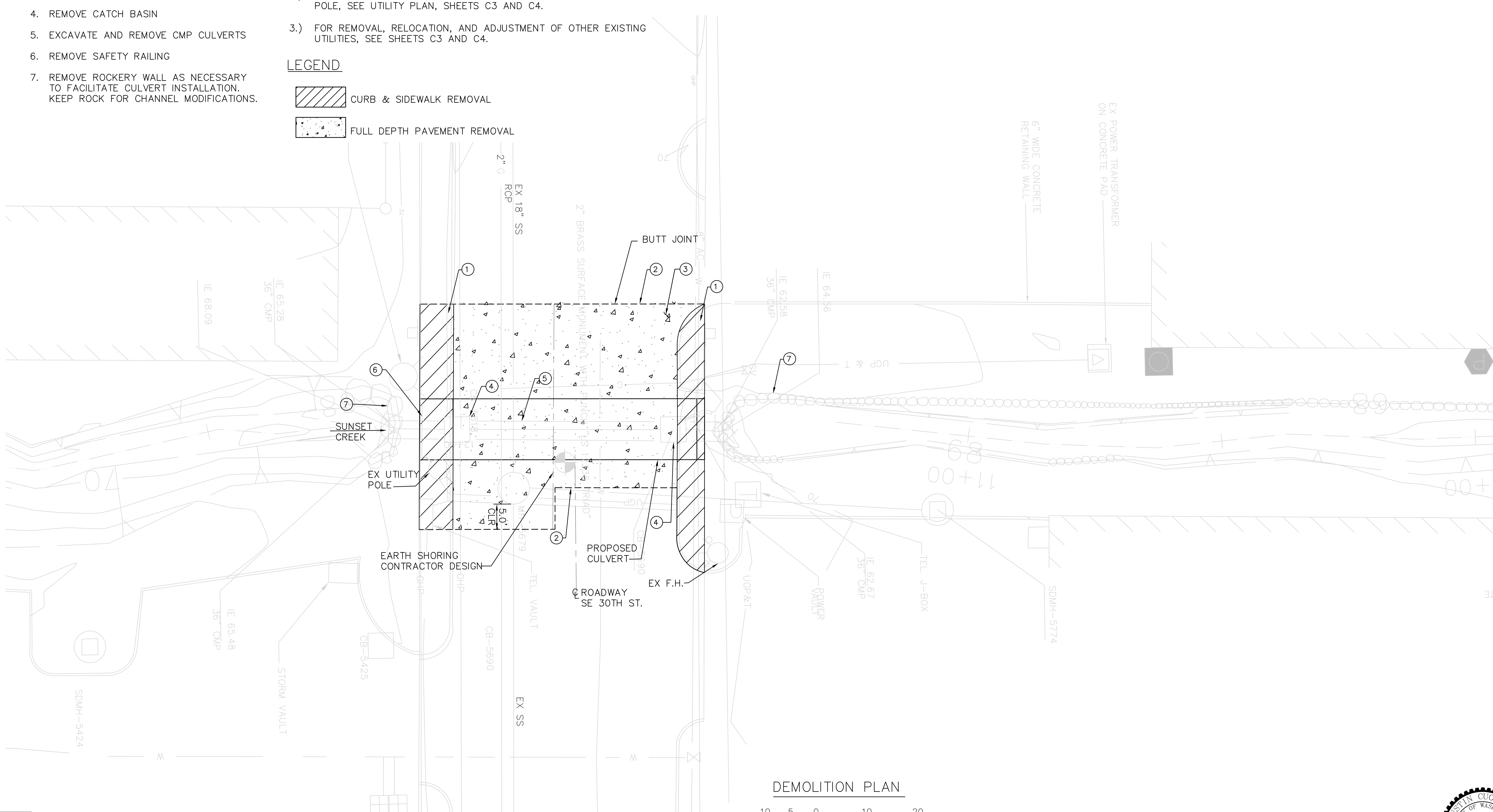
2.) FOR REMOVAL OR RELOCATION OF POWER POLE AND TELEPHONE POLE, SEE UTILITY PLAN, SHEETS C3 AND C4.

3.) FOR REMOVAL, RELOCATION, AND ADJUSTMENT OF OTHER EXISTING UTILITIES, SEE SHEETS C3 AND C4.

LEGEND

CURB & SIDEWALK REMOVAL

FULL DEPTH PAVEMENT REMOVAL



DEMOLITION PLAN

10 5 0 10 20
SCALE IN FEET

VERTICAL DATUM:
CITY OF BELLEVUE #140 NAVD'88 ELEV.=210.42
TOP NE CORNER 3'x3' CONCRETE FOOTING FOR 2'x2' BRICK PILLAR AT SW CORNER 128TH AVENUE SE AND SE 26TH PLACE.

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NORTH 1/2, SEC. 10, TWP. 24 N., RGE 5 E., W.M.

DUSTIN CUONG ONG — STATE OF WASHINGTON — 35684 — REGISTERED PROFESSIONAL ENGINEER — EXPIRES

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Bellevue, WA 98004
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Fax: 425.453.5848

SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER DATE
PROJECT MANAGER DATE

D.C. ONG	04/2008
DESIGNED BY	DATE
J. ROBERTS	04/2008
DRAWN BY	DATE
D.C. ONG	04/2008
CHECKED BY	DATE

City of Bellevue UTILITIES

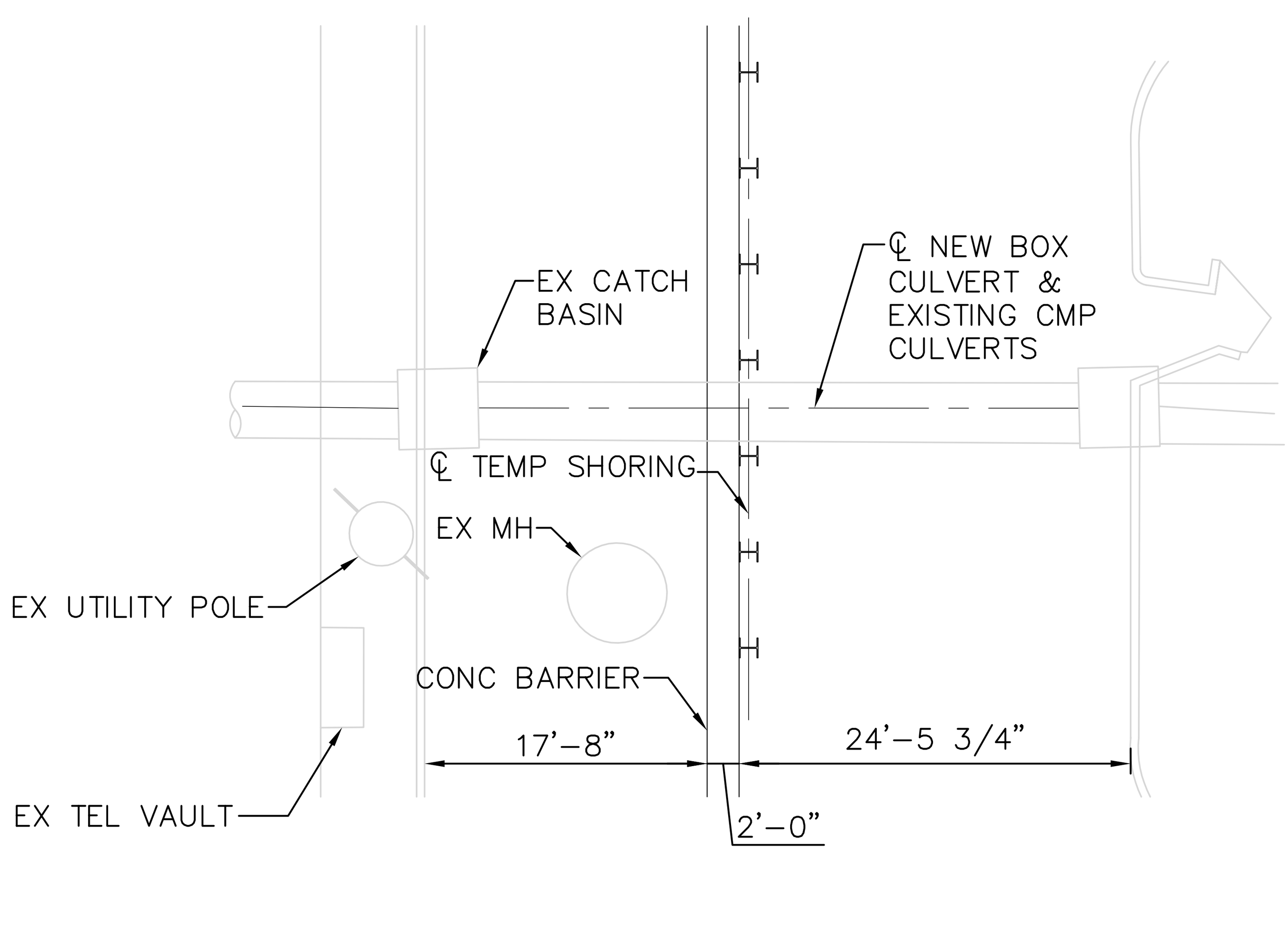
ROADWAY CORRIDOR DEMOLITION PLAN

DRAWING C-1 SHT 5 OF 24

Path: P:\Structural\2007\27015 - SE 30 & Sunset Cr (Herrera)\Cad\Drawing\C-1.dwg
Plot Date: 6/10/2008 2:31 PM Cad User: Jeff Roberts

STAGE 1

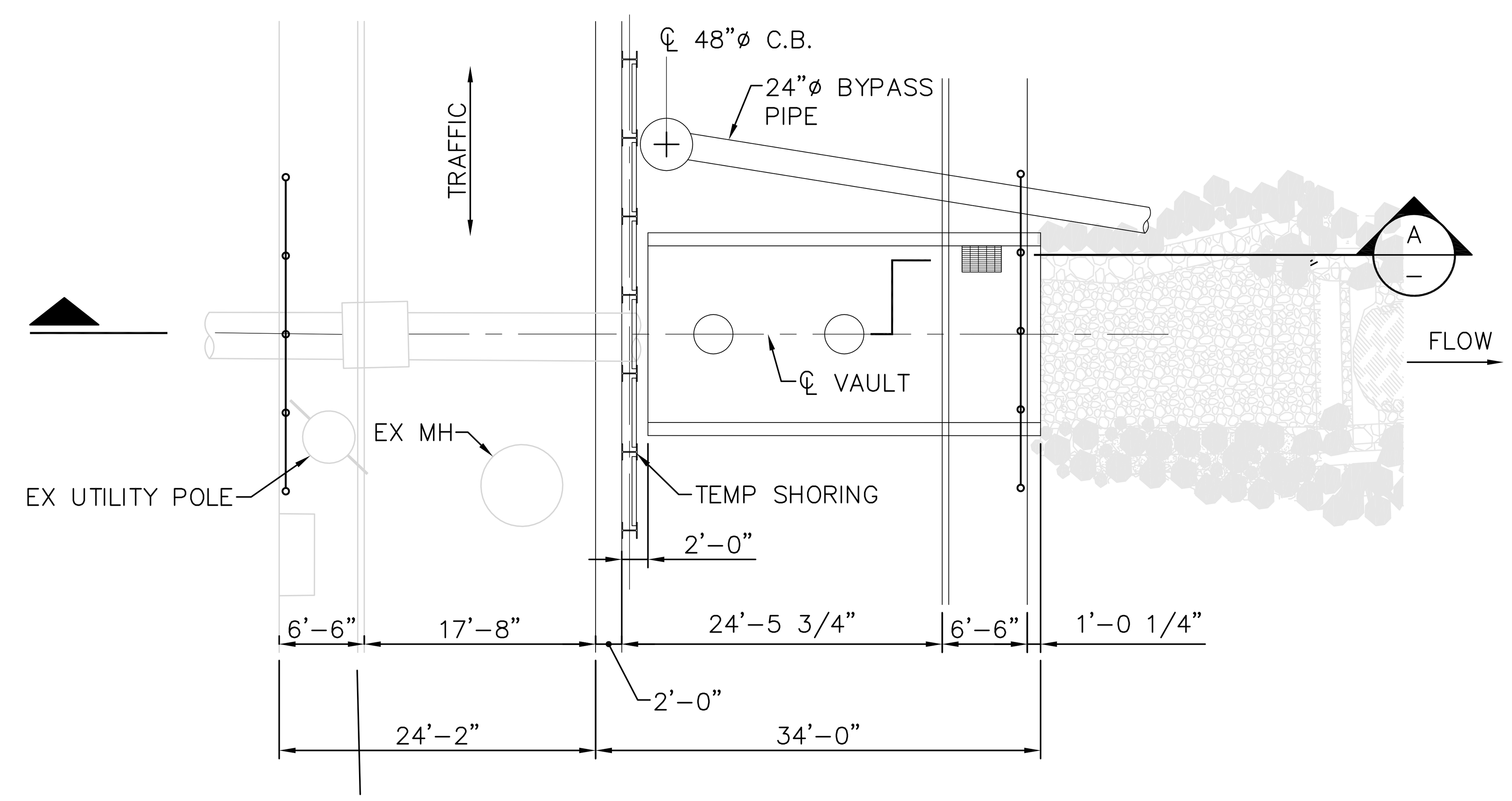
1. PREPARE ROAD CLOSURE AND PLACE CLOSURE SIGNS
2. REMOVE STRUCTURES AND OBSTRUCTIONS
3. INSTALL TEMPORARY SHORING (SOLDIER PILE SHOWN) AT LOCATIONS SHOWN.
4. INSTALL TEMPORARY TRAFFIC BARRIER



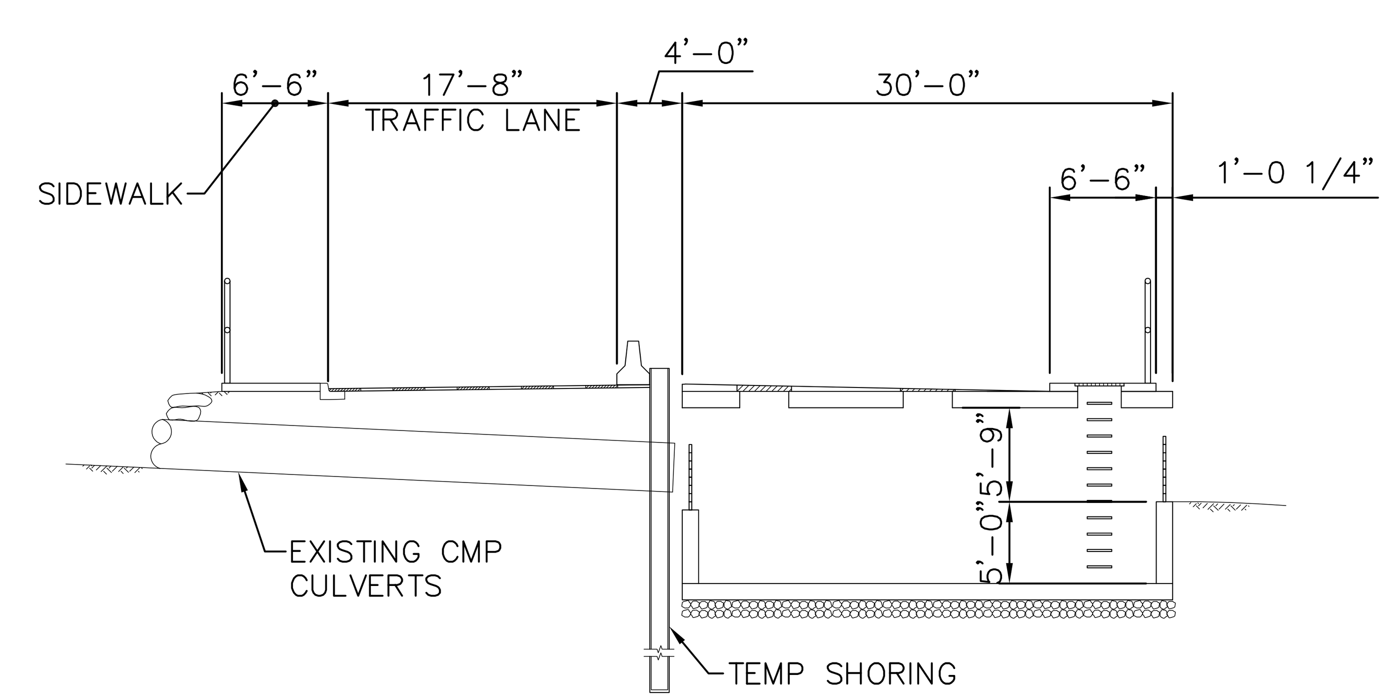
STAGE 1 (PLAN)
SCALE: 1"=10'

STAGE 2

1. CLOSE NORTH LANES. MAINTAIN ONE LANE OPEN AT ALL TIMES, ON SOUTH SIDE OF STREET.
2. INSTALL TEMPORARY PIPE TO DIVERT STREAM FLOW (NOT SHOWN)
3. START EXCAVATION AND REMOVE EXISTING ROCKERIES AND CMP CULVERT.
4. PREPARE FOUNDATION SOILS
5. INSTALL 3-SIDED BOXES, 48"ø TYPE 2 CB, AND 24"ø BYPASS PIPE
6. CONSTRUCT BAFFLE WALLS, REMOVABLE LIDS, AND LADDERS
7. CONSTRUCT DOWNSTREAM CHANNEL MODIFICATIONS



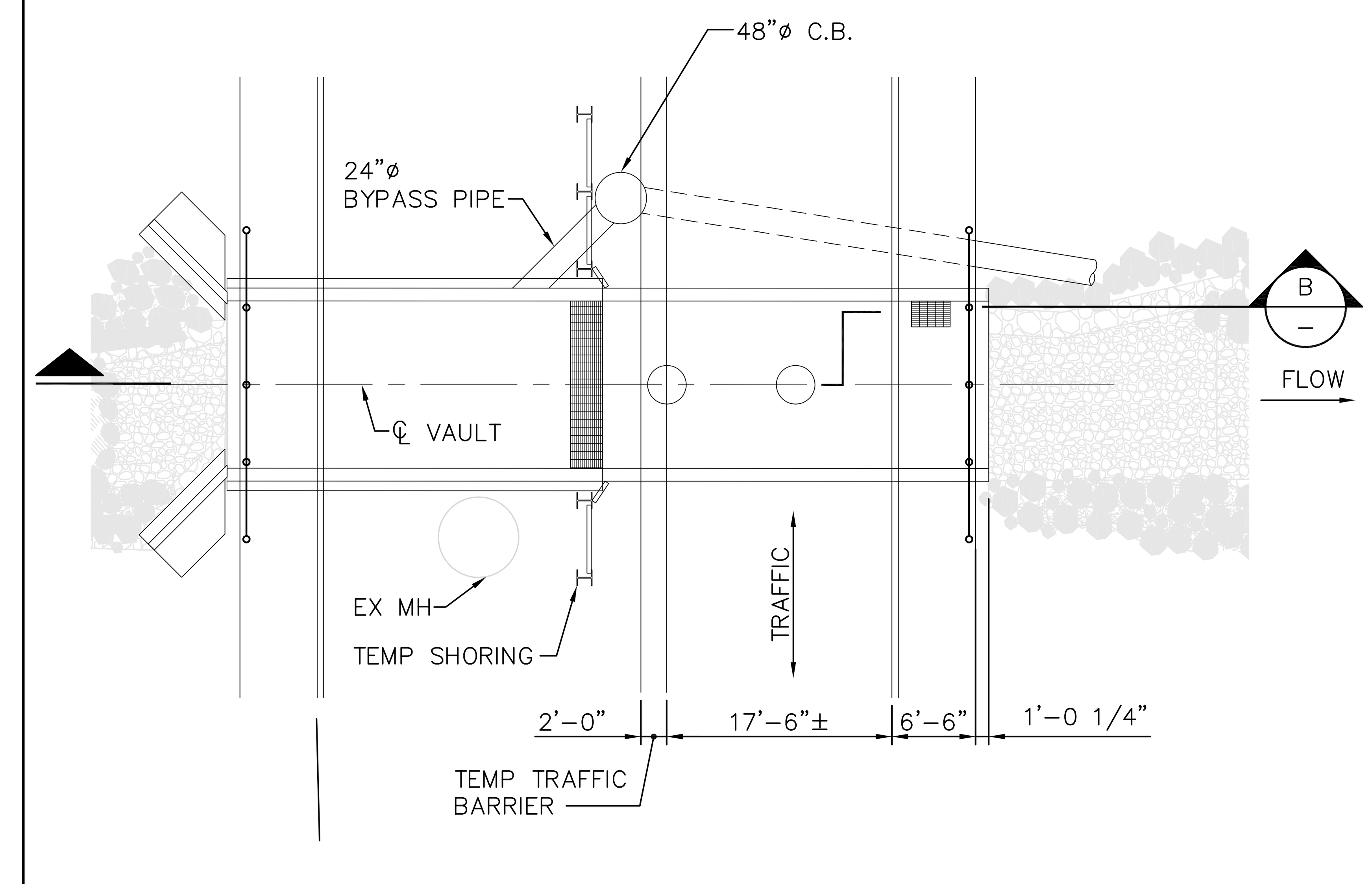
STAGE 2 (PLAN)
SCALE: 1"=10'



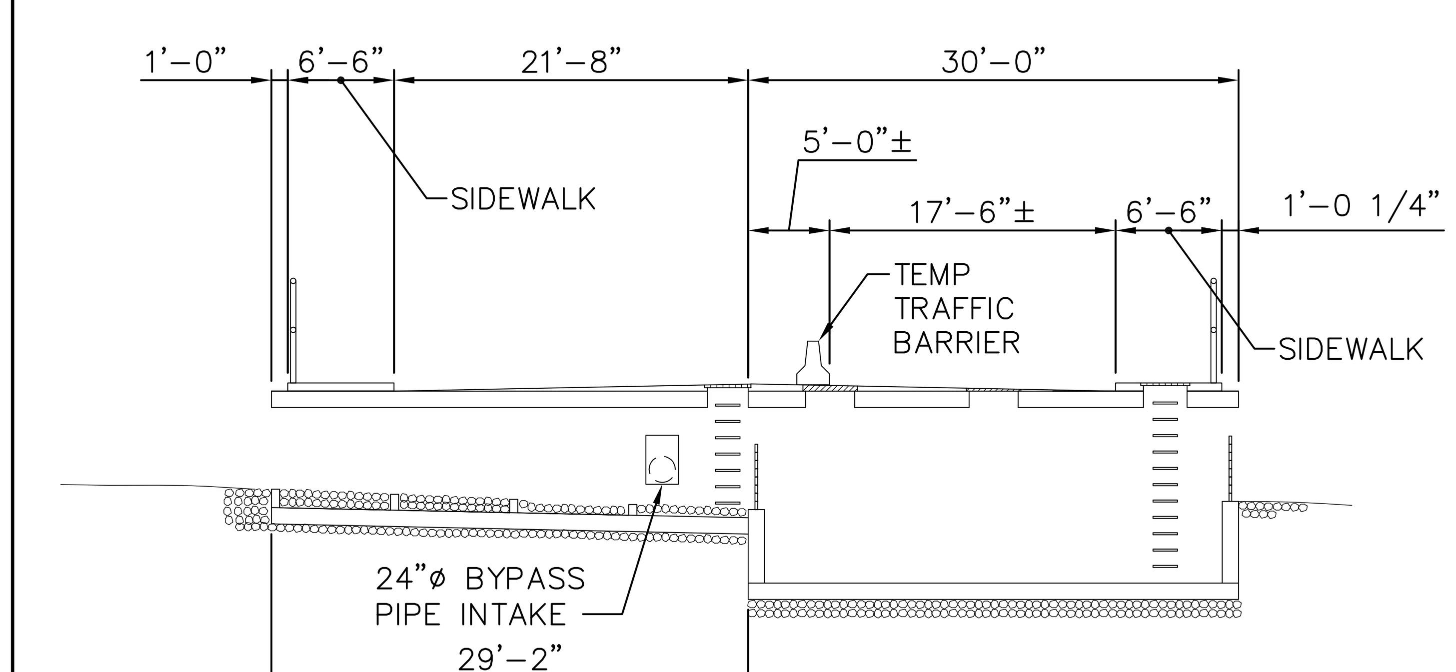
SECTION A
SCALE: 1"=10'

STAGE 3

1. RELOCATE TEMPORARY TRAFFIC BARRIER AT THE LOCATION SHOWN
2. OPEN NORTH LANE TO TRAFFIC, CLOSE SOUTH SIDE OF STREET
3. BEGIN EXCAVATION AND REMOVE EXISTING ROCKERIES AND REMAINING CMP CULVERT. REMOVE SOLDIER PILES THAT INTERFERE WITH NEW VAULT STRUCTURE. PROTECT EXISTING 5'ø MANHOLE DURING EXCAVATION.
4. PREPARE FOUNDATION SOILS
5. INSTALL 4-SIDED BOXES AND WING WALLS. CONSTRUCT 24"ø BYPASS CONNECTION TO 48"ø C.B., PIPE, AND BAFFLES
6. CONSTRUCT UPSTREAM CHANNEL MODIFICATIONS
7. CONSTRUCT SIDEWALKS AND CURBS, PLACE ROADWAY CONCRETE SURFACE OVER CULVERT, AND INSTALL HANDRAILS



STAGE 3 (PLAN)
SCALE: 1"=10'



SECTION B
SCALE: 1"=10'

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EXPIRES

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS

CIVILTECH ENGINEERING
10800 NE 8th Street Suite 820
Bellevue, WA 98004
Phone: 425.453.6488
Fax: 425.453.5848

SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER DATE

PROJECT MANAGER DATE

D.C. ONG	04/2008
DESIGNED BY	DATE
J. ROBERTS	04/2008
DRAWN BY	DATE
D.C. ONG	04/2008
CHECKED BY	DATE

City of Bellevue UTILITIES

ROADWAY PHASING PLAN AND NOTES

DRAWING C-2

SHT 6 OF 24

Path: P:\Structural\2007\27015 - SE 30 & Sunset Cr (Herrera)\Cad\Drawing\C-2.dwg
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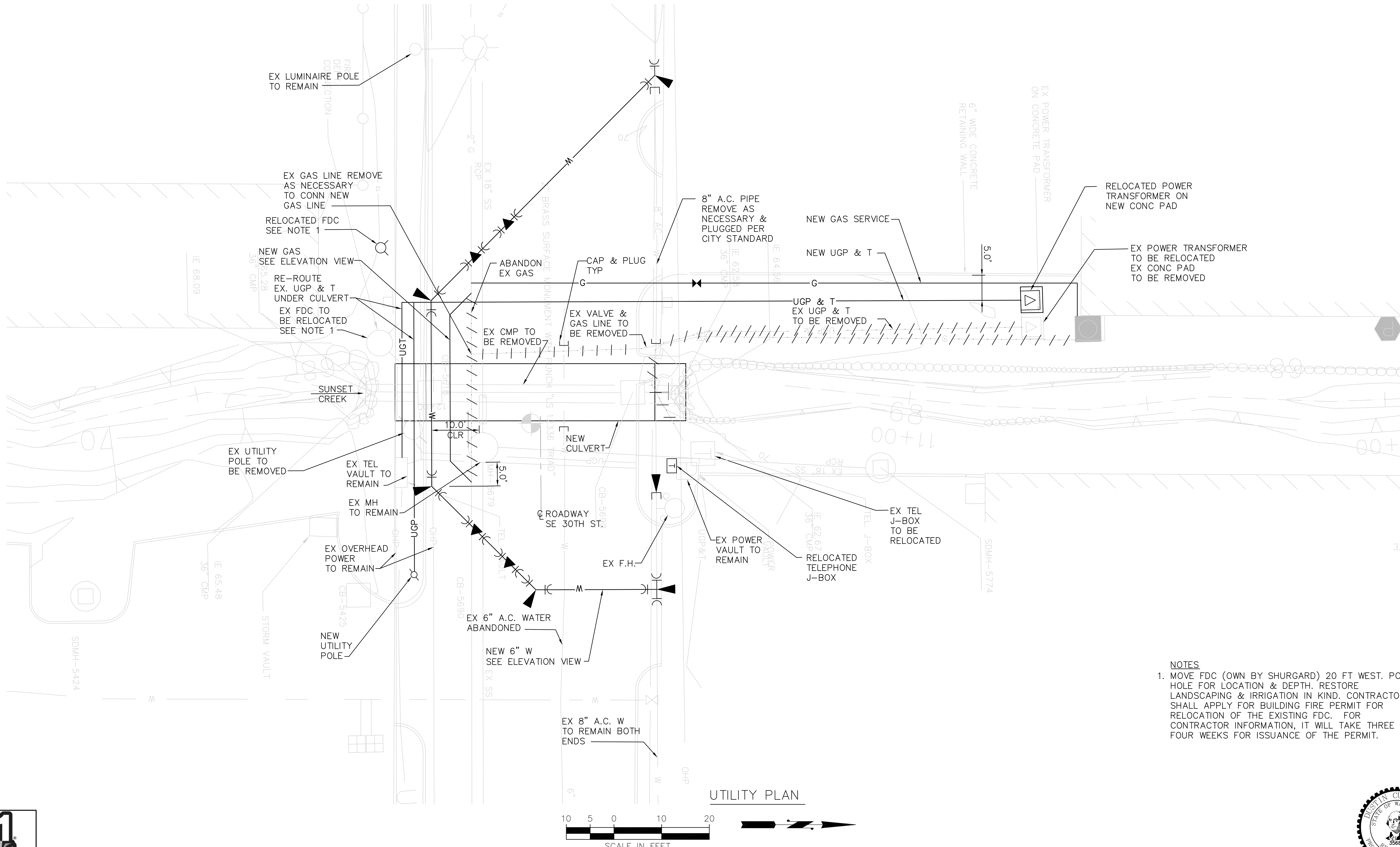
Cad User: Jeff Roberts



UTILITY PLAN

NOTES
1. MOVE FDC (OWN BY SHURGARD) 20 FT WEST. POT HOLE FOR LOCATION & DEPTH. RESTORE LANDSCAPING & IRRIGATION IN KIND. CONTRACTOR SHALL APPLY FOR BUILDING FIRE PERMIT FOR RELOCATION OF THE EXISTING FDC. FOR CONTRACTOR INFORMATION, IT WILL TAKE THREE TO FOUR WEEKS FOR ISSUANCE OF THE PERMIT.

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60% DESIGN - NOT FOR CONSTRUCTION

NORTH 1/2, SEC. 10, TWP. 24 N., RGE 5 E., W.M.

DUSTIN CUONG ONG, STATE OF WASHINGTON, 35684, REGISTERED PROFESSIONAL ENGINEER
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Plot Date: 6/10/2008 2:39 PM Cad User: Jeff Roberts

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SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

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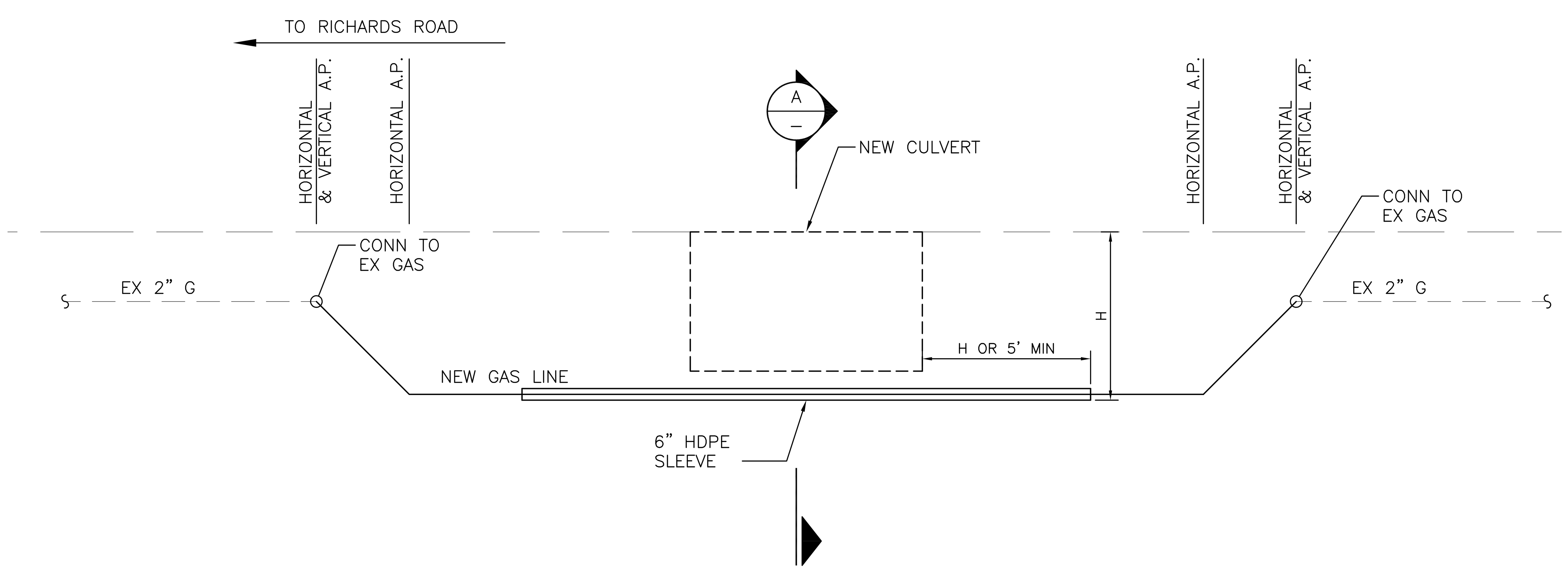
D.C. ONG	04/2008
CHECKED BY	DATE

City of Bellevue UTILITIES

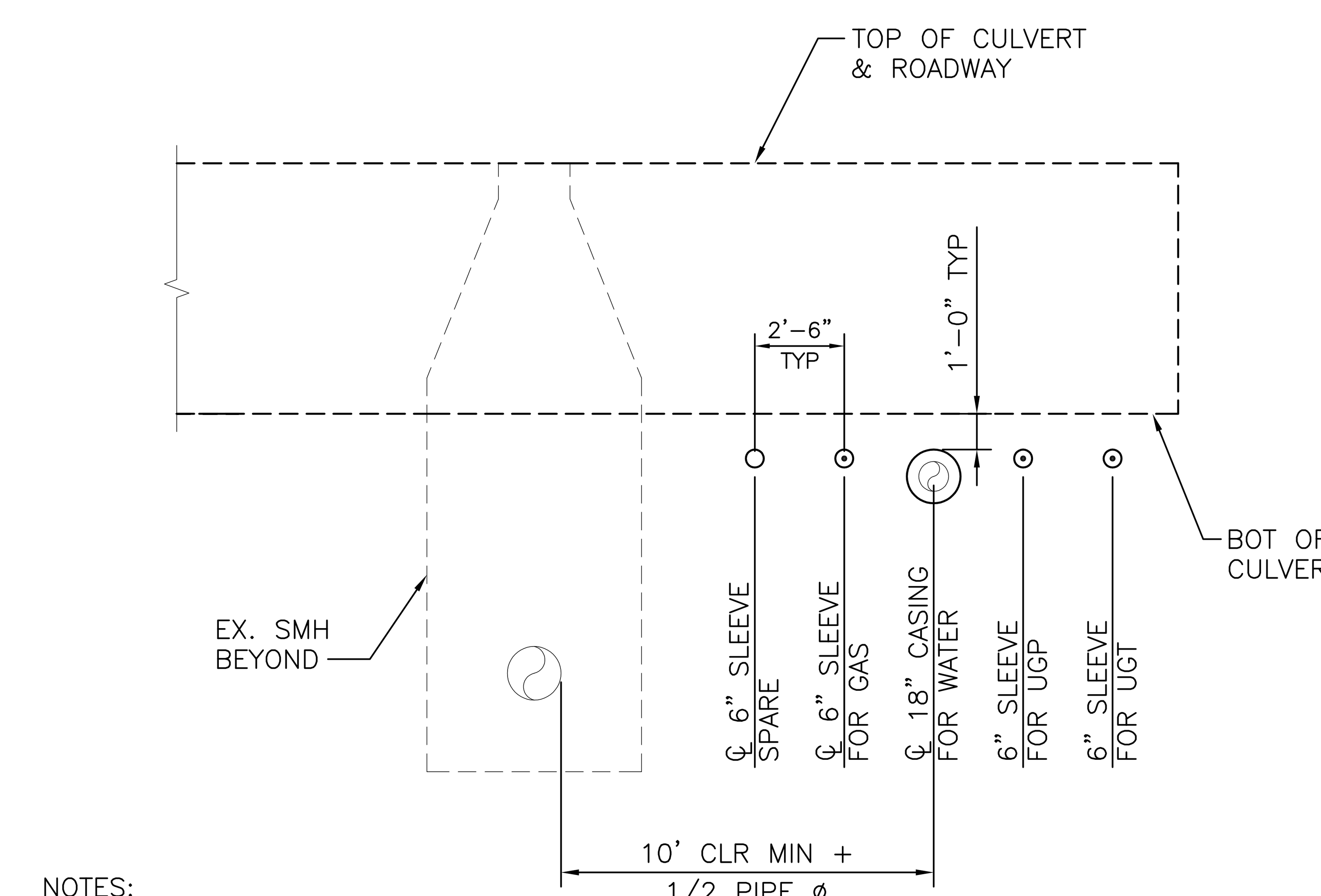
UTILITIES PLAN

DRAWING C-3 SHT 7 OF 24

PROFILE 8" WATER LINE RE-ALIGNMENT



PROFILE GAS LINE RE-ALIGNMENT



NOTES:
1. 6" SLEEVE SHALL BE HDPE
2. 12" SLEEVE SHALL BE ASTM A53 GRADE B

SLEEVE DETAIL A
SCALE: NTS

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City of Bellevue UTILITIES

UTILITIES DETAILS

DRAWING C-4 SHT 8 OF 24

DUSTIN CUONG ONG STATE OF WASHINGTON 35684 REGISTERED PROFESSIONAL ENGINEER
EXPIRES

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Plot Date: 6/10/2008 2:40 PM Cad User: Jeff Roberts

ⓧ ROADWAY CONSTRUCTION NOTES:

1. CONSTRUCT CEMENT CONCRETE TRAFFIC CURB AND GUTTER PER CITY OF BELLEVUE STANDARD DETAIL TE–10.
2. CONSTRUCT CURBSIDE SIDEWALK PER CITY OF BELLEVUE STANDARD DETAIL TE–11.
3. CONSTRUCT DRIVEWAY APPROACH PER CITY OF BELLEVUE STANDARD DETAIL DEV–5.
4. PAVEMENT THICKNESS WILL BE 4 INCHES OF HOT MIX ASPHALT CLASS 1/2" PG 64–22
5. REPLACE CULVERT, SEE SHEET C–7.
6. INSTALL METAL SAFETY RAILING PER CITY OF BELLEVUE STANDARD DETAIL TE–34.
7. 4" CRUSHED SURFACING TOP COURSE.
8. COMPACT GRAVEL BORROW OR NATIVE SOIL TO 95% DRY DENSITY.
9. 6 INCHES OF COMMERCIAL HOT MIX ASPHALT CLASS 1" PG 64–22

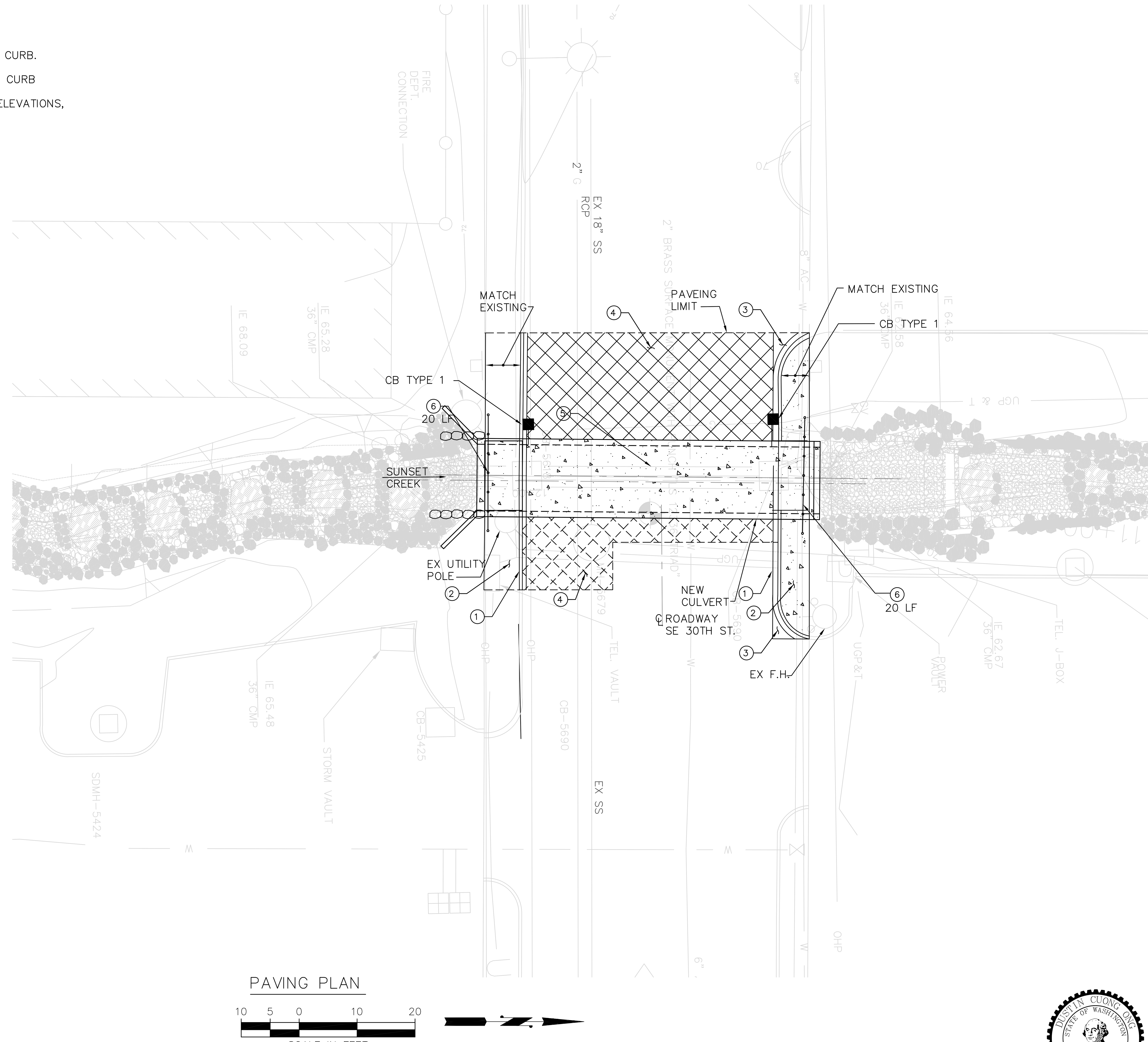
GENERAL NOTES:

1. ROADWAY DIMENSIONS ARE TO FACE OF CURB.
2. SIDEWALK DIMENSIONS ARE TO BACK OF CURB
3. FOR TOP OF CURB RETURN DATA AND ELEVATIONS, MATCH EXISTING

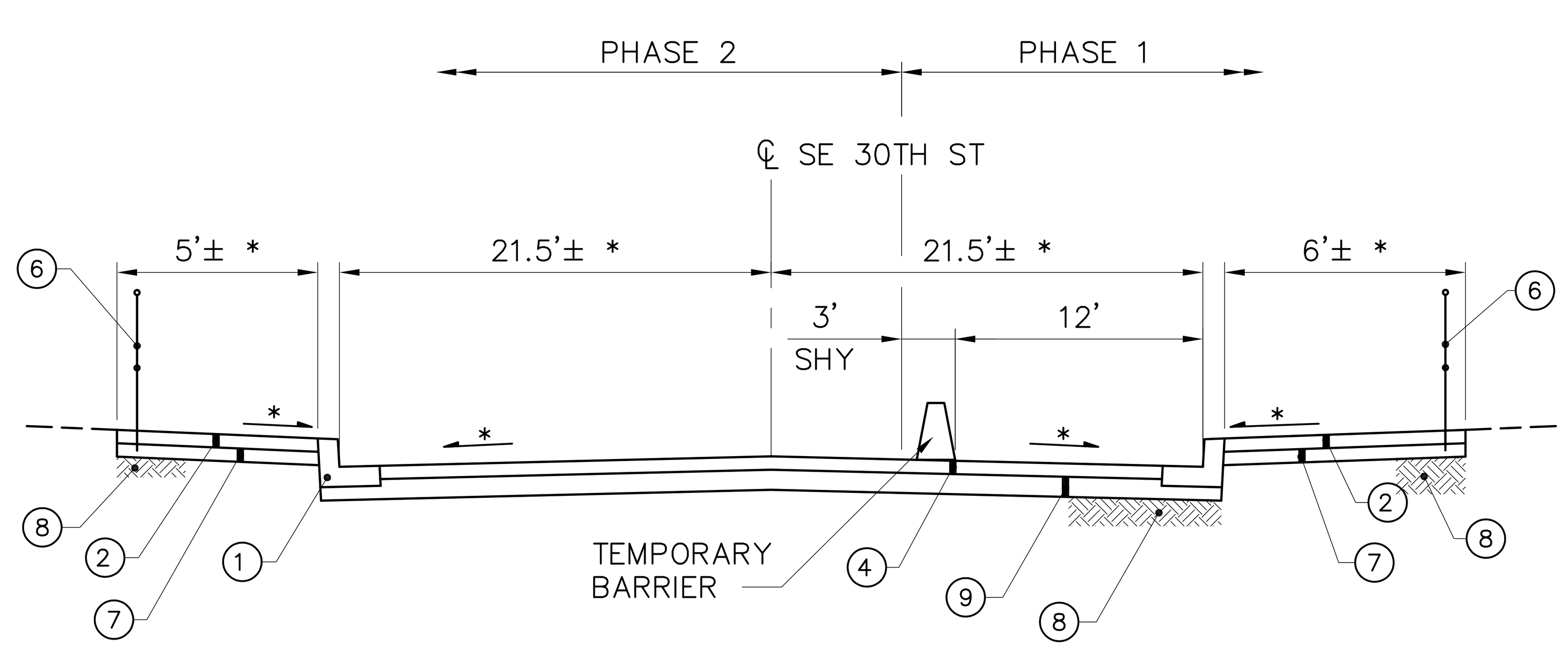
LEGEND

FULL DEPTH PAVEMENT

CEMENT CONCRETE



PAVING PLAN



TYPICAL ROADWAY SECTION

* VERIFY IN FIELD & MATCH EXISTING CONDITION FOR FIT–UP

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City of Bellevue UTILITIES

ROADWAY PLAN AND SECTION

DRAWING C-5

BLANK SHEET

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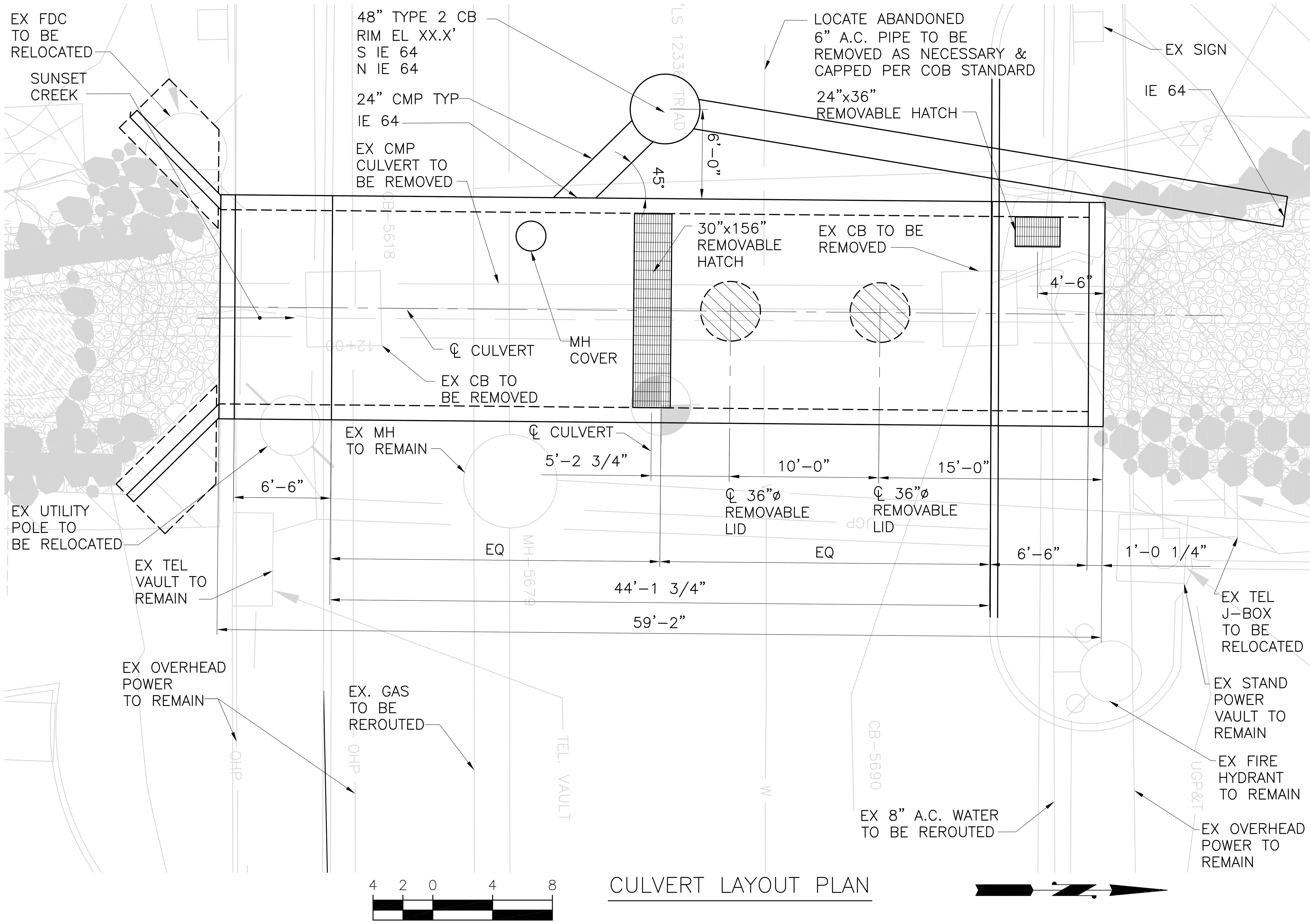
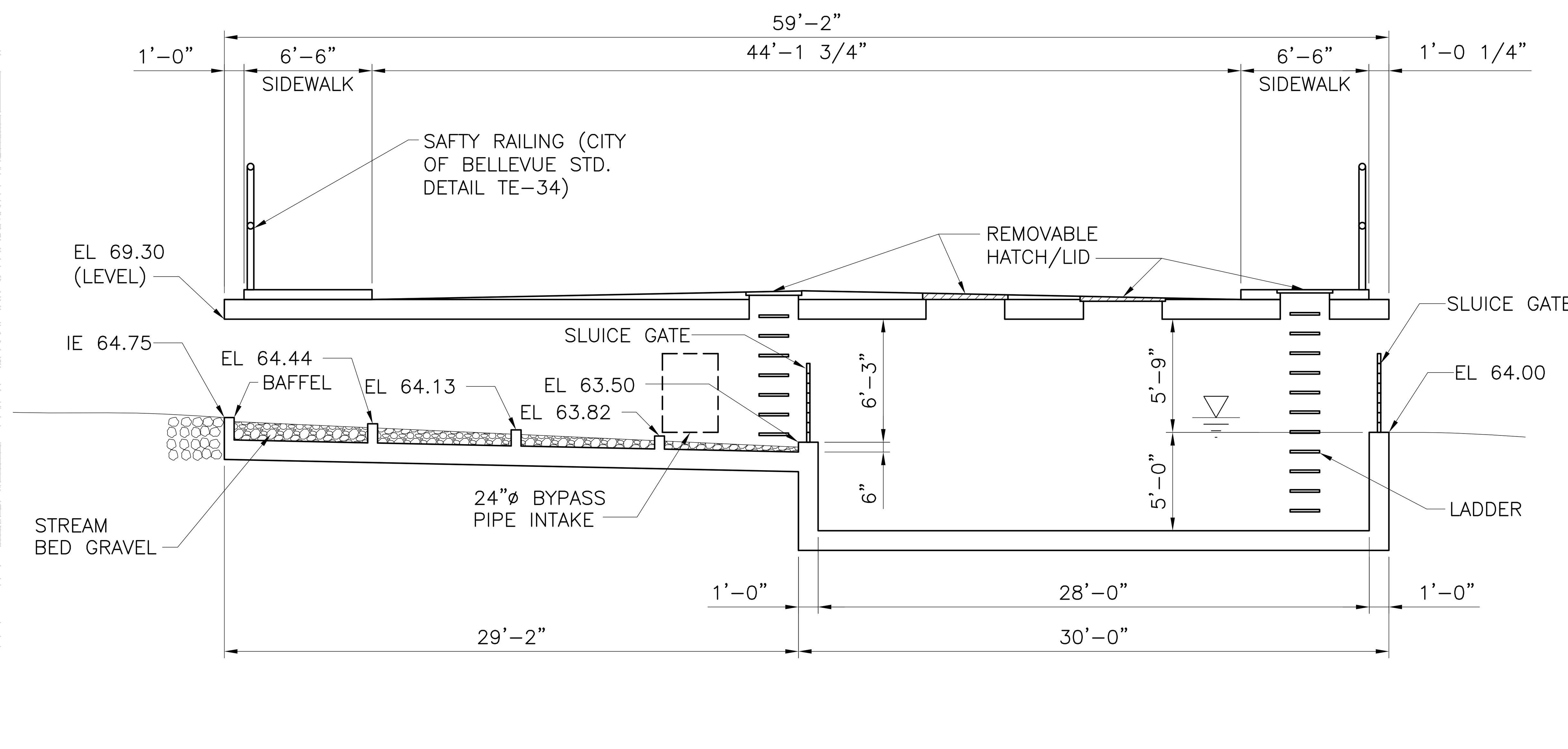
City of Bellevue
UTILITIES

ROADWAY SECTION

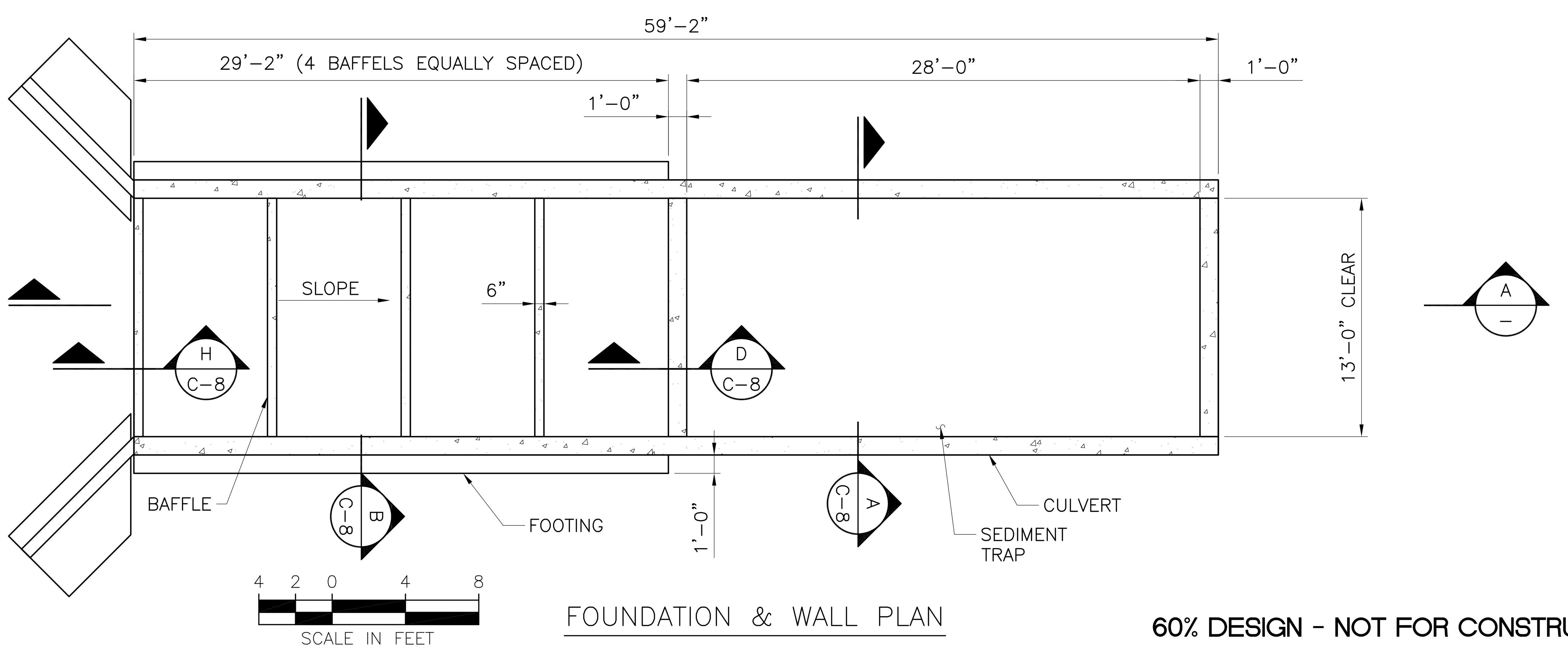
DRAWING C-6



CULVERT LAYOUT PLAN



PROFILE-SECTION
SCALE: 3/8"=1'-0"



FOUNDATION & WALL PLAN

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NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS

CIVILTECH ENGINEERING
10800 NE 8th Street Suite 820
Bellevue, WA 98004
Phone: 425.453.6488
Fax: 425.453.5848

SE 30TH STREET / SUNSET CREEK
CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER DATE
PROJECT MANAGER DATE

D.C. ONG	04/2008
DESIGNED BY	DATE
J. ROBERTS	04/2008
DRAWN BY	DATE
D.C. ONG	04/2008
CHECKED BY	DATE

City of Bellevue
UTILITIES

CULVERT REPLACEMENT
PLAN AND NOTES

DRAWING C-7 | SHT 11 OF 24

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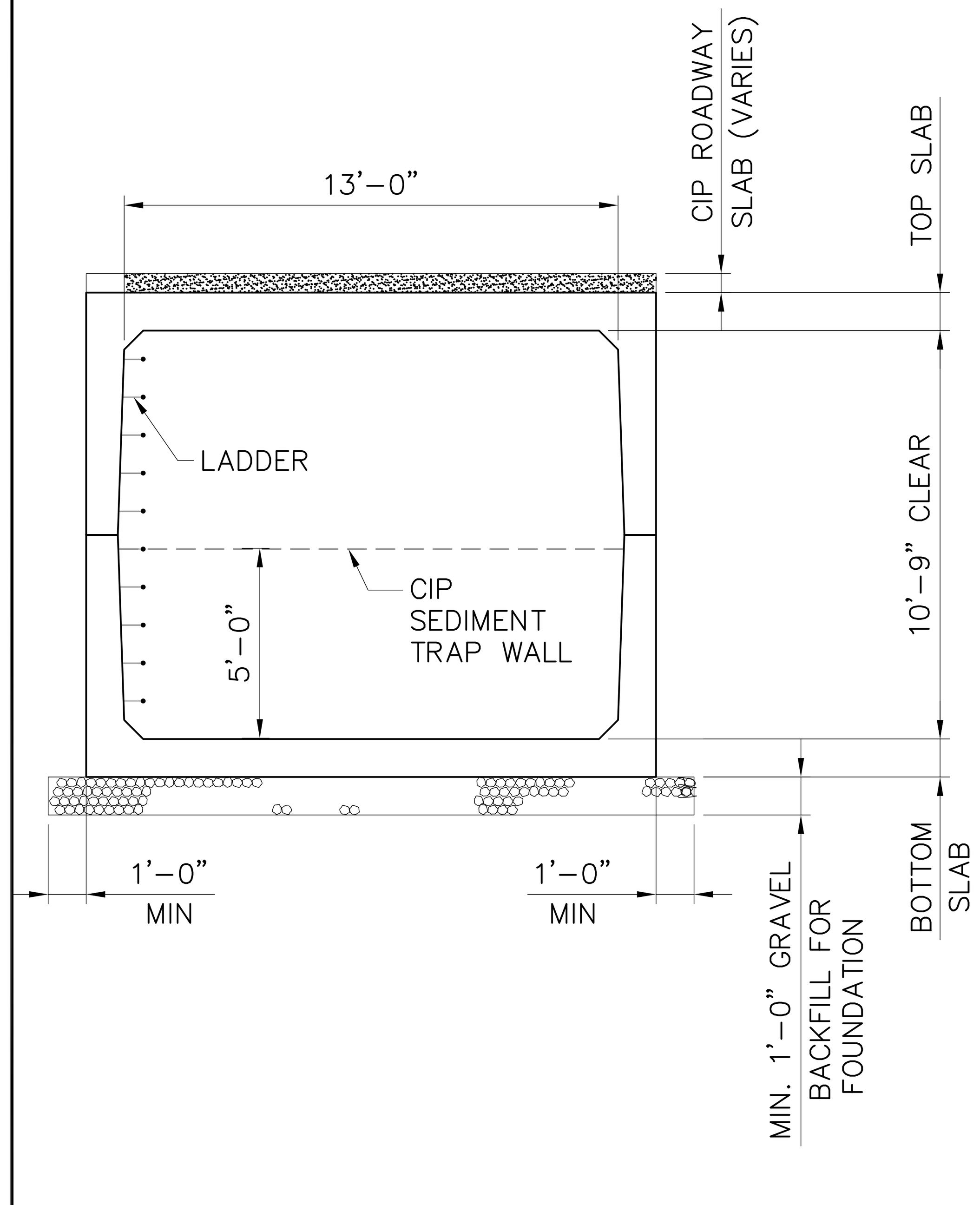
Cad User: Jeff Roberts



SECTION (A / C-7)
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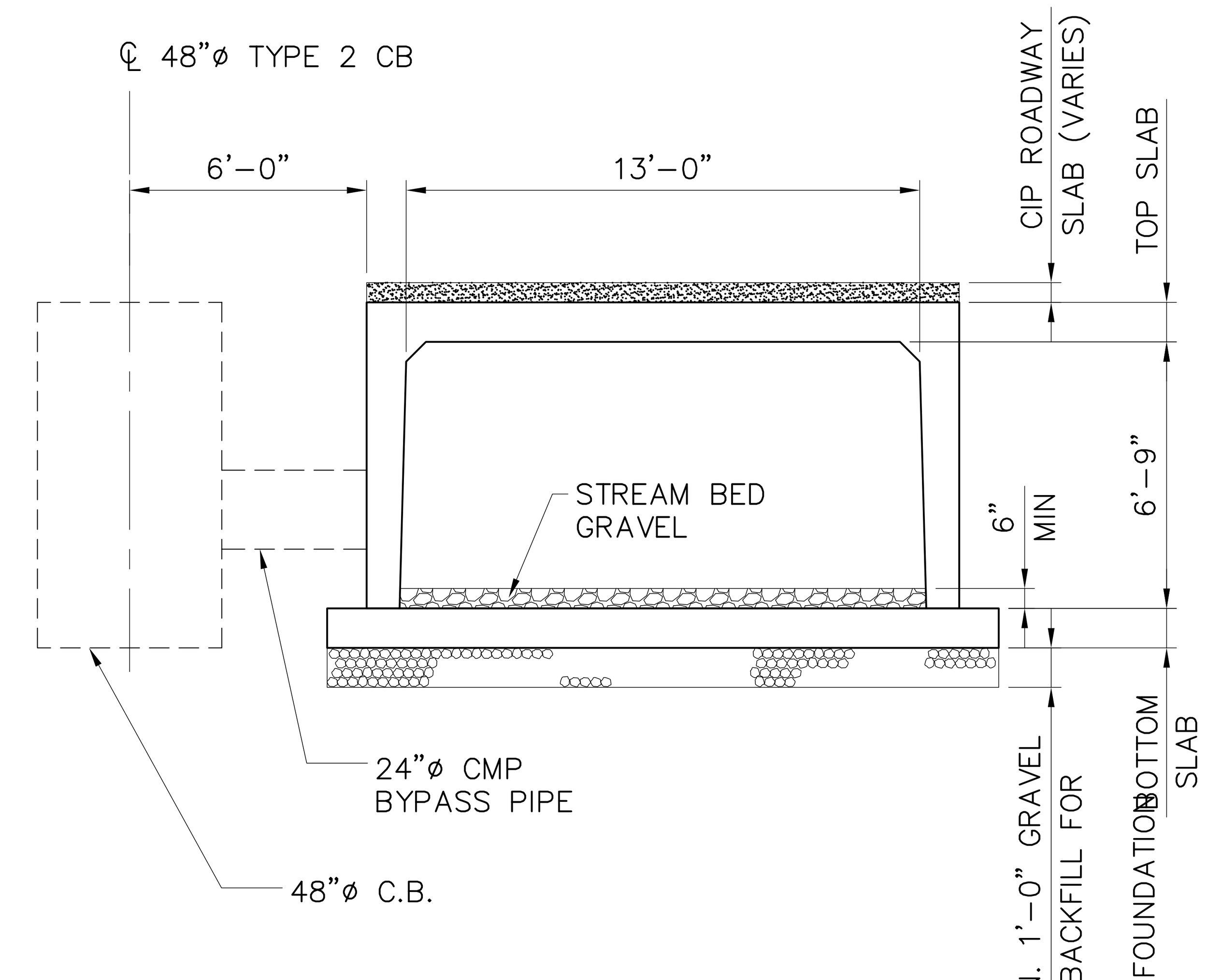

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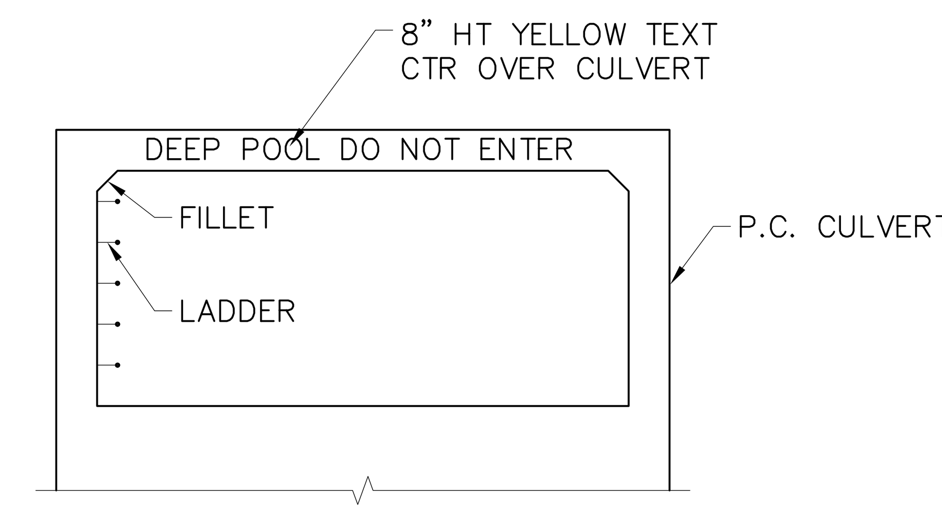
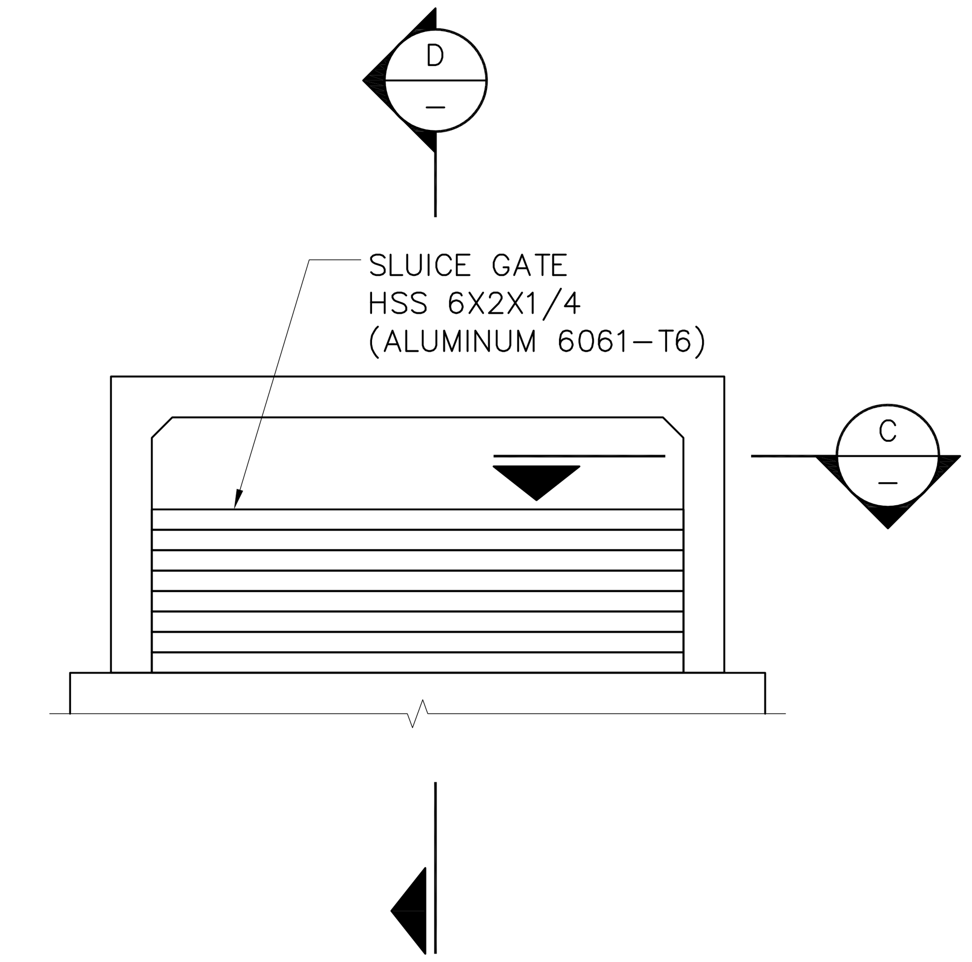


NOTE:
WARNING SIGN AT BOTH ENDS OF CULVERT.

WARNING DETAIL (1 / C-7)
SCALE: 1/4"=1'-0"



SLUICE GATE ELEVATION (2 / C-7)
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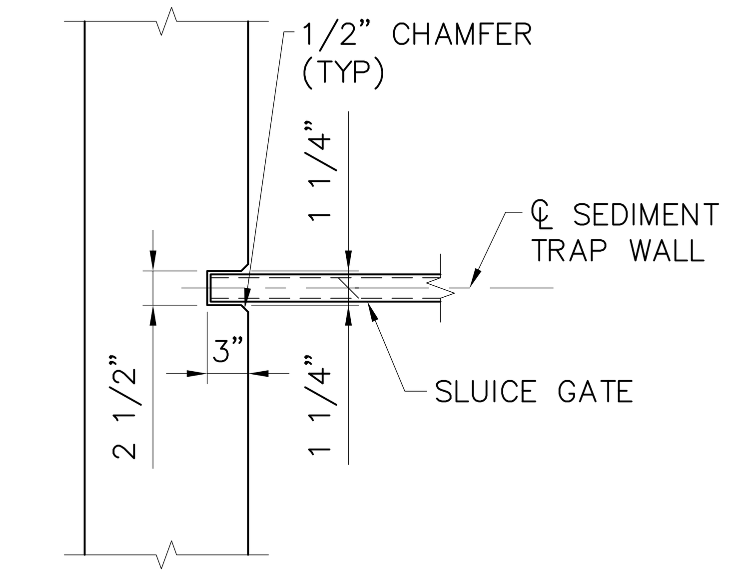

SECTION (C / –)
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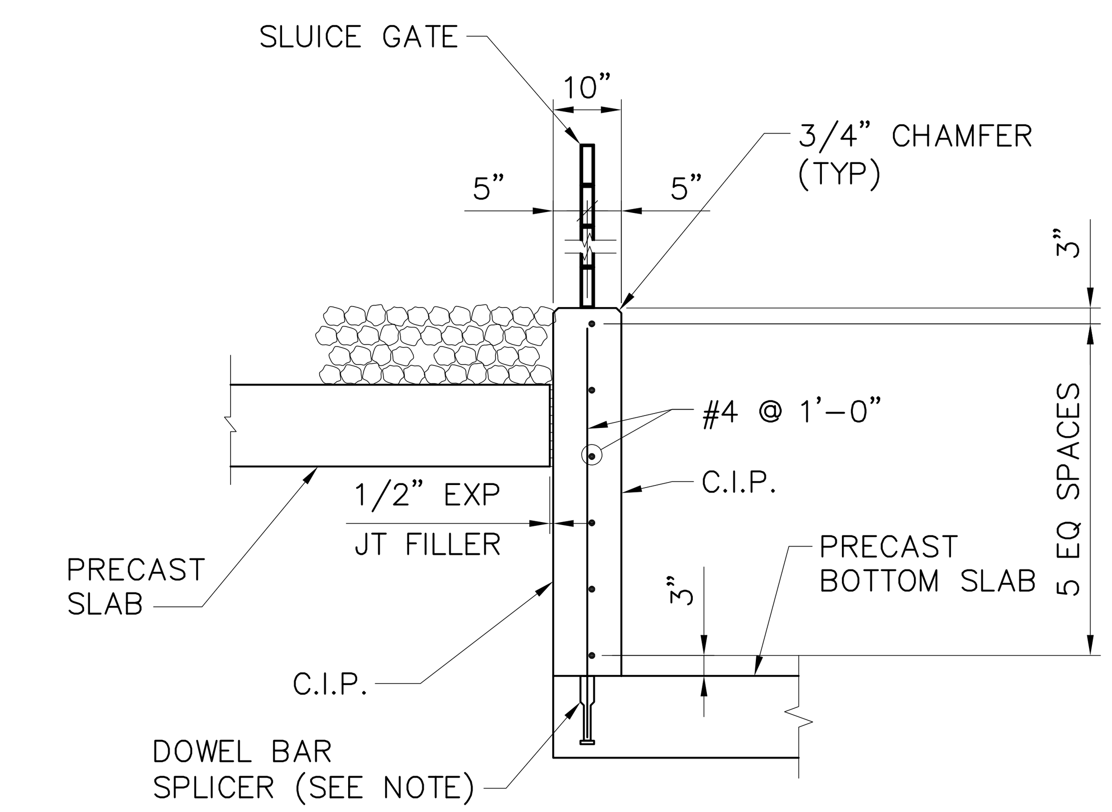
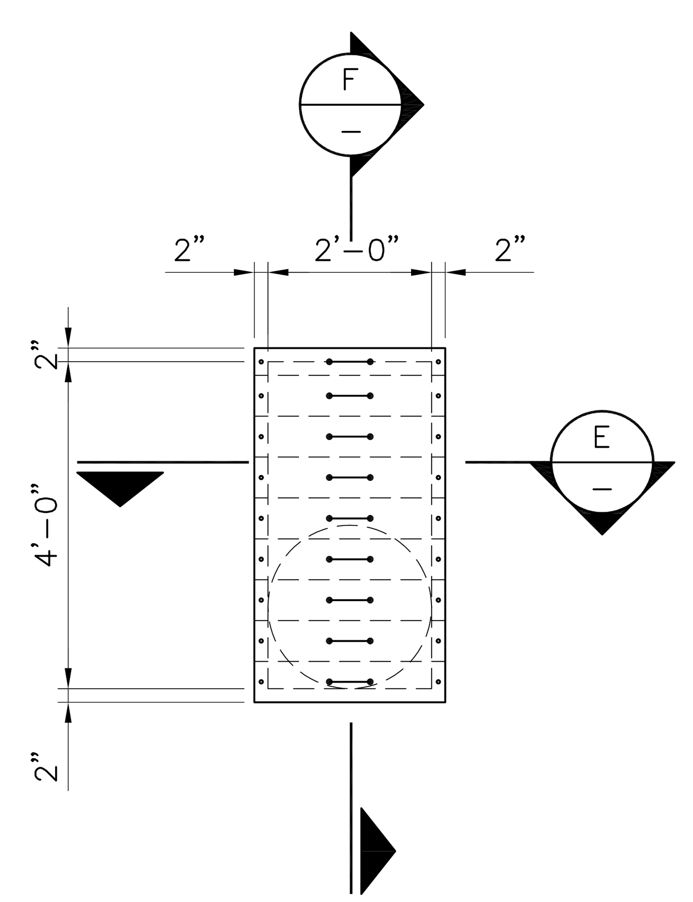


SECTION (D / C-7)
SCALE: 1/2"=1'-0"
(WALL @ BOX OUTLET END–SIMILAR)



BYPASS INTAKE GATE ELEVATION (3 / –)
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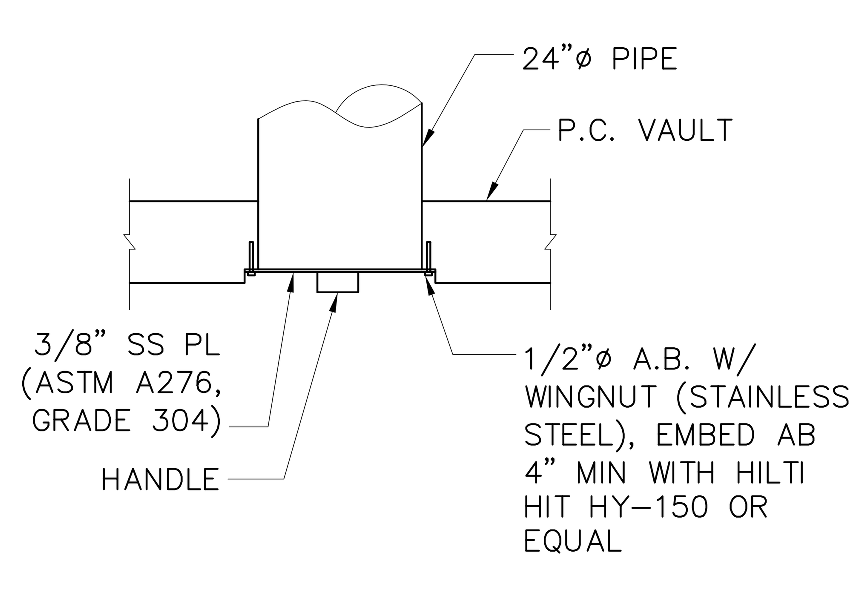
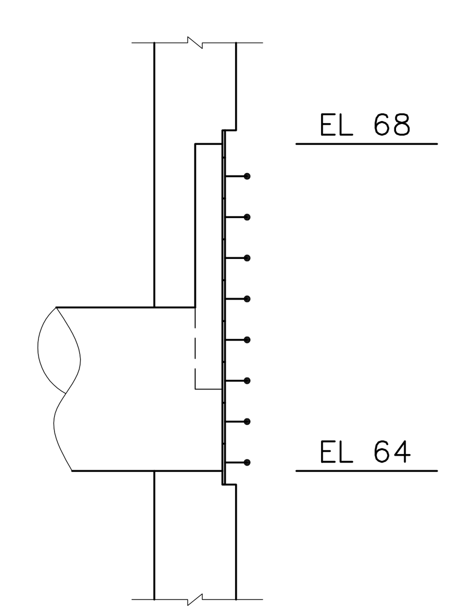
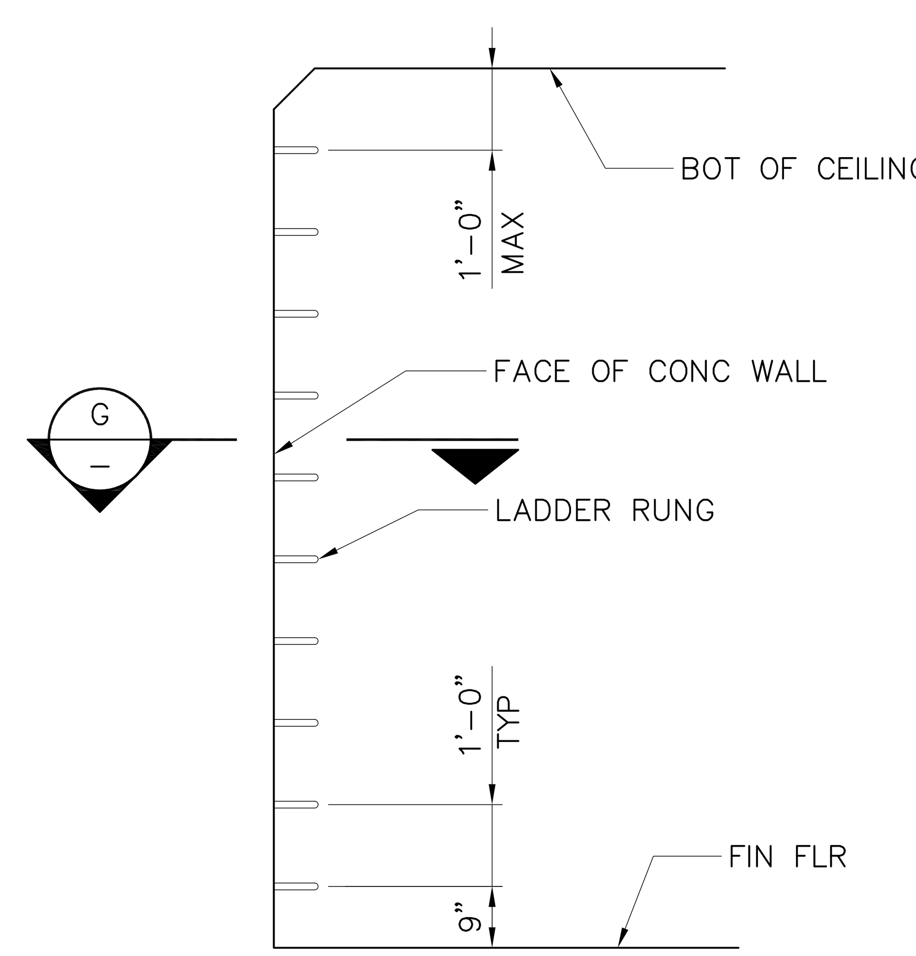


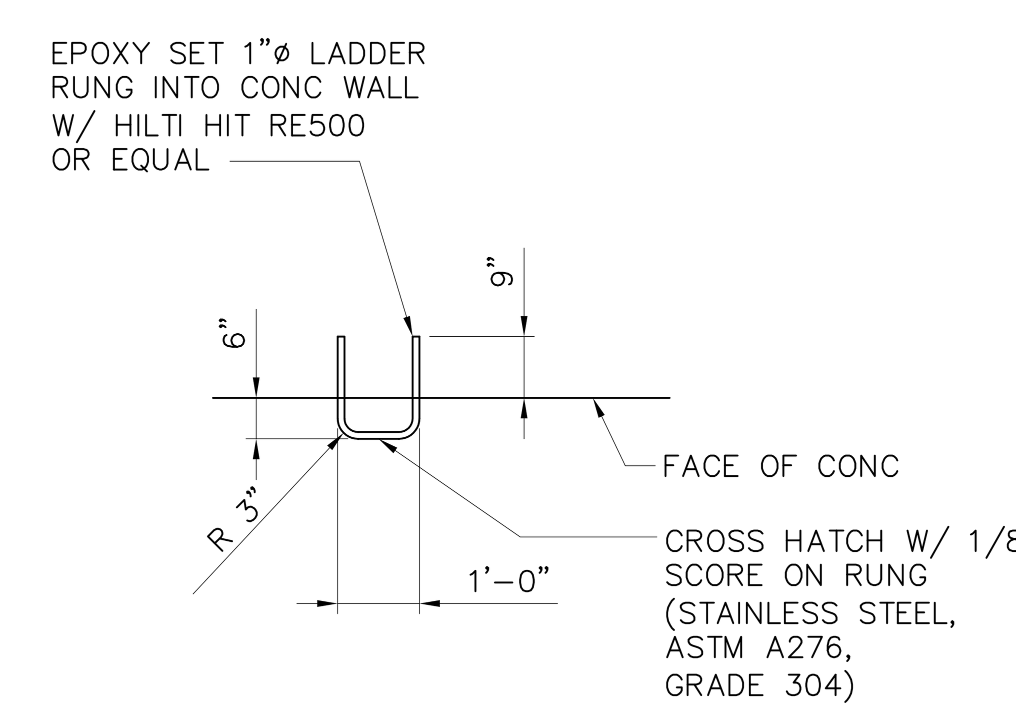
SECTION (E / –)
SCALE: 1/2"=1'-0"



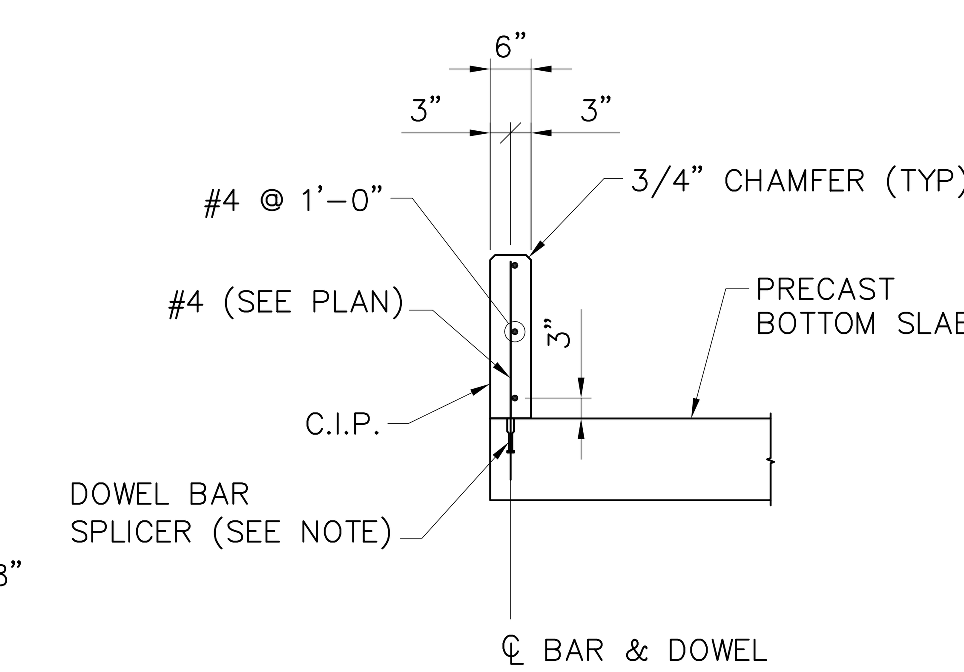
SECTION (F / –)
SCALE: 1/2"=1'-0"



LADDER ELEVATION (4 / –)
SCALE: 1/2"=1'-0"

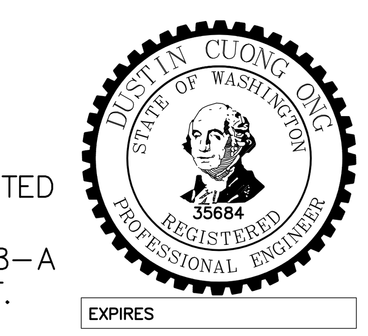


SECTION (G / –)
SCALE: 1/2"=1'-0"



SECTION (H / C-7)
SCALE: 1/2"=1'-0"
(TYP ALL BAFFLES UNLESS NOTED)

NOTES
1. ALL BARS & DOWEL BAR SPLICERS SHALL BE EPOXY COATED
2. f'c= 4000 PSI (MIN) fy = 60 KSI (ASTM A615)
3. DOWEL BAR SPLICERS SHALL BE DAYTON SUPERIOR D-108-A HEADED OR D-102-A 90° HOOKED OR OTHER EQUIVALENT.



ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

811 Know what's below. Call before you dig.

60% DESIGN - NOT FOR CONSTRUCTION

NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS

CIVILTECH ENGINEERING
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SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By
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D.C. ONG	04/2008
DESIGNED BY	DATE
J. ROBERTS	04/2008
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D.C. ONG	04/2008
CHECKED BY	DATE

City of Bellevue UTILITIES

CULVERT REPLACEMENT PROFILE AND NOTES

DRAWING C-8 SHT 12 OF 24

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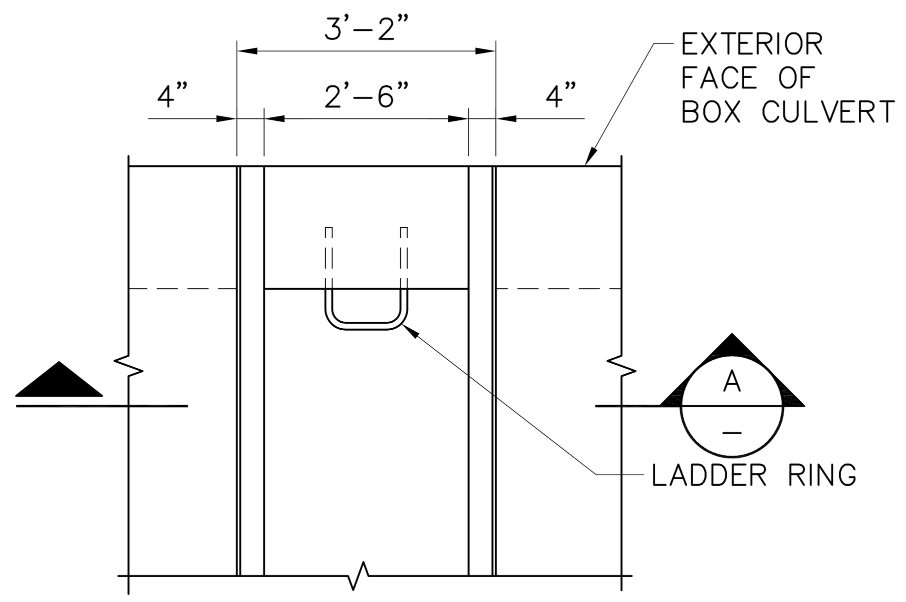
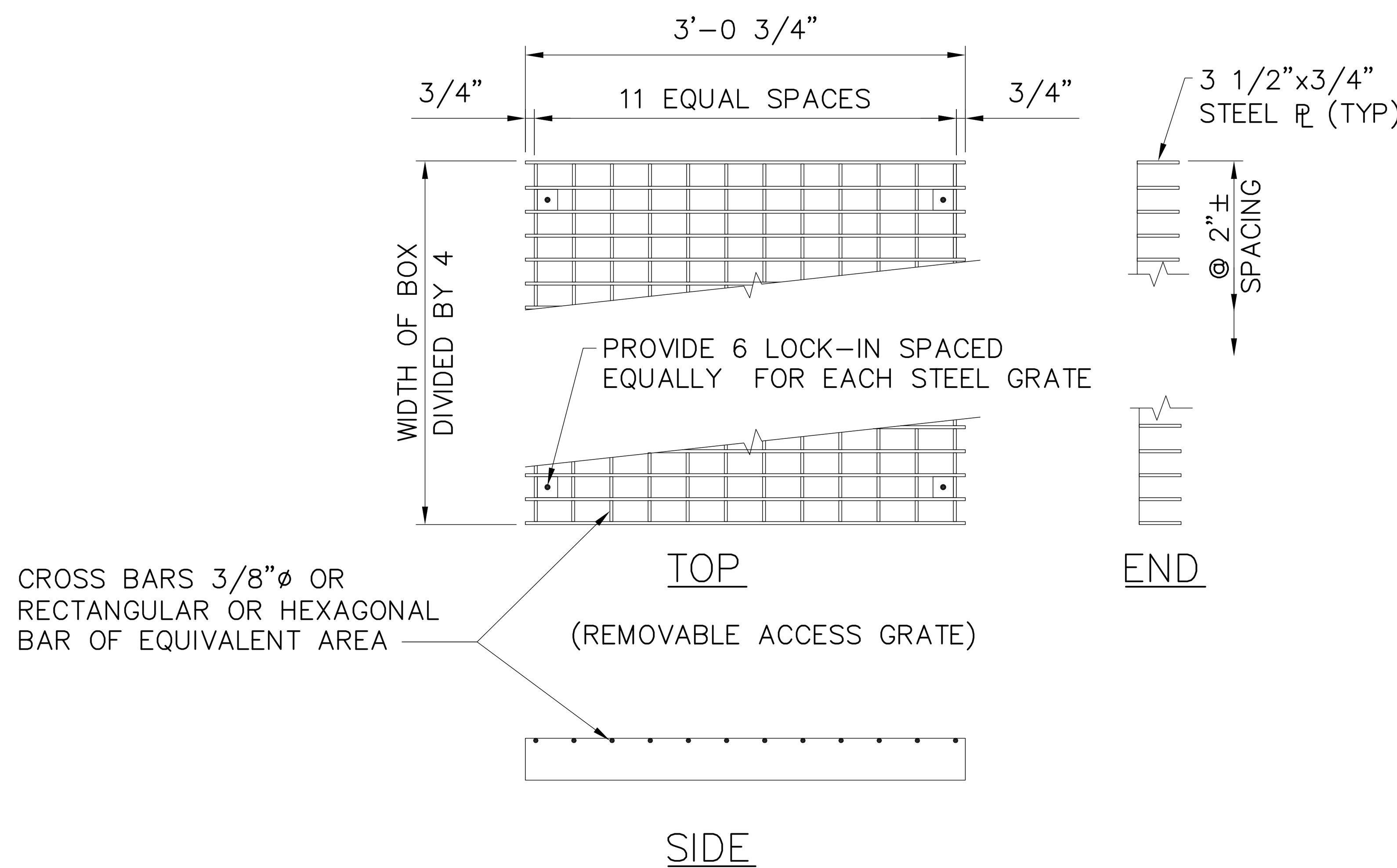
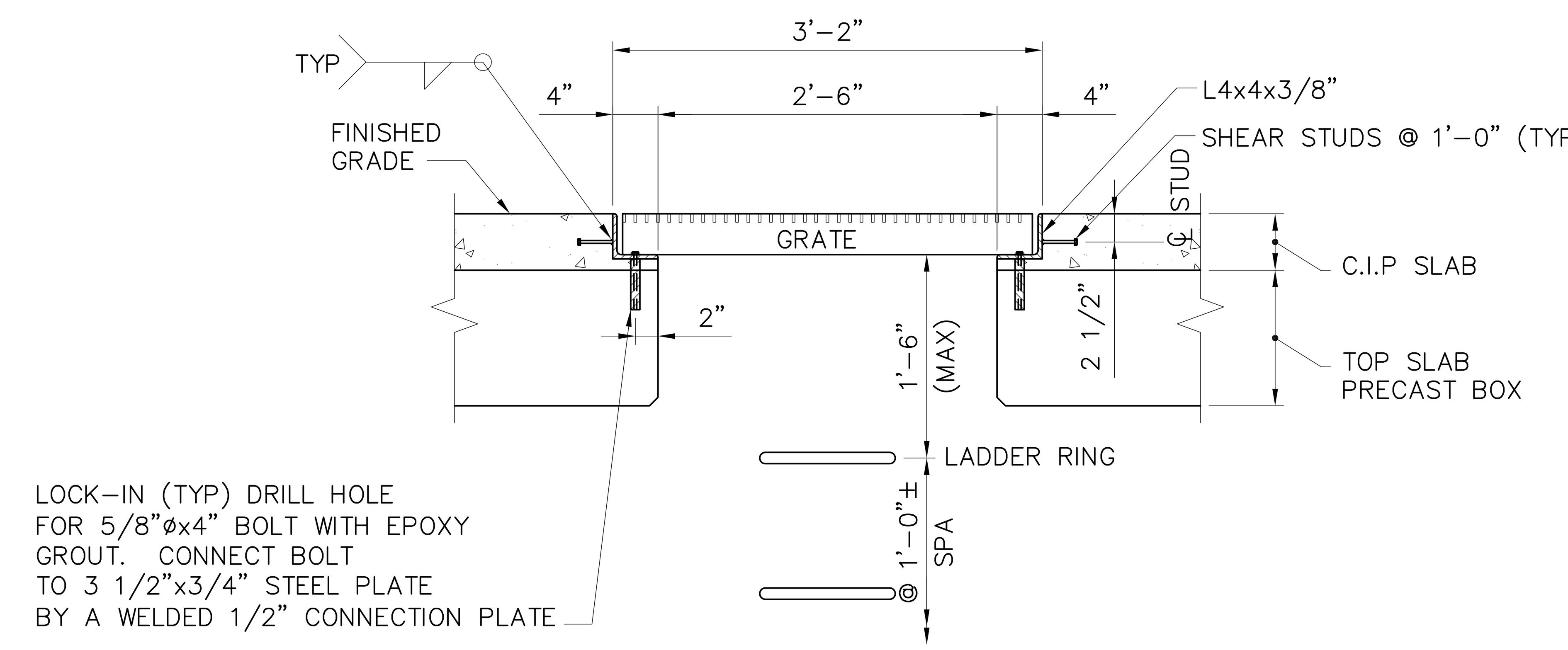


PLAN
SCALE: 1/2" = 1'-0"
(30"x WIDTH OF CULVERT REMOVABLE LID)
(STEEL GRATE, LOCK-IN BOLT & SHEAR STUDS NOT SHOWN)



REMOVABLE ACCESS GRATE (1/–)
SCALE: 1"=1'-0"



SECTION (A/–)
SCALE: 1"=1'-0"

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SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

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D.C. ONG	04/2008
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DRAWN BY	DATE
D.C. ONG	04/2008
CHECKED BY	DATE

City of Bellevue
UTILITIES

SECTIONS AND DETAILS

DRAWING C-9 SHT 13 OF 24

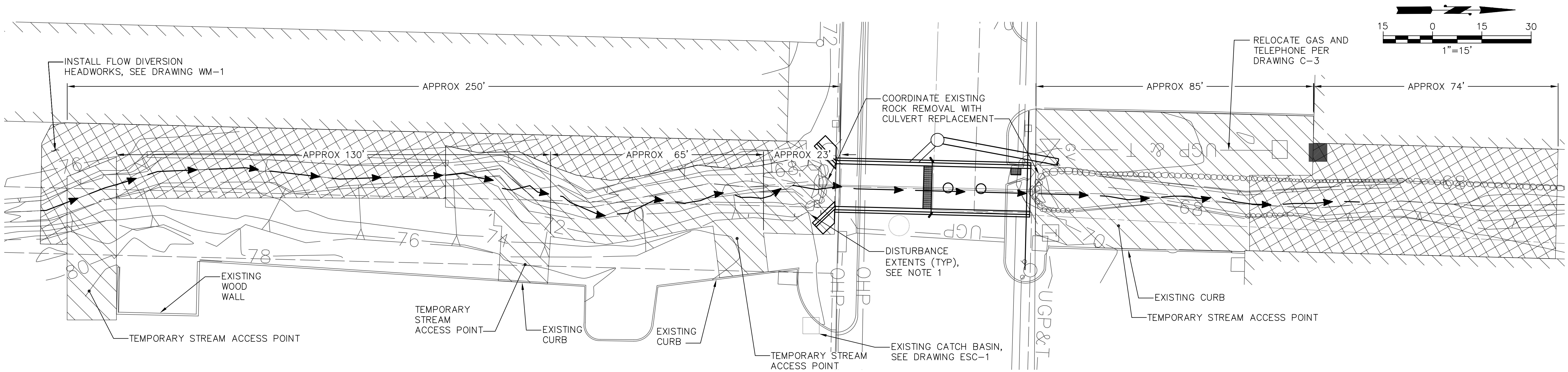
DUSTIN CUONG ONG, STATE OF WASHINGTON, 35684, REGISTERED PROFESSIONAL ENGINEER
EXPIRES

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

Path: P:\Structural\2007\27015 - SE 30 & Sunset Cr (Herrera)\Cad\Drawing\C-9.dwg
Plot Date: 6/10/2008 2:43 PM Cad User: Jeff Roberts

GENERAL NOTES:

1. CONTRACTOR SHALL FENCE THE PERIMETER OF THE CONSTRUCTION ZONE WITH A MINIMUM OF 6' TALL CHAINLINK FENCING PRIOR TO COMMENCEMENT OF ANY CONSTRUCTION ACTIVITIES.
2. PRIOR TO ANY CLEARING OR GRUBBING THE CONTRACTOR SHALL INSTALL TREE PROTECTION FOR ALL TREES DESIGNATED/FLAGGED BY THE CITY OF BELLEVUE TO REMAIN. TREE PROTECTION SHALL CONSIST OF ¾" 4'X'4 PLYWOOD BOXES CENTERED ON THE TRUNK OF THE TREE OR APPROVED EQUAL.
3. EXISTING PARKING LOT CURBS AND PAVEMENT USED FOR ACCESS SHALL BE PROTECTED FROM DAMAGE BY THE CONTRACTOR. DAMAGE INCURRED DURING CONSTRUCTION TO ADJACENT PROPERTY SHALL BE THE SOLE RESPONSIBILITY OF THE CONTRACTOR.



STREAM CORRIDOR SITE PREPARATION PLAN 1/C-1

SCALE: NOTED

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HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
Suite 1100
Seattle, Washington
98121-1820
206-441-9080
206-441-9108 FAX
http://www.herrerainc.com

SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER DATE

PROJECT MANAGER DATE

C. BARTON	05/2008
DESIGNED BY	DATE
W. WIESZCZECINSKI	06/2008
DRAWN BY	DATE
M. EWBANK	06/2008
CHECKED BY	DATE

City of Bellevue UTILITIES

STREAM CORRIDOR SITE PREPARATION PLAN

DRAWING C-10

SHT 14 OF 23

MARK EWBANK STATE OF WASHINGTON 29434 CIVIL ENGINEER PROFESSIONAL ENGINEER

ONE INCH

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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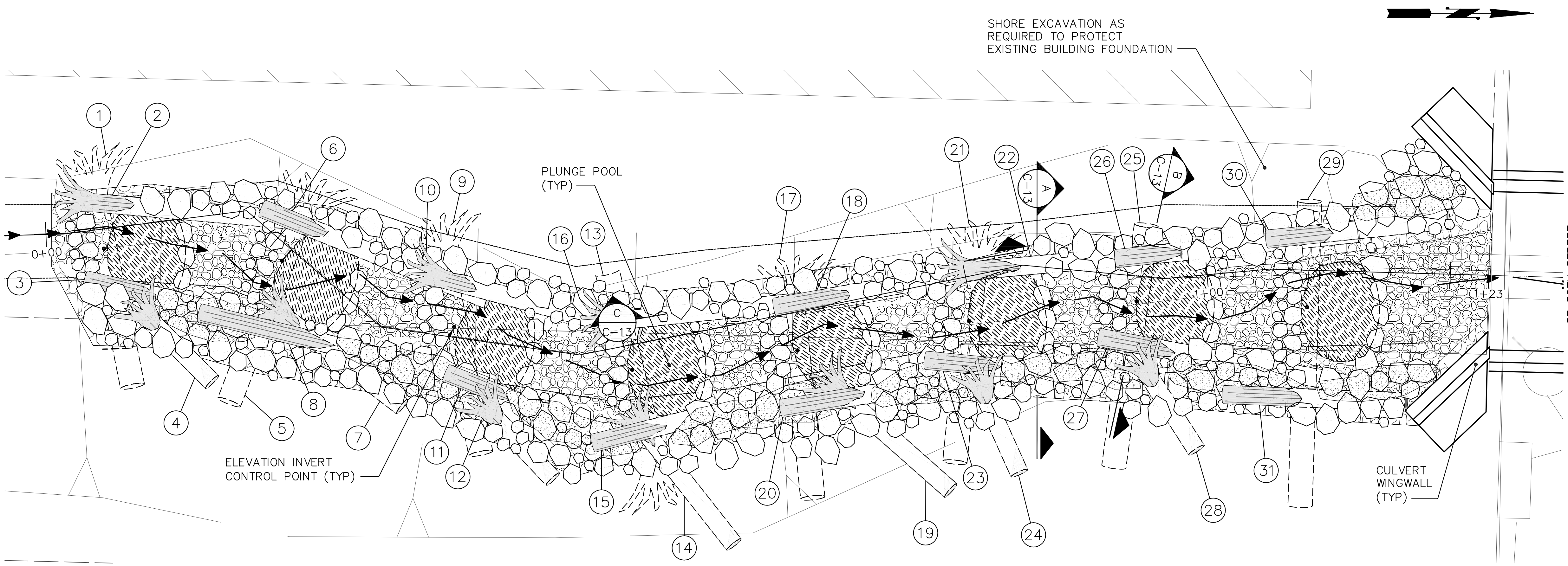
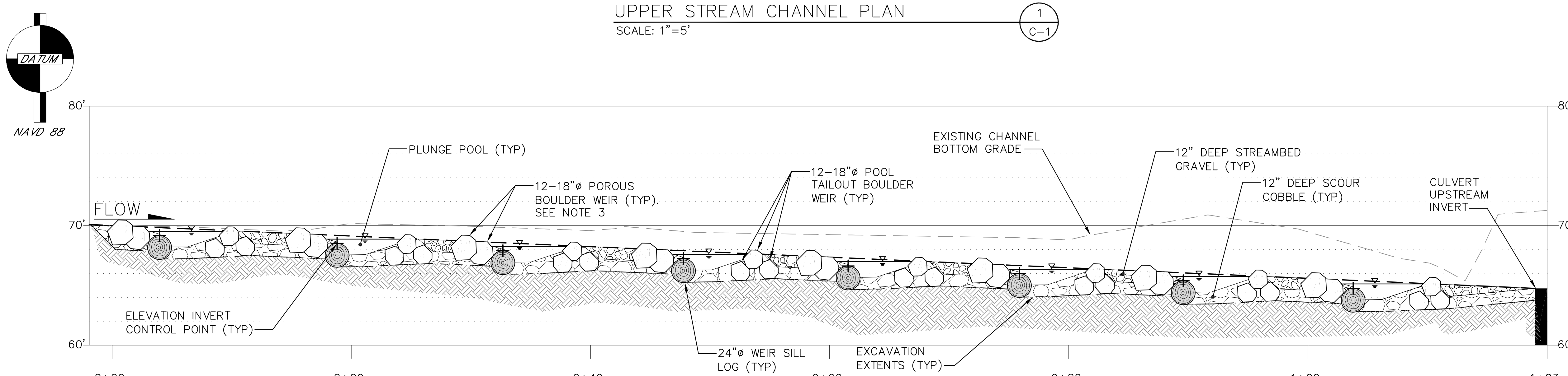


UPPER STREAM CHANNEL PLAN (1 / C-1)
SCALE: 1"=5'



UPPER STREAM CHANNEL PROFILE (A / –)
SCALE: 1"=5'

GENERAL NOTES:

1. FILL ALL VOIDS DURING BACKFILLING AND CONSOLIDATE FILL USING WYCO 992A–FI–10 10 CONCRETE VIBRATOR OR APPROVED EQUAL.
2. LOG IDENTIFICATION NUMBERS REFLECT POTENTIAL CONSTRUCTION SEQUENCING AND LOG PLACEMENT SEQUENCING. SEE DRAWING C–13 FOR LOG SCHEDULE.
3. CONTACT POINTS BETWEEN BOULDERS SHALL BE MAINTAINED 4" ABOVE PLUNGE POOL WATER SURFACE.

MARK EWBANK, STATE OF WASHINGTON, 29434, CIVIL ENGINEER, PROFESSIONAL ENGINEER

ONE INCH — AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase I\C-11.dwg Cad User: Wojciech Wieszczecinski
Plot Date: 6/11/2008 11:39 AM

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2200 Sixth Avenue
Suite 1100
Seattle, Washington 98121-1820
206-441-9080
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SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

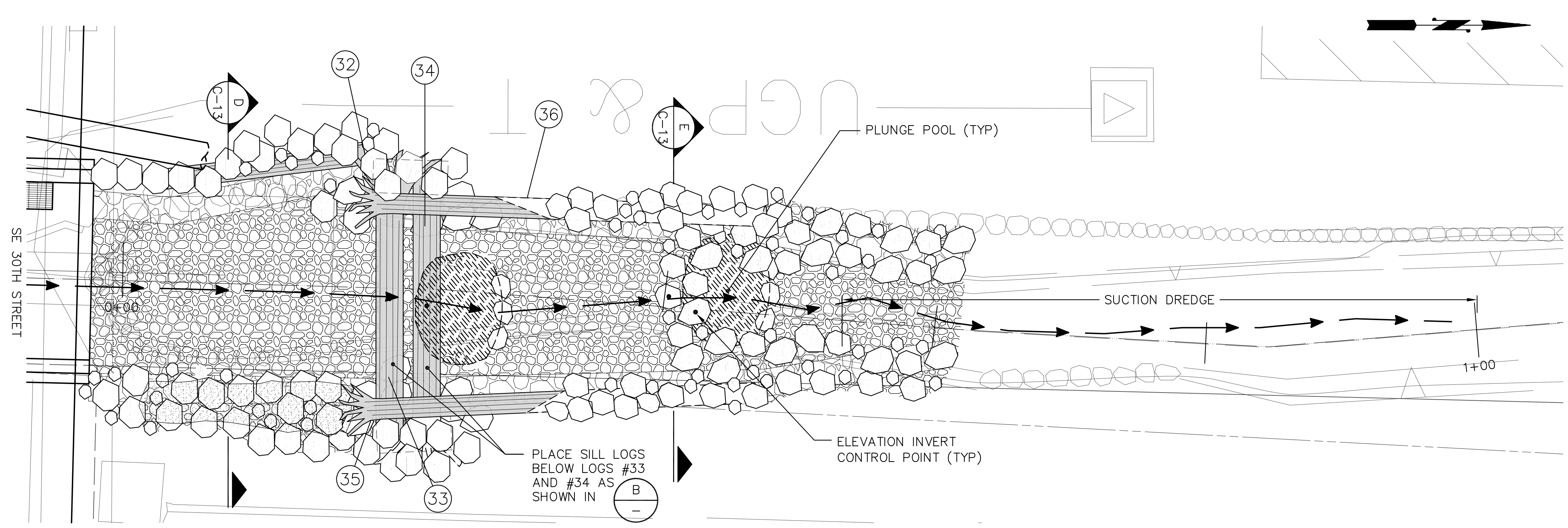
Approved By
DESIGN MANAGER — DATE
PROJECT MANAGER — DATE

C. BARTON	05/2008
DESIGNED BY	DATE
W. WIESZCZECINSKI	06/2008
DRAWN BY	DATE
M. EWBANK	06/2008
CHECKED BY	DATE

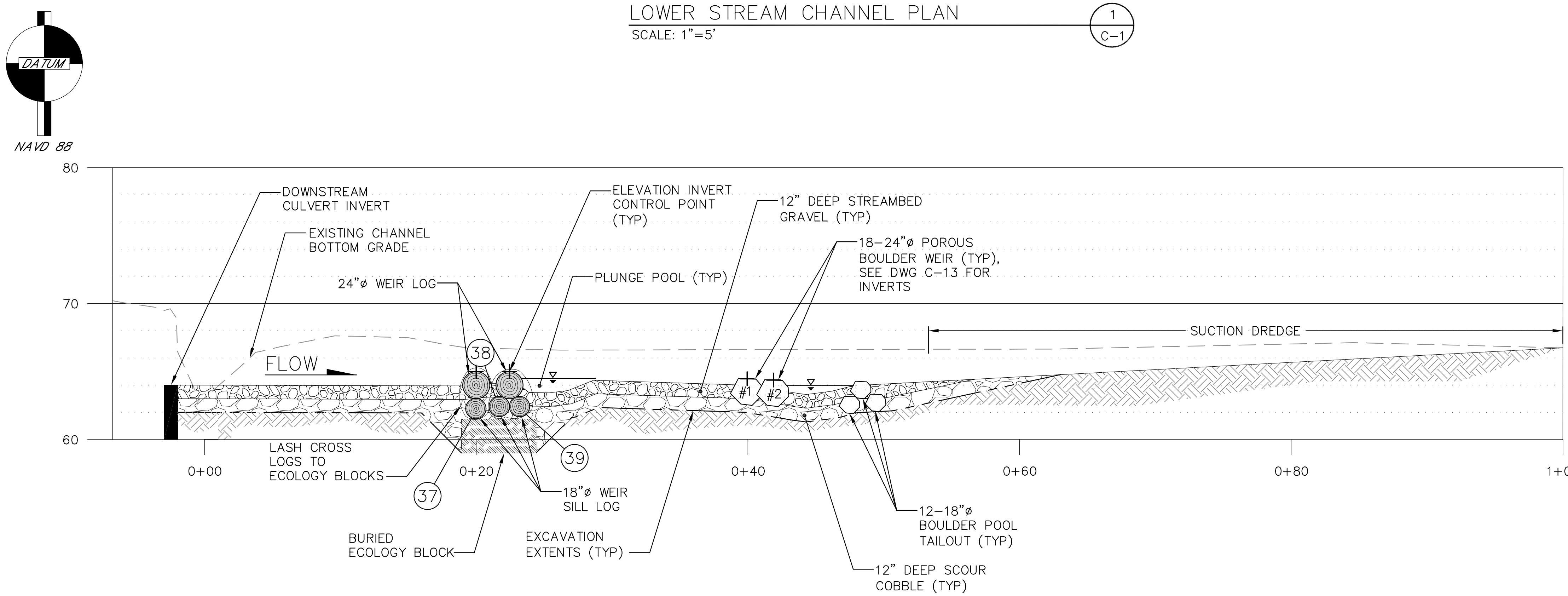
City of Bellevue UTILITIES

UPPER STREAM CHANNEL MODIFICATIONS PLAN AND PROFILE

DRAWING C-11 SHT 15 OF 23



LOWER STREAM CHANNEL PLAN 1 C-1
SCALE: 1"=5'



LOWER STREAM CHANNEL PROFILE B –
SCALE: 1"=5'

GENERAL NOTES:

1. FILL ALL VOIDS DURING BACKFILLING AND CONSOLIDATE FILL USING WYCO 992A-FI-10 10 CONCRETE VIBRATOR OR APPROVED EQUAL.
2. LOG IDENTIFICATION NUMBERS REFLECT POTENTIAL CONSTRUCTION SEQUENCING AND LOG PLACEMENT SEQUENCING. SEE DRAWING C-13 FOR LOG SCHEDULE.

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

MARK EWBANK
STATE OF WASHINGTON
29434
CIVIL ENGINEER
PROFESSIONAL ENGINEER

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Plot Date: 6/11/2008 11:40 AM
Cad User: Wojciech Wieszczecinski

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2200 Sixth Avenue
Suite 1100
Seattle, Washington
98121-1820
206-441-9080
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C. BARTON	05/2008
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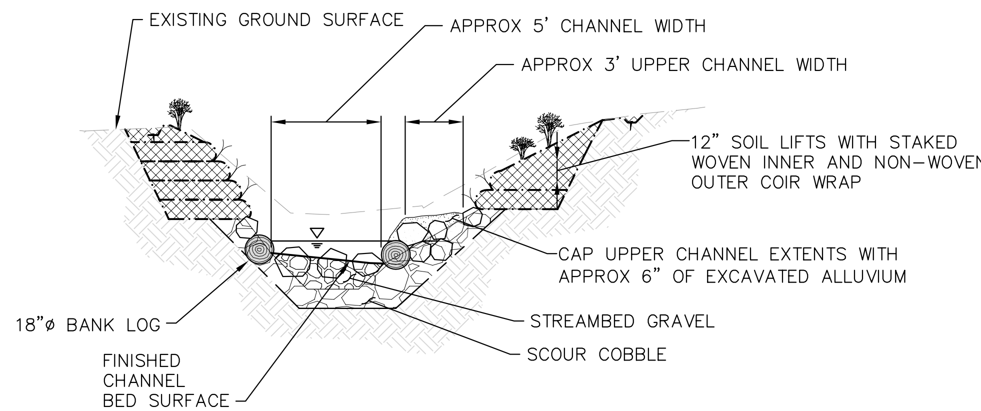
W. WIESZCZECINSKI	06/2008
DRAWN BY	DATE
M. EWBANK	06/2008
CHECKED BY	DATE

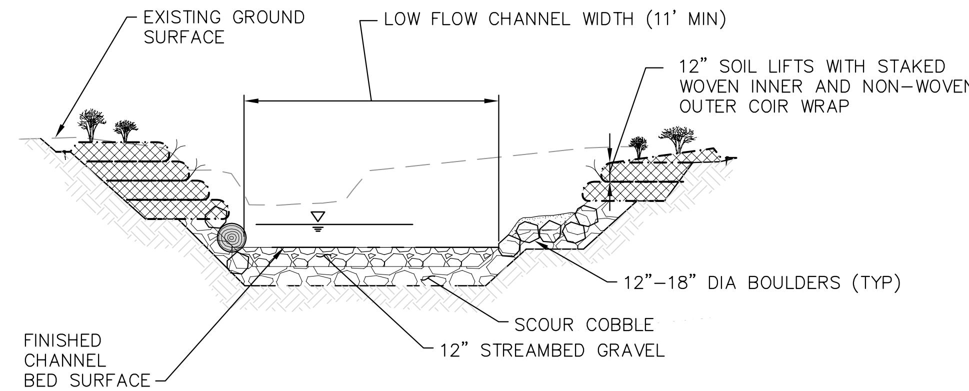
CITY OF BELLEVUE WASHINGTON
City of Bellevue
UTILITIES

LOWER STREAM CHANNEL MODIFICATIONS PLAN AND PROFILE

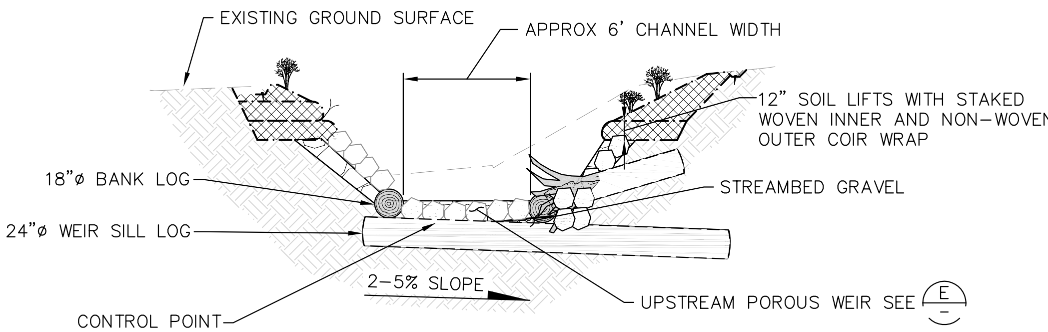
DRAWING C-12 SHT 16 OF 23



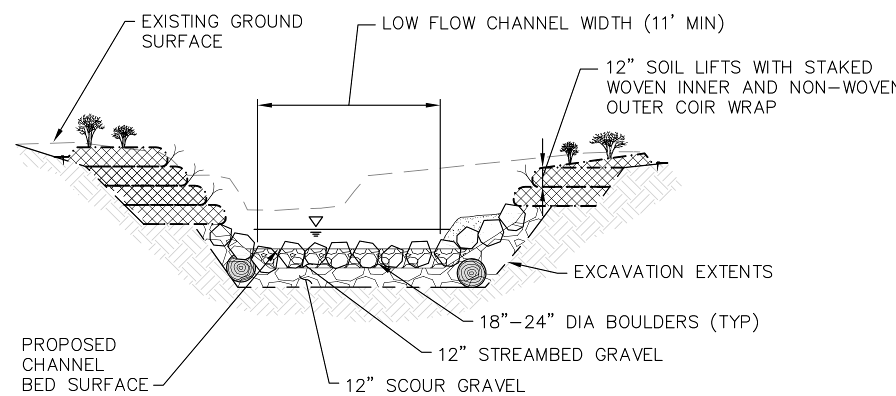
SECTION–TYPICAL UPSTREAM CHANNEL (A / C-11)
SCALE: 1"=5'



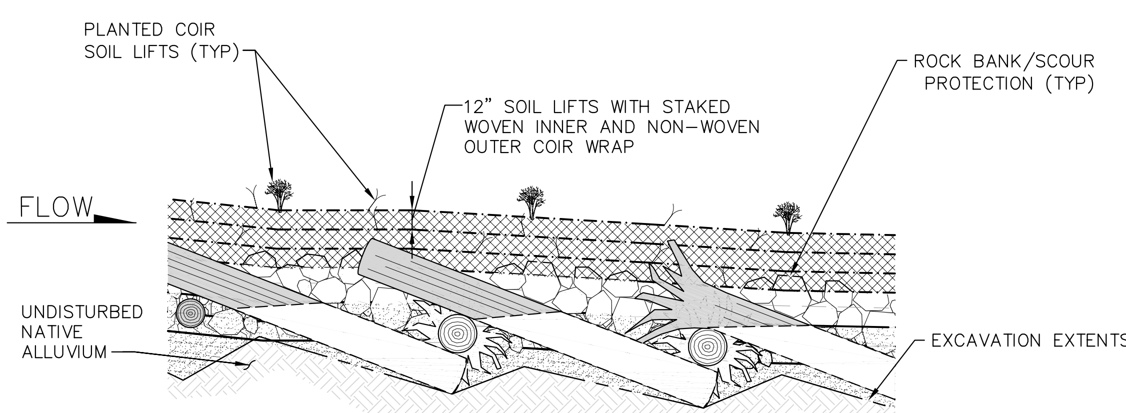
SECTION–TYPICAL DOWNSTREAM CHANNEL (D / C-12)
SCALE: 1"=5'



SECTION–TYPICAL UPSTREAM LOG GRADE CONTROL (B / C-11)
SCALE: 1"=5'



SECTION–TYPICAL DOWNSTREAM CHANNEL AT BOULDER WEIR (E / C-12)
SCALE: 1"=5'



SECTION–TYPICAL UPSTREAM CHANNEL BANK (C / C-11)
SCALE: 1"=5'

TABLE – DOWNSTREAM LOG SCHEDULE:

LOG #	DIA. (IN)	LENGTH (FT)	ROOTWAD	INVERT ELEVATION	APPROX STATION
32	18–22	15	NO	–	
33	24	22	YES	65.0	0+20
34	24	22	YES	65.0	0+22
35	18–22	30	YES	–	
36	18–22	30	YES	–	
37	18–22	22	NO	–	0+19
38	18–22	22	NO	–	0+21
39	18–22	22	NO	–	0+23

TABLE – UPSTREAM LOG SCHEDULE:

LOG #	DIA. (IN)	LENGTH (FT)	ROOTWAD	INVERT ELEVATION	APPROX STATION	DOWN SLOPE DIRECTION
1	24	20	YES	69.2	0+04	EAST
2	18–22	25	YES	–		
3	18–22	20	NO	–		
4	18–22	10	YES	–		
5	24	20	YES	68.5	0+21	WEST
6	18–22	15	NO	–		
7	18–22	18	YES	–		
8	18–22	25	NO	–		
9	24	20	YES	67.9	0+37	EAST
10	18–22	20	YES	–		
11	18–22	20	NO	–		
12	18–22	10	YES	–		
13	24	20	YES	67.2	0+52	WEST
14	18–22	15	YES	–		
15	18–22	20	NO	–		
16	18–22	20	YES	–		
17	24	20	YES	66.6	1+01	EAST
18	18–22	20	NO	–		
19	18–22	18	NO	–		
20	18–22	20	NO	–		
21	24	20	NO	66.0	1+15	WEST
22	18–22	18	NO	–		
23	18–22	20	NO	–		
24	18–22	20	NO	–		
25	24	20	NO	65.4	1+30	EAST
26	18–22	20	NO	–		
27	18–22	20	NO	–		
28	18–22	10	YES	–		
29	24	25	NO	64.8	1+44	WEST
30	18–22	15	NO	–		
31	18–22	15	NO	–		

TABLE – DOWNSTREAM BOULDER INVERTS:

BOULDER #	INVERT ELEVATION	APPROX STATION
#1	64.47	0+40
#2	64.38	0+42

ONE INCH
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MARK EWBANK
STATE OF WASHINGTON
29434
CIVIL ENGINEER
PROFESSIONAL ENGINEER

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Plot Date: 6/11/2008 11:41 AM
Cad User: Wojciech Wieszczecinski

NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
Suite 1100
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SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

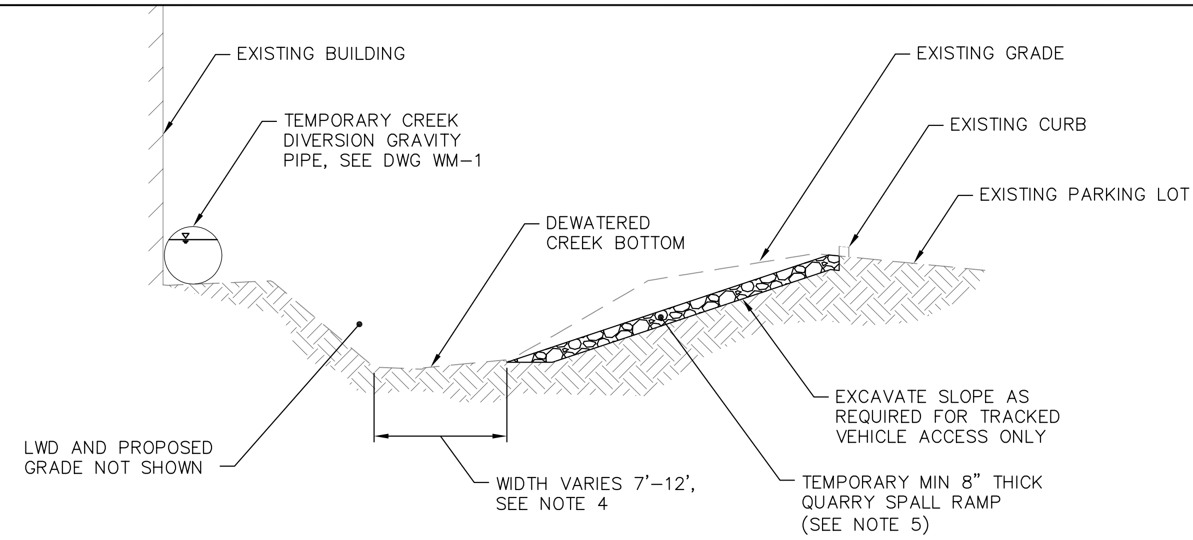
DESIGN MANAGER — DATE
PROJECT MANAGER — DATE

C. BARTON 05/2008
DESIGNED BY DATE
W. WIESZCZECINSKI 06/2008
DRAWN BY DATE
M. EWBANK 06/2008
CHECKED BY DATE

CITY OF BELLEVUE WASHINGTON
City of Bellevue
UTILITIES

STREAM CHANNEL MODIFICATIONS DETAILS

DRAWING C-13 SHT 17 OF 23

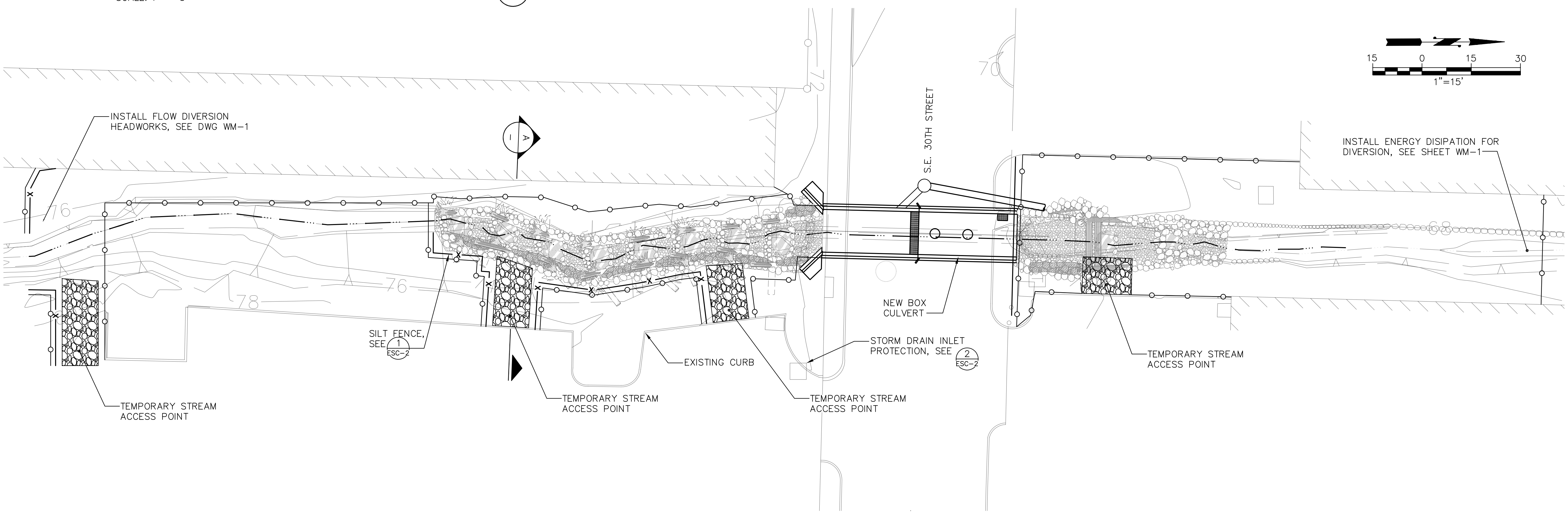


TEMPORARY STREAM ACCESS SECTION (TYP.) A / –

SCALE: 1" = 5'

GENERAL NOTES:

1. NO MECHANIZED EQUIPMENT SHALL BE STORED WITHIN 100' OF CREEK.
2. HIGH VISIBILITY FENCE AND SILT FENCE SHALL BE INSTALLED PRIOR TO COMMENCING CLEARING AND GRUBBING. A MINIMUM OF 2 DAYS NOTICE WILL BE GIVEN TO THE ENGINEER TO ALLOW FOR APPROVAL OF CLEARING LIMITS PRIOR TO ANY CLEARING OR GRUBBING ACTIVITIES.
3. CONTRACTOR SHALL MAINTAIN SAFE ACCESS TO PARKING LOT FOR PRIVATE PROPERTY OWNERS DURING CONSTRUCTION.
4. TEMPORARY ACCESS FOR TRACKED EQUIPMENT ON CHANNEL ALIGNMENT MAY REQUIRE TEMPORARY GRADING OF CHANNEL BOTTOM.
5. QUARRY SPALLS FOR TEMPORARY STREAM ACCESS SHALL BE REMOVED WHEN NO LONGER NEEDED.



TESC PLAN 1 / C-1

SCALE: NOTED

Path: O:\proj\Y2006\06-03501-001\CAD\Dwgs\Phase I\ESC-1.dwg Cad User: Wojciech Wieszczecinski
Plot Date: 6/11/2008 11:43 AM

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MARK EWBANK STATE OF WASHINGTON 29434 CIVIL ENGINEER PROFESSIONAL ENGINEER

ONE INCH — AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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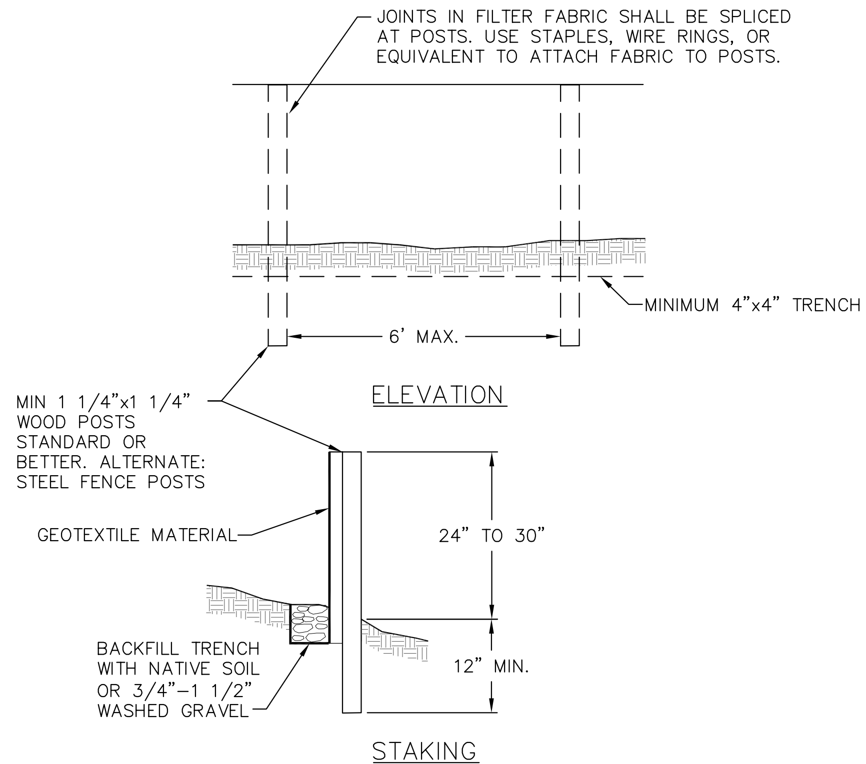
M. EWBANK	06/2008
CHECKED BY	DATE

CITY OF BELLEVUE WASHINGTON

City of Bellevue UTILITIES

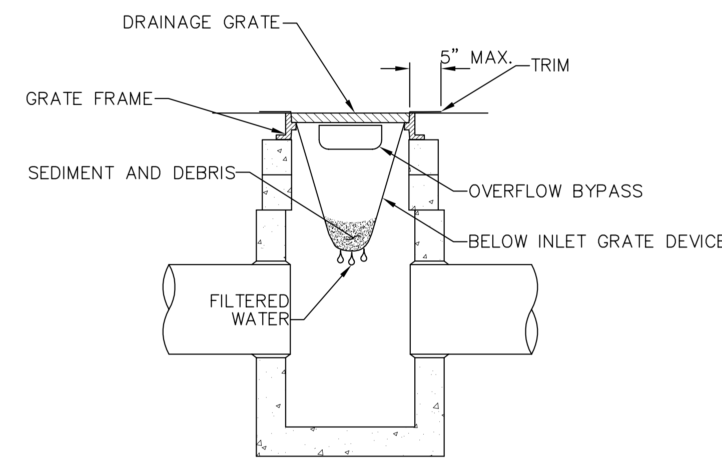
TEMPORARY EROSION AND SEDIMENT CONTROL PLAN

DRAWING ESC-1 SHT 18 OF 23



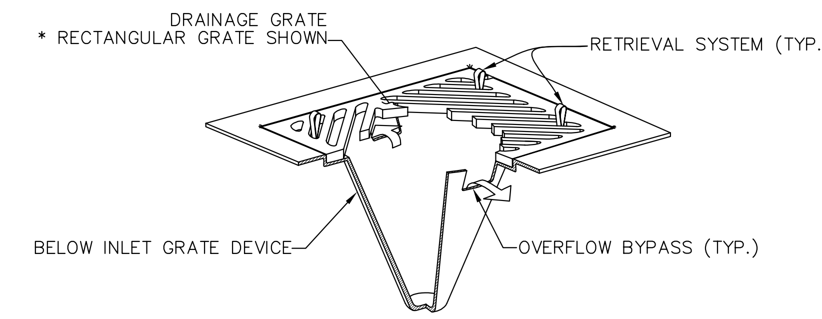
SILT FENCE DETAIL (1 / ESC-1)

SCALE: NTS



NOTES:

1. SIZE THE BELOW INLET GRATE DEVICE (BIGD) FOR THE STORM WATER STRUCTURE IT WILL SERVICE.
2. THE BIGD SHALL HAVE A BUILT-IN HIGH-FLOW RELIEF SYSTEM (OVERFLOW BYPASS).
3. THE RETRIEVAL SYSTEM MUST ALLOW REMOVAL OF THE BIGD WITHOUT SPILLING THE COLLECTED MATERIAL.
4. PERFORM MAINTENANCE IN ACCORDANCE WITH STANDARD SPECIFICATION 8-01.3(15).



ISOMETRIC VIEW

STORM DRAIN INLET PROTECTION (2 / ESC-1)

SCALE: NTS

NOTES:

1. THE FILTER FABRIC (CONSTRUCTION GEOTEXTILE FOR TEMPORARY SILT FENCE) SHALL BE PURCHASED IN A CONTINUOUS ROLL, 5FT WIDE, CUT TO THE LENGTH OF THE BARRIER TO AVOID USE OF JOINTS. WHEN JOINTS ARE NECESSARY, THE FILTER FABRIC SHALL BE SPLICED TOGETHER ONLY AT A SUPPORT POST, WITH A MINIMUM 6 INCH OVERLAP, AND SECURELY FASTENED TO THE POST.
2. THE FENCE POSTS SHALL BE SPACED A MAXIMUM OF 6 FEET APART AND DRIVEN SECURELY INTO THE GROUND A MINIMUM OF 12 INCHES.
3. A TRENCH SHALL BE EXCAVATED A MINIMUM OF 4 INCHES WIDE BY 4 INCHES DEEP, UPSLOPE AND ADJACENT TO THE POST TO ALLOW THE FILTER FABRIC TO BE BURIED.
4. THE FILTER FABRIC SHALL BE STAPLED OR WIRED TO THE POSTS, AND 12 INCHES OF THE FABRIC SHALL BE EXTENDED INTO THE TRENCH. THE FABRIC SHALL NOT EXTEND MORE THAN 30 INCHES ABOVE THE ORIGINAL GROUND SURFACE. FILTER FABRIC SHALL NOT BE STAPLED TO TREES.
5. THE TRENCH SHALL BE BACKFILLED WITH NATIVE SOIL OR WITH 3/4"-1 1/2" WASHED GRAVEL.
6. SILT FENCES SHALL BE REMOVED AT DIRECTION OF ENGINEER, BUT NOT BEFORE THE UPSLOPE AREA HAS BEEN PERMANENTLY STABILIZED.
7. SILT FENCES SHALL BE INSPECTED IMMEDIATELY AFTER EACH RAINFALL EVENT AND AT LEAST DAILY DURING PROLONGED RAINFALL. ANY REQUIRED REPAIRS SHALL BE MADE IMMEDIATELY.
8. SILT FENCE PERFORMANCE SHALL BE EVALUATED AND SILT FENCE LOCATIONS SHALL BE EVALUATED AND ADJUSTED AS DIRECTED OR APPROVED BY THE ENGINEER AND THE PERMITTING AUTHORITY.
9. SILT FENCE SHALL BE INSTALLED AS SHOWN ON DRAWINGS.
10. ANY DEVIATION OR CHANGE TO SILT FENCE DETAILS MUST BE APPROVED BY THE OWNERS REPRESENTATIVE.
11. THE CONTRACTOR SHALL MAINTAIN A COPY OF THE MANUFACTURER'S SPECIFICATIONS FOR FILTER FABRIC ON SITE.
12. MAINTENANCE STANDARDS:
    - A. ANY DAMAGE SHALL BE REPAIRED IMMEDIATELY.
    - B. IF CONCENTRATED FLOWS ARE EVIDENT UPHILL OF THE SILT FENCE, THEY MUST BE INTERCEPTED AND CONVEYED TO A SEDIMENT TRAP OR POND, OR OTHERWISE DIVERTED TO A LOCATION THAT DOES NOT RESULT IN TURBID DISCHARGES TO SURFACE WATERS.
    - C. THE UPHILL SIDE OF THE SILT FENCE SHALL BE CHECKED FOR SIGNS OF THE SILT FENCE CLOGGING, ACTING AS A BARRIER TO FLOW, AND CAUSING CHANNELIZATION OF FLOWS PARALLEL TO THE FENCE. IF SUCH CHANNELIZATION OCCURS, THE CONTRACTOR SHALL REPLACE THE FENCE OR REMOVE THE TRAPPED SEDIMENT.
    - D. SEDIMENT SHALL BE REMOVED AND PROPERLY DISPOSED OF WHEN THE SEDIMENT IS 6 INCHES HIGH.
    - E. IF THE FILTER FABRIC HAS DETERIORATED DUE TO ULTRAVIOLET BREAKDOWN, IT SHALL BE REPLACED.

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MARK EWBANK STATE OF WASHINGTON 29434 CIVIL ENGINEER PROFESSIONAL ENGINEER

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HERRERA ENVIRONMENTAL CONSULTANTS
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SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By

DESIGN MANAGER — DATE

PROJECT MANAGER — DATE

C. BARTON 05/2008
DESIGNED BY — DATE
W. WIESZCZECINSKI 06/2008
DRAWN BY — DATE
M. EWBANK 06/2008
CHECKED BY — DATE

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City of Bellevue
UTILITIES

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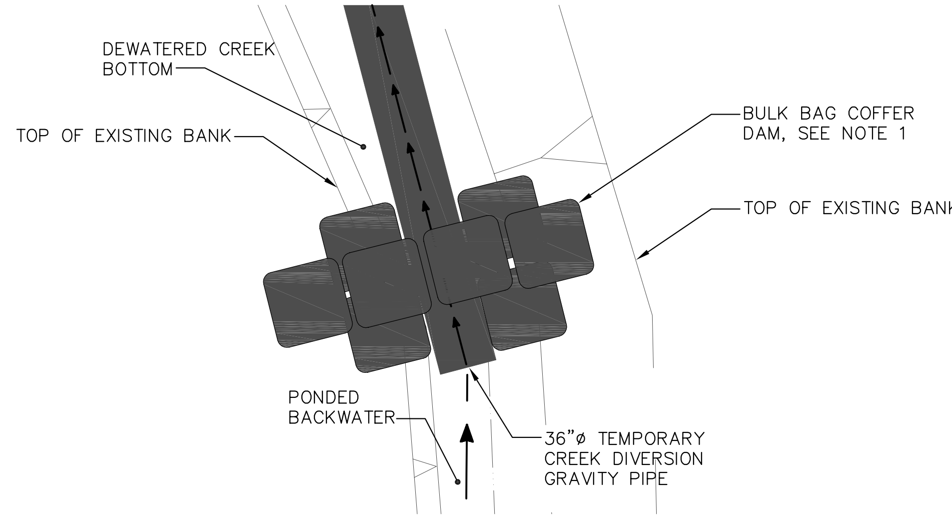
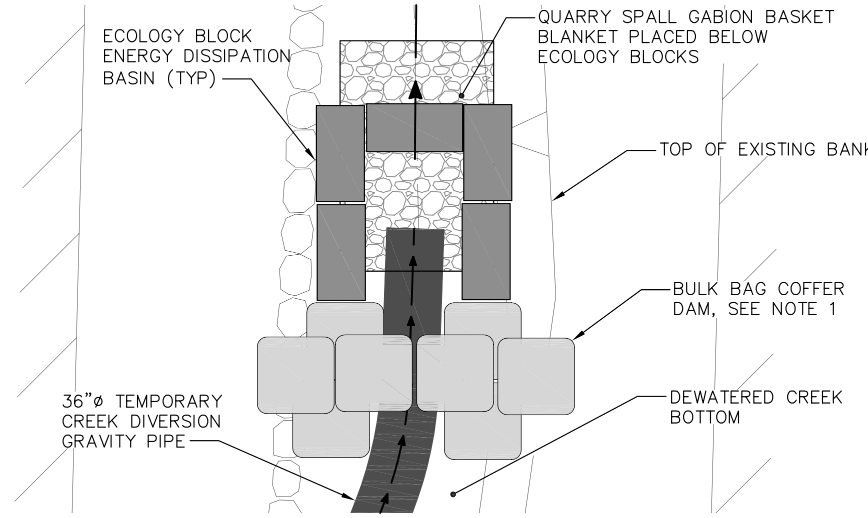


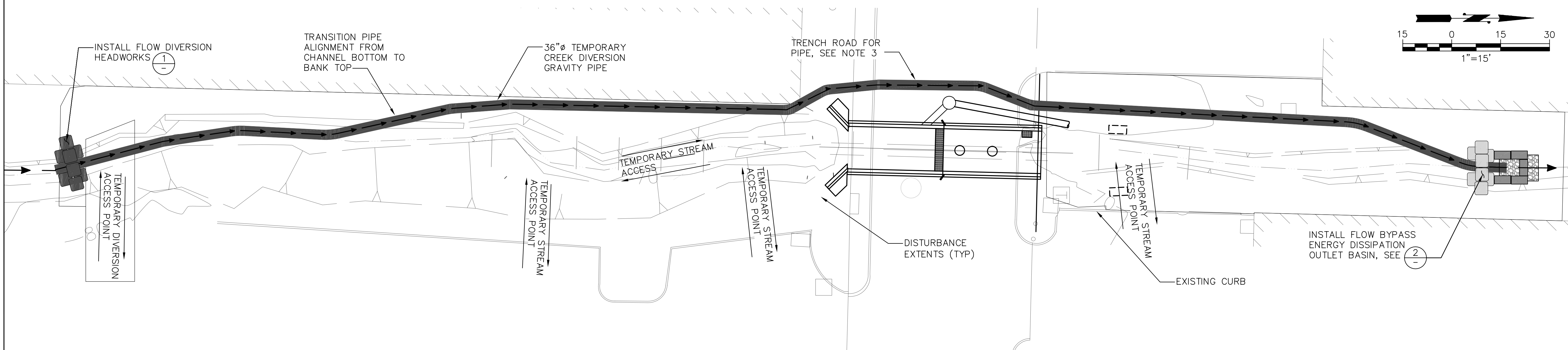
UPSTREAM COFFER DAM DETAIL (1/–)
SCALE: 1" = 5'



DOWNSTREAM OUTLET STRUCTURE DETAIL (2/–)
SCALE: 1" = 5'

GENERAL NOTES:

1. BULK BAGS SHALL BE FILLED WITH CLEAN WASHED ROUNDED GRAVEL.
2. TEMPORARY PUMPING OF CREEK DURING GRAVITY PIPE, UPSTREAM COFFERDAM, AND DOWNSTREAM OUTFALL DISSIPATION INSTALLATION AND REMOVAL WILL BE REQUIRED.
3. COORDINATE TEMPORARY DIVERSION PIPE TRENCH WITH CULVERT SHORING REQUIREMENTS AND UTILITY RELOCATION.
4. COORDINATE FISH EXCLUSION WITH CREEK DIVERSION.



STREAM CHANNEL DIVERSION PLAN (1/C-1)
SCALE: NOTED

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M. EWBANK 06/2008
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City of Bellevue
UTILITIES

FLOW DIVERSION AND FISH EXCLUSION DETAILS

DRAWING WM-1
SHT 20 OF 23

MARK EWBANK
STATE OF WASHINGTON
29434
CIVIL ENGINEER
PROFESSIONAL ENGINEER

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PLANT SCHEDULE

RIPARIAN LOW LIGHT 1 (RLL1)	SPECIES ABBRV	SCIENTIFIC NAME
	ALRU	ALNUS RUBRA
	THPL	THUJA PLICATA
	ACCI	ACER CIRCINATUM
	COCO	CORYLUS CORNUTA
	RUPA	RUBUS PARVIFLORUS
	SYAL	SYMPHORICARPOS ALBUS
	POMU	POLYSTICHUM MUNTIUM

RIPARIAN LOW LIGHT 2 (RLL2)	SPECIES ABBRV	SCIENTIFIC NAME
	ALRU	ALNUS RUBRA
	PSME	PSEUDOTSUGA MENZIESII
	ACCI	ACER CIRCINATUM
	COCO	CORYLUS CORNUTA
	MAAQ	MAHONIA AQUIFOLIUM
	RONU	ROSA NUTKANA
	RUPA	RUBUS PARVIFLORUS
	SYAL	SYMPHORICARPOS ALBUS

RIPARIAN HIGH LIGHT 1&2 (RHL)	SPECIES ABBRV	SCIENTIFIC NAME
	ALRU	ALNUS RUBRA
	PSME	PSEUDOTSUGA MENZIESII
	HODI	HOLODISCUS DISCOLOR
	MAAQ	MAHONIA AQUIFOLIUM
	RONU	ROSA NUTKANA
	POBA	POPULUS BALSAMIFERA
	SYAL	SYMPHORICARPOS ALBUS

LIVE STAKES (LS)	SPECIES ABBRV	SCIENTIFIC NAME
	COSE	CORNUS SERICEA
	SALU	SALIX LUCIDA SSP. LASIANDRA
	SASC	SALIX SCOULERIANA
	SASI	SALIX SITCHENSIS

LEGEND:

EXISTING CREEK FLOW LINE

PLANTING KEY LEGEND:

PLANTING MIX. SEE PLANTING LEGEND

PLANTING AREA NUMBER

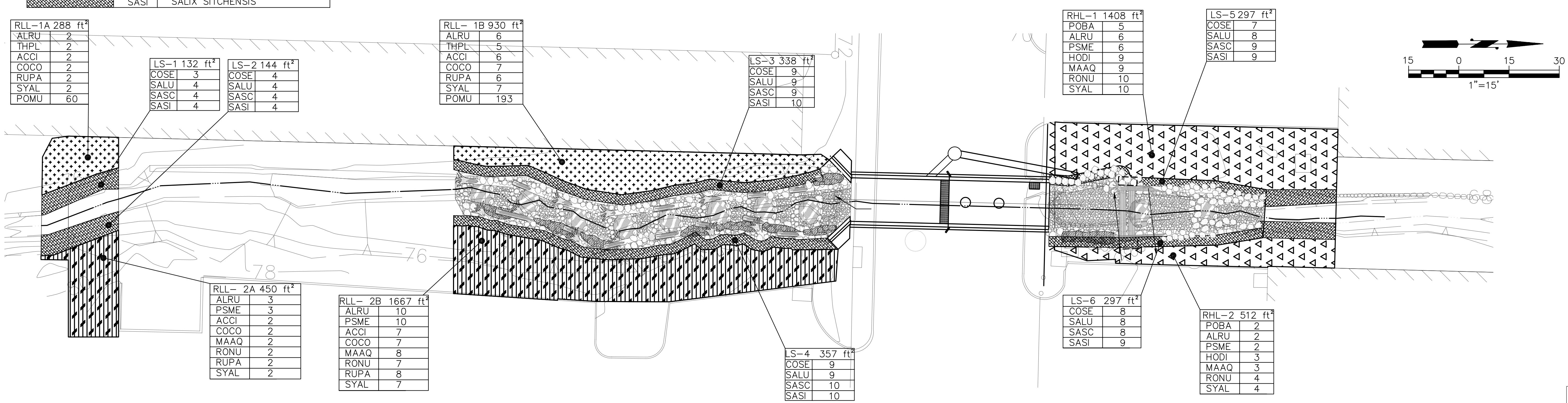
RLL-1B	649 ft^2
ALRU	4
THPL	4
ACCI	3
COCO	4
RUPA	4
SYAL	4
POMU	133

PLANTING ABBREV. SEE PLANTING LEGEND

QUANTITY OF PLANTS IN AREA

GENERAL NOTES:

1. NOXIOUS WEEDS SHALL BE REMOVED PRIOR TO COMMENCING CONSTRUCTION. WEEDS SHALL BE REMOVED BY SELECTIVE CLEARING METHODS WITHIN THE RIPARIAN ENHANCEMENT ZONES. THE WORK SITE SHALL BE MAINTAINED IN A WEED FREE CONDITION THROUGHOUT CONSTRUCTION UNTIL THE CLOSE OF THE CONTRACT. AT A MINIMUM, HIMALAYAN BLACKBERRY, REED CANARYGRASS, JAPANESE KNOTWEED AND ENGLISH IVY SHALL BE COMPLETELY REMOVED FROM THE PROJECT SITE.
2. SELECTIVE CLEARING METHODS CONSIST OF LIGHTWEIGHT HAND OR HAND-HELD EQUIPMENT TO PREVENT DAMAGE TO ROOTS OF EXISTING VEGETATION, COMPACTION OF SOIL, AND DISPERSAL OF SEEDS OR POLLEN FROM INVASIVE PLANTS.
3. NATIVE SEED MIX SHALL BE APPLIED TO ALL DISTURBED AREAS TO STABILIZED SOILS & TO PROVIDE HERBACEOUS COVER. SEEDING SHALL OCCUR AFTER SOIL PREPARATION AND GRADING HAS BEEN APPROVED BY ENGINEER. NATIVE SEED MIX SHALL BE APPLIED BY HAND TO FACES OF SOIL LIFTS PRIOR TO WRAPPING WITH WOVEN GEOTEXTILE. ALL OTHER AREAS WILL BE HYDROSEEDED.
4. ALL PLANTS, EXCEPT AS NOTED, SHALL BE NURSERY CONTAINER GROWN A MINIMUM OF ONE YEAR AND CONTAINERIZED PER ANSI STANDARDS. PLANT MATERIAL IS TO BE SUPPLIED BY COMMERCIAL NURSERIES THAT SPECIALIZE IN NATIVE PLANTS. PLANT SUBSTITUTIONS ARE SUBJECT TO APPROVAL BY THE ENGINEER.
5. SPECIFICATIONS FOR SIZE AND CONDITION ON DWG P-3 ARE MINIMUM.
6. PLANT SPECIES SELECTIONS FOR EACH PLANTING AREA ARE BASED ON PREDICTED LIGHT AND WATER AVAILABILITY. PLANTS SHALL BE RANDOMLY MIXED THROUGHOUT EACH PLANTING ZONE. VERIFICATION OF APPROPRIATE ENVIRONMENTAL CONDITIONS PER SPECIES REQUIREMENTS WILL BE NECESSARY TO ACHIEVE MAXIMUM PLANT SURVIVAL. LAYOUT OF ALL PLANT MATERIAL AND SEEDING TO BE APPROVED BY THE ENGINEER PRIOR TO INSTALLATION. PLANTING PLAN MAY REQUIRE MODIFICATION FOLLOWING ASSESSMENT OF AS-BUILT CONDITIONS: USE PLAN FOR QUANTITIES – FINAL LOCATIONS OF PLANTS SUBJECT TO CHANGE.
7. SHRUBS, TREES AND, LIVE STAKES SHALL BE INSTALLED ACCORDING TO DETAILS ON DWG. P-2.
8. DISCREPANCIES BETWEEN PLANS AND SITE CONDITIONS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER PRIOR TO PROCEEDING.
9. ENGINEER TO APPROVE GRADING PRIOR TO PLANTING.
10. KEEP ALL PLANT MATERIAL WELL-WATERED AND SHADED UNTIL THE ACTUAL TIME OF PLANTING: DO NOT ALLOW PLANT MATERIAL TO BE EXPOSED TO SUNLIGHT OR OTHER DRYING CONDITIONS PRIOR TO PLANTING.
11. ALL SHRUB AND TREE PLANTING SHALL OCCUR DURING THE DORMANT SEASON (NOVEMBER THROUGH FEBRUARY).
12. THOROUGHLY WATER ALL PLANTED AREAS IMMEDIATELY AFTER PLANTING AND WATER FOR OPTIMUM HEALTH DURING DRY PERIODS DURING THE PLANT ESTABLISHMENT PERIOD.
13. EXISTING AREAS DISTURBED BY CONSTRUCTION ACTIVITIES AND NOT SHOWN TO BE RE-LANDSCAPED ON THESE PLANS SHALL BE RESTORED AND SEEDED AS DIRECTED BY THE ENGINEER.
14. SEE SPECIFICATIONS FOR ADDITIONAL SEEDING, PLANTING, AND SOIL PREPARATION NOTES.
15. ALL TREE OR SHRUB PLANTINGS SHALL BE SETBACK A MINIMUM OF 5 FEET FROM ALL PAVEMENT EDGES, AND ALL TREE PLANTINGS SHALL BE SETBACK A MINIMUM OF 10 FEET FROM BUILDINGS.



RLL-1A	288 ft^2
ALRU	2
THPL	2
ACCI	2
COCO	2
RUPA	2
SYAL	2
POMU	60

LS-1	132 ft^2
COSE	3
SALU	4
SASC	4
SASI	4

LS-2	144 ft^2
COSE	4
SALU	4
SASC	4
SASI	4

RLL- 1B	930 ft^2
ALRU	6
THPL	5
ACCI	6
COCO	7
RUPA	6
SYAL	7
POMU	193

LS-3	338 ft^2
COSE	9
SALU	9
SASC	9
SASI	10

RHL-1	1408 ft^2
POBA	5
ALRU	6
PSME	6
HODI	9
MAAQ	9
RONU	10
SYAL	10

LS-5	297 ft^2
COSE	7
SALU	8
SASC	9
SASI	9

RLL- 2A	450 ft^2
ALRU	3
PSME	3
ACCI	2
COCO	2
MAAQ	2
RONU	2
RUPA	2
SYAL	2

RLL- 2B	1667 ft^2
ALRU	10
PSME	10
ACCI	7
COCO	7
MAAQ	8
RONU	7
RUPA	8
SYAL	7

LS-4	357 ft^2
COSE	9
SALU	9
SASC	10
SASI	10

LS-6	297 ft^2
COSE	8
SALU	8
SASC	8
SASI	9

RHL-2	512 ft^2
POBA	2
ALRU	2
PSME	2
HODI	3
MAAQ	3
RONU	4
SYAL	4

STREAM CHANNEL SITE PREP PLAN
SCALE: NOTED

1
C-1

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PLANTING PLAN

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SHT 21 OF 23

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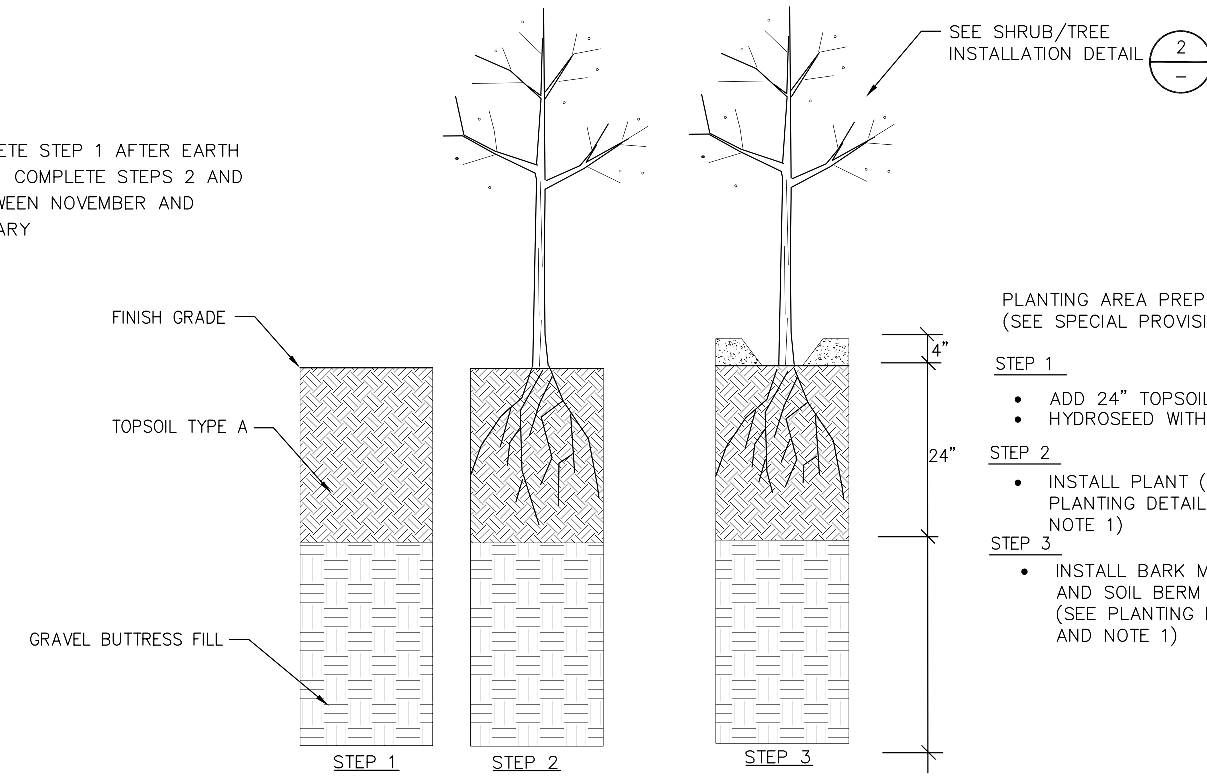
NOTE:

1. COMPLETE STEP 1 AFTER EARTH WORK. COMPLETE STEPS 2 AND 3 BETWEEN NOVEMBER AND FEBRUARY



PLANTING AREA PREPARATION (SEE SPECIAL PROVISIONS)

STEP 1
- ADD 24" TOPSOIL TYPE A
- HYDROSEED WITH SEED MIX

STEP 2
- INSTALL PLANT (SEE PLANTING DETAIL AND NOTE 1)

STEP 3
- INSTALL BARK MULCH AND SOIL BERM RINGS (SEE PLANTING DETAIL AND NOTE 1)

TOPSOIL TYPE A AMENDMENT AND PLANTING SEQUENCE OF WORK (1/–)

SCALE: NTS

NOTES:

- INSPECT PLANT MATERIAL PRIOR TO ACCEPTANCE OF DELIVERY. PLANTS SHOULD BE FREE OF DISEASE AND INJURY AND SHOULD NOT EXHIBIT POOR PRUNING OR CIRCLING, GIRDLING, OR KINKED ROOTS.
- PLANTING HOLES ON SLOPES SHOULD BE 3x ROOTBALL WIDTH.

(1) DIG PLANTING HOLE NO DEEPER THAN THE HEIGHT BUT AT LEAST 2x THE WIDTH OF THE CONTAINERIZED ROOTBALL (USE TOPSOIL AS BACKFILL)

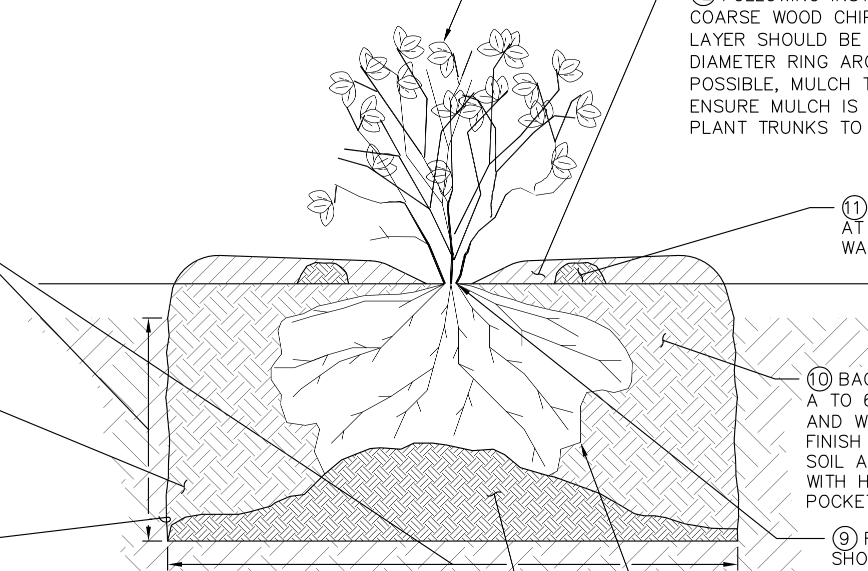
(2) REMOVE ROOTS, WEEDS, LARGE ROCKS, AND OTHER DEBRIS FROM PLANTING HOLE

(3) ROUGHEN SIDES OF PLANTING HOLE WITH SHOVEL OR SPADE

(4) REMOVE PLANT FROM CONTAINER (ENSURE CONTAINER SOIL IS MOIST) BY GENTLY SQUEEZING OR SHAKING CONTAINER. REMOVE ALL FOREIGN MATERIAL (PLASTIC, BURLAP, TAGS, ETC.)

(5) SPREAD ROOTS, ROUGHEN ROOTBALL EDGES, AND REMOVE AS MUCH CONTAINER SOIL AS POSSIBLE TO PROVENT SOIL INTERFACE PROBLEMS. (IF ROOTS ARE BOUND, A SHOVEL CAN BE USED TO SPLIT ("BUTTERFLY") THE BOTTOM 2/3 OF THE ROOTBALL)

(6) PRUNE ANY KINKED OR CIRCLING WOODY ROOTS OR THOSE THAT WILL NOT FIT IN PLANTING HOLE



(7) BUILD A SMALL SOIL MOUND IN CENTER OF PLANTING HOLE (SHOULD BE TALL ENOUGH TO SATISFY REQUIREMENTS IN (9))

(8) PLACE PLANT ON TOP OF THE SOIL MOUND AND SPREAD ROOTS EVENLY

(9) ROOT–SHOOT INTERFACE SHOULD BE AT OR SLIGHTLY ABOVE SOIL SURFACE (ENSURES LOWER PORTION OF STEM DOES NOT ROT DUE TO BURIAL)

(10) BACKFILL WITH TOPSOIL TYPE A TO 6" FROM SOIL SURFACE AND WATER IN TO SETTLE SOIL. FINISH BACKFILLING AND FIRM SOIL AROUND PLANT GENTLY WITH HANDS TO ELIMINATE AIR POCKETS

(11) BUILD A SOIL BERM RING AT DRIP LINE INCREASE WATER RETENTION

(12) FOLLOWING INSTALLATION, A 3" THICK COARSE WOOD CHIP (WEEDFREE) MULCH LAYER SHOULD BE APPLIED AS A ≥ 24" DIAMETER RING AROUND THE PLANT (IF POSSIBLE, MULCH THE ENTIRE SITE). ENSURE MULCH IS KEPT 1–2" AWAY FROM PLANT TRUNKS TO PREVENT ROTTING

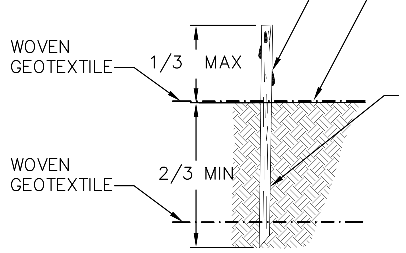
(13) PRUNE OUT DEAD, DAMAGED, OR DISEASED MATERIAL, BUT DO NOT TOP PRUNE

CONTAINERIZED TREE/SHRUB INSTALLATION SEQUENCE (2/–)

SCALE: NTS

INSTALL LIVE STAKE APICAL END UP SO THAT AT LEAST TWO NODES/BUD SCARS ARE ABOVE GROUND WITH AT LEAST 2/3 OF STAKE BELOW GROUND.

INSTALL STAKES SO THAT THEY SPAN SOIL LIFT AND PUNCTURE BOTH TOP & BOTTOM LAYERS OF WOVEN GEOTEXTILES.



PREPARATION OF PILOT HOLE WITH STEEL BAR MAY BE NECESSARY TO ACHIEVE REQUIRED STAKE DEPTH. TAMP TO FIRM SOIL AROUND CUTTINGS TO ELIMINATE AIR POCKETS. DO NOT HAMMER OR POUND CUTTINGS.

NOTES:

1. BASAL END OF LIVE STAKES SHOULD BE 0.5–1.5 INCHES IN DIAMETER AND AT LEAST 36 INCHES IN LENGTH.
2. KEEP LIVE STAKES COVERED, COOL, AND MOIST AT ALL TIMES PRIOR TO PLANTING. AT NO TIME SHOULD LIVE STAKES BE EXPOSED AND ALLOWED TO DRY OUT.
3. WHEN PLANTING ON STREAM BANKS, ANGLE STAKES SLIGHTLY DOWNSTREAM.

LIVE STAKE INSTALLATION (3/–)

SCALE: NTS

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K. LEPINE	06/2008
CHECKED BY	DATE

City of Bellevue UTILITIES

PLANTING DETAILS

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STRUCTURAL CLASS	SPECIES ABBRV	QUANTITY	SCIENTIFIC NAME	COMMON NAME	WETLAND INDICATOR	MATERIAL TYPE & SIZE	SPACING ON CENTER (FEET)	NOTES
TREES								
	POBA	7	POPULUS BALSAMIFERA	BLACK COTTONWOOD	FAC	1 GAL CONT. 12" HEIGHT	9	
	ALRU	29	ALNUS RUBRA	RED ALDER	FAC	1 GAL CONT. 12" HEIGHT	9	
	PSME	23	PSEUDOTSUGA MENZIESII	DOUGLAS FIR	FACU	2 GAL CONT. 24" HEIGHT	9	
	SALU	42	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW	NI	LIVE STAKE 36" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	INSTALL AT OHWM AND BELOW
	THPL	6	THUJA PLICATA	WESTERN RED CEDAR	FAC	2 GAL CONT. 24" HEIGHT	9	
SHRUBS								
	ACCI	17	ACER CIRCINATUM	VINE MAPLE	FAC–	1 GAL CONT. 12" HEIGHT	5	
	COSE	40	CORNUS SERICEA	RED OSIER DOGWOOD	FACW	LIVE STAKE 36" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	INSTALL AT OHWM AND BELOW
	COCO	18	CORYLUS CORNUTA	BEAKED HAZELNUT	FACU	1 GAL CONT. 12" HEIGHT	5	
	HODI	12	HOLODISCUS DISCOLOR	OCEANSPRAY	UPL	1 GAL CONT. 12" HEIGHT	5	
	MAAQ	23	MAHONIA AQUIFOLIUM	TALL OREGON GRAPE	UPL	1 GAL CONT. 12" HEIGHT	5	
	RONU	25	ROSA NUTKANA	NOOTKA ROSE	FAC	1 GAL CONT. 12" HEIGHT	5	
	RUPA	17	RUBUS PARVIFLORUS	THIMBLEBERRY	FAC–	1 GAL CONT. 12" HEIGHT	5	
	SYAL	31	SYMPHORICARPOS ALBUS	SNOWBERRY	FACU	1 GAL CONT. 12" HEIGHT	5	
	SASC	44	SALIX SCOULERIANA	SCOULER'S WILLOW	FAC	LIVE STAKE 36" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	INSTALL AT OHWM AND ABOVE
	SASI	46	SALIX SITCHENSIS	SITKA WILLOW	FACW	LIVE STAKE 36" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	INSTALL AT OHWM AND BELOW
HERBS								
	POMU	196	POLYSTICHUM MUNITUM	SWORD FERN	FACU	1 GAL CONT.	2	

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60% DESIGN - NOT FOR CONSTRUCTION

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
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Seattle, Washington
98121-1820
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http://www.herrerainc.com

SE 30TH STREET / SUNSET CREEK CULVERT REPLACEMENT PROJECT

Approved By
DESIGN MANAGER DATE
PROJECT MANAGER DATE

C. ELLIOT 05/2008
DESIGNED BY DATE
W. WIESZCZECINSKI 06/2008
DRAWN BY DATE
K. LEPINE 06/2008
CHECKED BY DATE

City of Bellevue UTILITIES

PLANT MATERIAL LIST

DRAWING P-3

SHT 23 OF 23

CRITICAL AREAS REPORT

Sunset Creek/Richards Creek Flood Control and Habitat Improvement Project

Prepared for

City of Bellevue
Utilities Department

September 2010

Note:
Some pages in this document have been purposefully skipped or blank pages inserted so that this document will copy correctly when duplexed.

CRITICAL AREAS REPORT

Sunset Creek/Richards Creek Flood Control and Habitat Improvement Project

Prepared for

City of Bellevue
Utilities Department
450 – 110th Avenue NE
Bellevue, Washington 98004

Prepared by

Herrera Environmental Consultants
2200 Sixth Avenue, Suite 1100
Seattle, Washington 98121
Telephone: 206.441.9080

September 7, 2010

Disclaimer

Herrera Environmental Consultants, Inc. has prepared this report for use by the City of Bellevue. The results and conclusions in this report represent the professional opinion of Herrera Environmental Consultants, Inc. They are based in part upon (1) site reconnaissance, and (2) examination of public domain information concerning the study area.

The work was performed according to critical area studies and reporting standards required by the City of Bellevue Code (Part 20.25H) and the accepted standards in the field of jurisdictional wetland determination and delineation using the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987), the Interim Regional Supplement to the Corps of Engineers Wetlands Delineation Manual: Western Mountains, Valleys, and Coast Region (Environmental Laboratory 2008), and the Washington State Wetlands Identification and Delineation Manual (Ecology 1997). However, final determination of jurisdictional wetland boundaries pertinent to Section 404 of the Clean Water Act is the responsibility of the Seattle District of the U.S. Army Corps of Engineers. Various agencies of the state of Washington and local jurisdictions may require a review of final site development plans that could potentially affect zoning, buffer requirements, water quality, and/or habitat functions of lands in question. Therefore, the findings and conclusions in this report should be reviewed by appropriate regulatory agencies before any detailed site planning and/or construction activities.

Contents

Tables

Figures

1.0 Report Summary

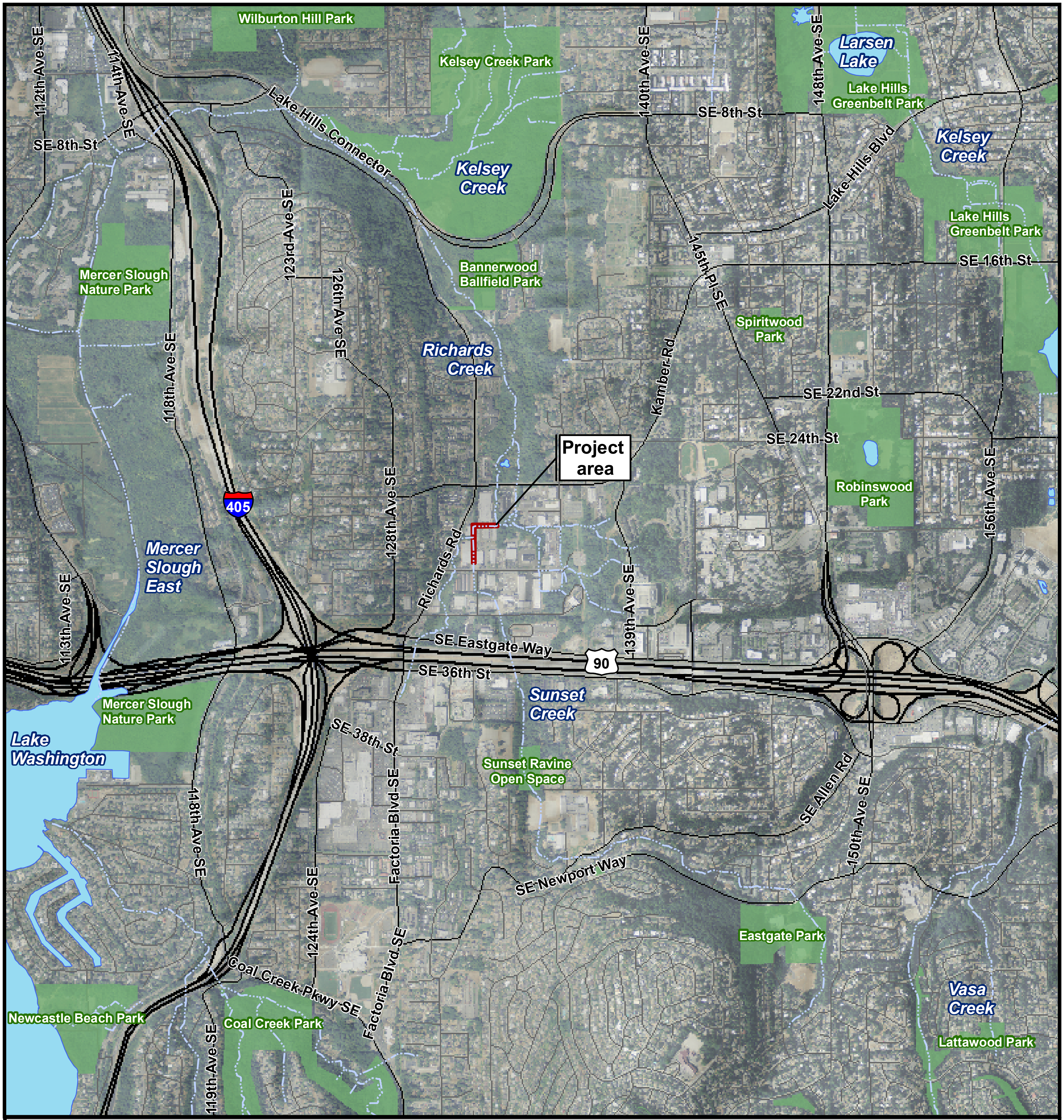
The City of Bellevue is proposing to construct the Sunset Creek/Richards Creek Flood Control and Habitat Improvement Project as the second phase of the Flood Control and Sediment Management Plan for Richards Creek, Sunset Creek, and East Creek (Herrera 2008). The independent, yet complimentary project phases recommended in this plan are intended to comprehensively address chronic flooding, promote channel stability, and improve channel and wetland habitat conditions within Richards, Sunset, and East Creeks. The first phase was constructed in 2009 and included a replacement culvert and sediment trap at SE 30th Street as well as channel modifications upstream and downstream to provide a stable streambed transition to the culvert inlet and outlet. The current Phase 2 project ("the project") will continue the channel and habitat improvements and flood control measures along a reach of Sunset Creek downstream of SE 30th Street as well as along a reach of Richards Creek upstream of the confluence with East Creek. The project channel modifications include the following elements:

- Channel enlargement for a stable, wetted channel
- Installation of log grade control and habitat structures to prevent head-cut migration and provide stable, physical habitat
- Construction of a containment berm to limit the extent of flooding into neighboring properties
- Removal of non-native invasive vegetation
- Revegetation with native plants
- Construction of a wetland bench within the proposed channel to promote the reestablishment of wetland species and provide low-velocity shelter areas for fish

The project will also protect an approximately 180-foot-long reach of Richards Creek that is characterized by mature canopy and complex physical habitat and located immediately downstream of the confluence with Sunset Creek.

The current project is located within, and directly adjacent to, the channel of Sunset and Richards Creeks in the City of Bellevue (Figure 1). The project area is within the Kelsey Creek Basin of Water Resource Inventory Area (WRIA) 8 – the Cedar/Sammamish Watershed. The legal description of this location is the northwest 1/4 of Section 10, Township 24 North, Range 5 East (Figure 1).

The critical areas affected include Sunset and Richards Creeks, one wetland, buffers for these aquatic resources, a special floodplain hazard area, and habitats for protected species. Effects on these critical areas are described below.



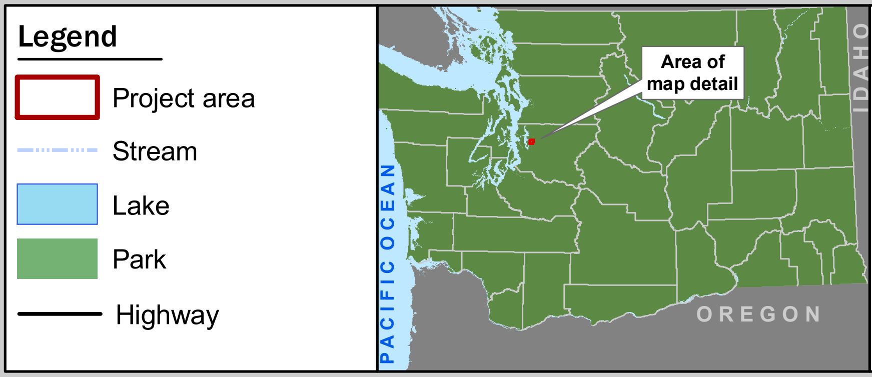


Figure 1. Vicinity map for Sunset Creek/ Richards Creek Flood Control and Habitat Management Project.

N

0 1,000 2,000 4,000 Feet

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As a result of the proposed Sunset Creek/Richards Creek Flood Control and Habitat Improvement Project, there would be temporary effects on the 100-year floodplain, Sunset/Richards Creek streambed, temporary and permanent impacts to adjacent wetlands, and temporary impacts to the buffers of the stream and wetlands. These effects are summarized in Table 1 and described below.

Table 1. Impacts to Sunset Creek/Richards Creek stream channel, wetlands, and buffers in the project area.

Resource	Temporary Impacts	Permanent Impacts
Sunset Creek channel (below OHWM)	2,033 square feet (0.047 acre)	None
Richards Creek Channel (below OHWM)	1,828 square feet (0.042 acre)	None
Wetland A	11,184 square feet (0.26 acre)	1,567 square feet (0.036 acre)
Stream and Wetland Buffers	8,270 square feet (0.19 acre)	None
Total	19,793 square feet (0.45 acre)	1,567 square feet (0.036 acre)

OHWM: Ordinary High Water Mark

The temporary impacts to the wetlands, streams, their buffers, and the floodplain would result from grading in the channel and the adjacent banks and wetlands. Also, log grade control structures and log rootwad bank stabilization measures will be installed. The wetlands and the wetland and stream buffers will be reconstructed and revegetated with native vegetation.

The permanent impacts to the wetlands would result from converting wetland to instream habitat and from building up the stream bank in Richards Creek to prevent flooding from occurring. However, the combined functions of the wetlands, riparian areas, and their buffers would be improved from their existing condition due to removal of riprap banks, removal of invasive and non-native vegetation, installation of large wood that would create fish habitat diversity, planting of dense native vegetation within the wetlands and riparian areas, and more frequent flooding of the wetlands. The project will result in a functional lift of wetland and riparian functions including improved flood control, water quality, and fish and wildlife habitat.

The streambed and banks will be restored during construction of the project. Spawning size gravel will be added to the stream, in order to improve fish habitat. To compensate for the permanent wetland impacts within the project area (0.036 acre) approximately 0.08 acre of wetland will be enhanced through non-native plant removal and planting of natives. This compensation is at a ratio of 2.25 acre of enhanced wetland to 1 acre of wetland impact.

2.0 Introduction

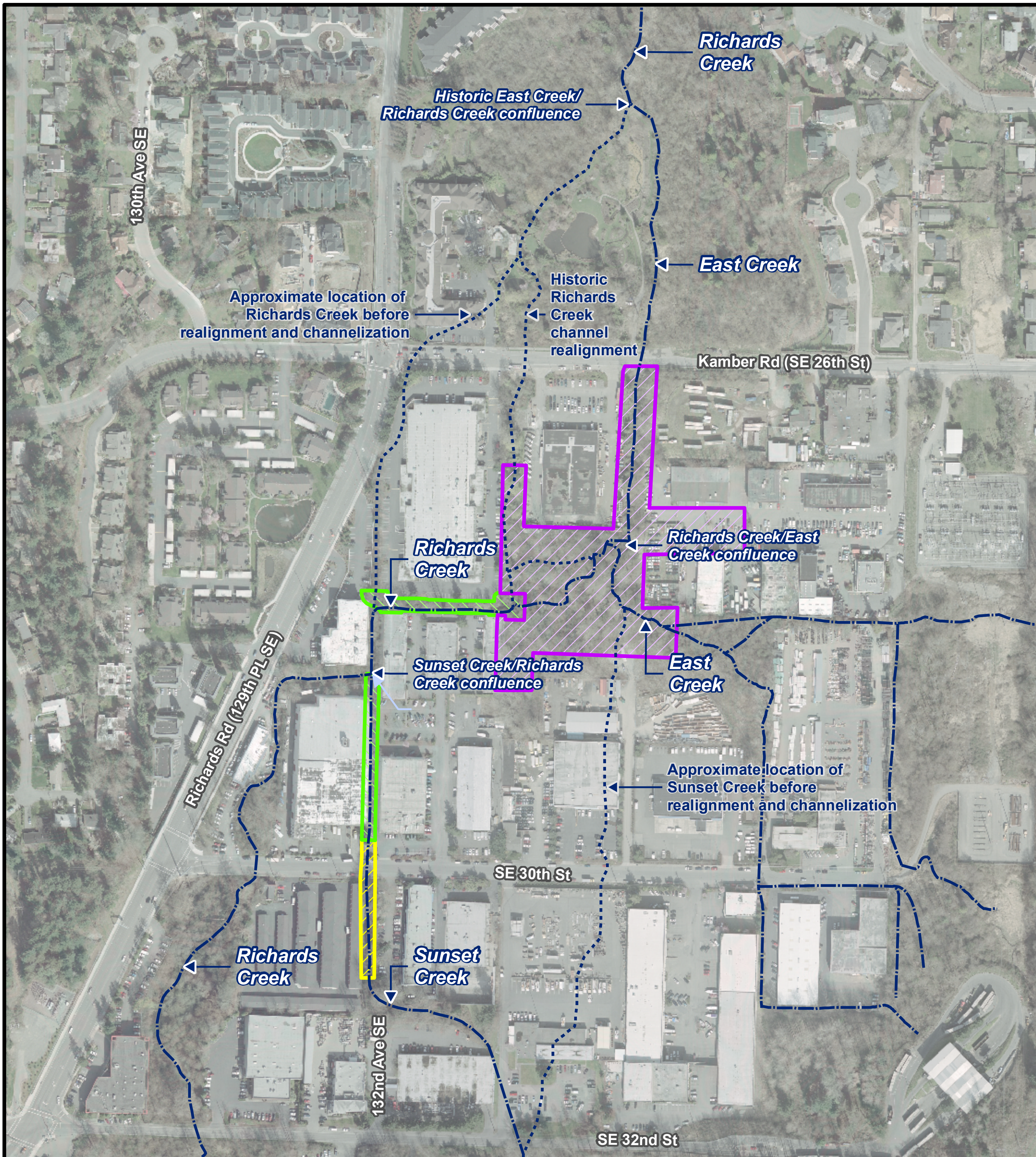
The Sunset Creek/Richards Creek Flood Control and Habitat Improvement Project (hereafter, "the project") increases the capacity of the stream, prevents channel degradation, enhances connectivity between the stream and adjacent wetlands, and improves instream fish habitat diversity and cover. This project is Phase 2 of a three-phase project that is being completed by the City of Bellevue in accordance with the Flood Control and Sediment Management Plan for Richards Creek, Sunset Creek, and East Creek (Herrera 2008) in order to control flooding of the surrounding properties and improve the instream and riparian habitat for fish and other wildlife in Sunset, Richards, and East Creeks.

2.1 Project History

The historical channel configuration of Sunset Creek, Richards Creek, and East Creek within the project area was significantly different than it is at the present time. Under predevelopment conditions, the channels within the project area were free to move laterally and shift course as sediment deposition filled channels and locally reduced sediment transport capacity, which is typical of channels on alluvial fans (see historic channel locations on Figure 2). During the development that occurred during the 1960s, when land was being graded and buildings adjacent to the channel network were being constructed, Sunset Creek, Richards Creek, and East Creek were realigned (Figure 2). To maintain the altered channel locations, the banks of these streams were armored in several areas. This channelization ended the natural process of dynamic sediment deposition and channel relocation and concentrated sediment deposition along the constructed channel alignments, without ability for the channels to shift in response to the sediment deposition.

The historic channel realignment, channel confinement, and increased rates of sediment production from land development throughout the watershed have directly resulted in recurrent flooding and sedimentation problems, channel instability, and degraded habitat conditions in the Richards Creek, Sunset Creek, and East Creek channel network near SE 30th Street and Kamber Road. To minimize flooding problems annual dredging activities removed approximately 20 cubic yards of sediment from around SE 30th Street each year. However, in promotion of more sustainable long-term solutions, the City contracted with Herrera to prepare the Sunset Creek Flood Control and Sediment Management Plan in 2008. This plan provides a comprehensive analysis and proposed solutions to ongoing sediment management and flooding challenges in these drainages, while producing a net improvement in habitat conditions. Stemming from this plan, the City of Bellevue (City) began to pursue a phased series of projects (Figure 1) to address flooding, promote channel stability, and improve habitat conditions.

The first phase of this work was constructed in 2009 on Sunset Creek (the most upstream portion of the phased proposed stream improvement area). Phase 1 (referred to as the SE 30th Street/Sunset Creek Flood Improvement Project) included replacement of twin 42-inch diameter



Legend

- Phase 1 project area
- Phase 2 project area
- Phase 3 project area
- Stream alignment
- Approximate historical stream alignment

Figure 2. Sunset, Richards, and East Creek network flood control and habitat improvement project phases and historic stream channels.

N

0 175 350 700 Feet

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Aerial photograph: City of Bellevue, 2007; Stream network: King County, 2008

K:\Projects\09-04582-000\Project\project_phases.mxd corrugated metal pipe culverts that convey Sunset Creek beneath SE 30th Street with a stream simulation and sedimentation culvert structure and channel modifications upstream and downstream of the roadway to stabilize the streambed transition to the new culvert inlet and outlet (Figure 2). The project discussed in this report, the Sunset Creek/Richards Creek Flood Control and Habitat Improvement Project, constitutes the second phase of work and continues with channel improvements and flood control measures along Sunset Creek downstream of Phase 1 to the confluence with Richards Creek. The project also entails stream improvements from the Optiva Curve (where Richards Creek turns sharply from north to east) to the historical Richards Creek flow split channel, approximately 300 feet upstream of the confluence with East Creek. The third phase of the project, referred to as East Creek Stream Channel Modification and Kelsey Creek Fish Passage Improvement project, will include flood control and habitat improvements downstream of Phase 2 in Richards and East Creeks (Figure 2). Both Phases 2 and 3 are planned to be constructed in 2011.

2.2 Project Setting

The project is located within, and directly adjacent to, the channel of Sunset and Richards Creeks in the City of Bellevue (Figure 1). The project area is within the Kelsey Creek Basin of Water Resource Inventory Area (WRIA) 8 – the Cedar/Sammamish Watershed. The legal description of this location is the northwest 1/4 of Section 10, Township 24 North, Range 5 East. See Figure 2 for the location of the project area and distinct project phases as described in the flood control and sediment management plan.

2.3 Project Description

The (Phase 2) project channel modifications include the following elements (as shown in Appendix A Project Engineering Plans):

- Channel enlargement for a stable, wetted channel
- Installation of log grade control and habitat structures to prevent head-cut migration and provide stable, physical habitat and rebuilding of stream banks
- Construction of a containment berm to limit the extent of flooding into neighboring properties
- Removal of non-native invasive vegetation
- Revegetation with native plants
- Construction of a wetland bench within the proposed channel to promote the reestablishment of wetland species and provide low-velocity shelter areas for fish

Wherever feasible, native vegetation and mature trees greater than 8 inches in diameter at breast height (dbh) will be retained.

The project extends a total of about 900 feet downstream of the Phase 1 project (or about 1,000 feet downstream of the SE 30th Street crossing), including channel work along 390 feet of Sunset Creek (to the confluence with Richards Creek) and about 380 feet of Richards Creek (downstream of the confluence with Sunset Creek) (Appendix A – Project Engineering Plans). These two stream reaches will be improved as discussed under the channel grading, grade control structures, bank stabilization structures, and rebuilt banks section (see Sheets C-1 through C-6, Appendix A). The project includes protection of an approximate 180 foot-long reach of Richards Creek, immediately downstream of its confluence with Sunset Creek, because the reach contains good instream fish habitat and diverse riparian habitat with a mature tree canopy.

2.4 Project Construction – Elements and Sequencing

The project is scheduled to be completed in the summer of 2011. All in-stream work will be conducted during the in-water work window established by the WDFW (July 1 to August 31). All in-stream work is expected to be conducted during one in-water work season. A total of 50 to 75 working days are estimated to be needed to complete construction.

The project consists of the following elements (exact sequencing may vary and some elements will occur concurrently):

1. Site preparation and staging
2. Install temporary flow bypass, fish removal and relocation
3. Dewater construction area
4. Channel grading, grade control structures, bank stabilization structures, and rebuild banks
5. Restore wetlands and revegetate riparian area
6. Reintroduce flow to channel

Each of these elements is described in more detail in the following sections.

2.4.1 Site Preparation and Staging

Site preparation activities include the contractor mobilizing to the project site, developing staging areas, establishing site access routes and traffic control, marking the work and clearing limits, and installing temporary erosion and sediment control (TESC) best management practices (BMPs). Space at the project site is limited and it is anticipated that the contractor will establish staging in the parking lot of a nearby business (see Sheet C-2, Appendix A). Staging areas totaling approximately 10,000 square feet are anticipated to be sufficient for the proposed project activities. Access to the project area will occur via SE 30th Street and parking lots adjacent to the stream channel on private property to the east of Sunset Creek and to the north of Richards Creek.

Vegetation removal will be limited to areas necessary to regrade the stream channel and banks and provide access to the channel as necessary to install grade control and bank stabilization structures and to remove riprap banks. The majority of riparian vegetation that will be affected consists of native willows (*Salix* spp.), black cottonwood (*Populus balsamifera*), various native shrubs and invasive and non-native species such as English ivy (*Hedera helix*), reed canarygrass (*Phalaris arundinacea*), Japanese knotweed (*Polygonum japonica*), and Himalayan blackberry (*Rubus armeniacus*). The estimated grading limits are shown on Sheet C-1 (Appendix A).

2.4.2 Install Bypass, Fish Removal and Relocation, Construction Site Dewatering

Construction work below the ordinary high water mark (OHWM) will be required for removal and installation of requiring dewatering of the work area. Once excavation of the bypass pipe trench is complete, a temporary flow bypass pipe will be installed as shown on Sheets C-2 and WM-1 in Appendix A. This activity will proceed as described below.

Two coffer dams and a gravity fed bypass pipe will be used to create the dewatered exclusion area. The first dam will be constructed approximately at the most upstream extent of the project area approximately 100 feet downstream of SE 30th Street. The stream flow will be routed into a pipe to be secured to the west side (left bank) of the channel. The dam will backwater flows into the gravity fed bypass pipe. The second dam will be constructed approximately 390 feet downstream of the upstream dam just before the confluence of Sunset and Richards Creek. Both coffer dams will be constructed using sandbags and plastic barrier sheeting installed manually. The bypass pipe will be 36 inches in diameter for Sunset Creek and capable of conveying flows up to 45 cubic feet per second (cfs). As there are no long-term flow gage records available, the bypass pipe conveyance capacity is estimated to approximate 72 percent of the modeled 1.01-year storm flow in Sunset Creek (38 cfs, Herrera 2008). The pipe will discharge to a temporary energy dissipater downstream of the coffer dam. The same bypass and fish removal process will be applied to the Richards Creek portion of the project (see Sheet WM-1, Appendix A) using a bypass pipe that is 42 inches in diameter, placed on the south (right) bank, capable of conveying flows up 95 cfs (approximately 72 percent of the modeled 1.01-year flow, Herrera 2008).

Concurrent with the installation of the bypass and dewatering of the channel, all fish and amphibians within the exclusion area will be captured and removed. Dewatering and fish relocation will be conducted following an accepted protocol developed for this activity by the Washington State Department of Transportation (WSDOT) (WSDOT 2009). The site will be allowed to drain to the limits of passive dewatering to facilitate fish removal. The remaining water within the exclusion area will either be pumped to the sanitary sewer system, or will be filtered using appropriate BMPs prior to return to the stream channel. To reduce the number of fish potentially affected by this activity, dewatering and fish relocation will be conducted as close to the beginning of the WDFW-specified in-water work window as possible. The channel will remain dewatered and inaccessible to fish until construction is complete.

The bypass pipe will be screened at the upstream end to prevent fish and other organisms from being entrained. The screening net will be situated for low pass-through velocity to avoid risk of impingement. The pipe is not expected to be passable to upstream movement, meaning the exclusion area will impose a partial barrier to fish passage during the in-water construction period. The coffer dams, bypass pipe, energy dissipater, and all related materials will be completely removed from the site when the project is completed.

2.4.3 Channel Grading, Grade Control Structures, Bank Stabilization Structures, and Rebuild Banks

The Sunset Creek and Richards Creek channels will be modified to provide more conveyance capacity and to slow the flow of the stream. Channel modifications will involve enlarging and re-grading the stream channel, removing any existing riprap bank armoring, and constructing grade control and bank stabilization structures. For the Sunset Creek portion, the banks will be slightly set back and an average depth of between 2.5 to 3 feet of sediment will be removed to increase conveyance capacity and to move the active channel away from the footings of adjacent buildings. For the Richards Creek portion, the banks will also be set back and the channel bed dropped by about 0.75 feet on average to increase conveyance capacity. The finished channel bed slope will approximate 0.9 percent, which corresponds to an equilibrium gradient for sediment transport and deposition through the reach. To create habitat diversity for fish and to stabilize the streambanks, approximately 40 logs with rootwads and an engineered log jam will be constructed into the bank at intervals that allow fish passage and create pool/riffle habitat (see Sheets C-1 through C-6, Appendix A). Additionally, an estimated 24 log grade control structures are proposed to be installed to protect this channel gradient. The structures will be spaced at a frequency to promote fish passage and have been designed such that there is no more than a 4 inch elevation difference between structures. These grade control structures will also help to halt a recent head-cut that has caused severe channel incision immediately downstream of the project reach and could continue upstream if no action is taken.

Unused streambed and bank materials will be hauled to a licensed disposal or material recycling facility. The volumes of excavation and fill below the OHWM for channel grading, wetland bench construction, bank reconstruction, installation of grade control and bank stabilization structures are outlined in Table 2. Fill quantities above and below the OHWM are also provided in Table 2.

Table 2. Excavation and fill quantities above and below the OHWM of Sunset and Richard creeks.

Above OHWM		Below OHWM	
Amount of Excavation (cu. yds.)	Amount of Fill (cu. yds.)	Amount of Excavation (cu. yds.)	Amount of Fill (cu. yds.)
548	41	315	67

2.4.4 Restore Wetlands and Revegetate Disturbed Riparian Area

Stream banks, wetlands, and areas within the riparian corridor that have been disturbed during channel regrading and structure placement will be rebuilt and stabilized where they are disturbed. The disturbed area clearing limits are expected to extend from approximately 390 feet in the Sunset Creek portion of the project and 380 feet in the Richards Creek portion of the project. The combined area of wetland and stream and wetland buffers (riparian habitat) that will be temporarily disturbed is estimated at approximately 19,793 square feet (0.45 acre).

Replanting plans are consistent with planting guidelines presented in the City of Bellevue's *Critical Areas Handbook* (City of Bellevue 2003). Bank toes will be protected from stream erosion using large woody debris and boulders that are buried into the stream bank and integrated into grade control structures. Higher portions of the bank that are disturbed will be stabilized with 12-inch high lifts of soil wrapped in woven and non-woven coir fabric. Each coir lift will be staked and the top layer will be secured with an anchor trench. Once the banks have been stabilized, all disturbed areas will be amended with Topsoil Type A and revegetated with the native species according to the specifications provided on Sheets P-1 through P-4 in Appendix A.

2.4.5 Reintroduce Flow

Following completion of the channel bed, wetland, and bank modifications, the temporary coffer dam will be removed, flows will be re-established through the project area, and the temporary bypass pipe will be removed. This activity will be conducted consistently with the WSDOT (2009) standard protocol for this practice.

3.0 Critical Areas Assessment

Consistent with LUC 20.25H.245, the supporting information upon which this report is based was developed by qualified professionals in the areas of wetlands and fisheries biology, and geomorphology using the best available science and guidance. This report provides Critical Area Report (CAR) information needs specified throughout LUC 20.25H. For ease of reference, information in this report includes sections for the following critical areas under this project: wetlands and streams (Section 3.3), special flood hazard areas (Section 3.4), and habitats associated with species of local importance (Section 3.5). The report covers information needs specified under general CAR reporting requirements LUC 20.25H.250.B 1 through 3 (see Sections 3.1 and 3.2 below). Also, the sections comply with technical reporting requirements specific to the critical areas and the general CAR reporting requirements provided in LUC 20.25H.250.B 4 through 8.

3.1 Identification and Classification of Critical Areas and Critical Area Buffers

This subsection addresses LUC 20.25H.250.B. subsections 1 and 2. Identified critical areas and critical area buffers within and adjacent to the impact area include the following (Figure 2):

- Streams and stream buffers (Type F waters [LUC 20.25H.075])
- Wetlands and wetland buffers (Category III [LUC 20.25H.095])
- Areas of special flood hazards [LUC 20.25H.175])
- Habitats associated with species of local importance [LUC 20.25H.150

3.2 Regulations and Codes Proposed for Modification

The proposed action is classified as an allowable use and development under four categories identified in LUC 20.25H.055.B: public flood protection measures, habitat improvement projects, instream structures, and stabilization measures. The project will address channel degradation and bank instability by providing stable streambed grade control and channel and bank modifications. The project will reduce flooding and erosion of commercial and industrial property (public flood protection measures) in the immediate vicinity of the project site while preserving and enhancing desirable habitat functions (habitat improvement projects). The uses are allowed if certain performance standards are met for each critical area identified in the project area as described below.

3.3 Wetland and Stream Assessment

The contents of this section satisfies CAR requirements for wetlands and streams specified under LUC 20.25H.110.B and CAR reporting requirements provided in LUC 20.25H.250.B 4 through 8. This section describes the conditions of wetlands and streams in the study area, wetland and stream ratings, and required buffer widths.

During the wetland and stream assessment, the project study area and vicinity was inspected for the presence of wetlands and streams.

The objectives of the study were to:

- Delineate (flag) all wetlands in the study area
- Classify all delineated wetlands using the U.S. Fish and Wildlife Service classification system (Cowardin et al. 1979)
- Classify all delineated wetlands using the hydrogeomorphic classification system (Brinson 1993)
- Classify all delineated wetlands and assess their functions using the Washington State Wetland Rating System for Western Washington–Revised (Hruby 2004), which is the classification system required by the City of Bellevue Code [LUC 20.25H.095]
- Determine the applicable wetland buffer widths required by the City of Bellevue Code [LUC 20.25H.095].
- Delineate (flag) the OHWM of all streams in the study area
- Classify all stream using the classification system required by the City of Bellevue Code [LUC 20.25H.075]
- Determine the applicable stream buffer widths required by the City of Bellevue Code [LUC 20.25H.075]

3.3.1 Methods and Materials

Evaluating the presence, extent, and type of wetlands and streams requires a review of available information about the site (e.g., surveys, studies), followed by an onsite wetland and stream delineation. The following sections describe the research methods and field protocols for the wetland and stream evaluations. More information about the methodology used in the wetland delineation performed for this project is available in Appendix B.

3.3.1.1 Review of Available Information

A literature review was performed to determine the historical and current presence of wetlands and streams in and near the study area. The sources of information are:

- Aerial photographs of the Sunset and Richards Creek project vicinity (Bellevue 2010)
- Topographic map of the project vicinity (Bellevue 2007)
- National Wetlands Inventory map of wetland areas in the project vicinity (USFWS 2010)
- City of Bellevue and King County wetland inventories (Bellevue 2010; King County 2010)
- Hydrography data (stream locations) for City of Bellevue (Bellevue 2010)
- A Catalog of Washington Streams and Salmon Utilization (WDF 1975)
- SalmonScape computer mapping system (WDFW 2010b)
- Washington State priority habitat and species (PHS) data (WDFW 2010a).
- Washington State Natural Heritage data (WDNR 2010)
- King County area soil survey maps for the project vicinity (NRCS 2010a)
- Soil descriptions for the project vicinity (NRCS 2010b)
- Hydric soils list for Washington (NRCS 2010c)

3.3.1.2 Wetland Delineation

This wetland delineation was performed in accordance with the *Washington State Wetlands Identification and Delineation Manual* (Ecology 1997) and the *Interim Supplement to the U.S. Army Corps of Engineers Wetlands Delineation Manual: Western Mountains, Valleys, and Coast Region* (Environmental Laboratory 2008), both of which are consistent with the 1987 Corps of Engineers *Wetlands Delineation Manual* (Environmental Laboratory 1987).

The methods in these guidance manuals use a three-parameter approach for identifying and delineating wetlands, and rely on the presence of field indicators for hydrophytic vegetation, hydric soils, and hydrology. The methods for evaluating these three parameters are described in Appendix A. This wetland delineation was performed according to procedures specified under the routine wetland determination method (Ecology 1997).

To identify potential wetlands, wetland biologists evaluated field conditions by traversing the study area and noting wetlands, streams and other aquatic features. The biologists evaluated conditions in the area within 300 feet of the study area boundary through observations from within the study area boundaries because they did not have permission to access these properties.

A test plot was established for each area that appeared to have potential wetland characteristics. For each test plot, data on dominant plant species, soil conditions in test plots, and evidence of hydrologic conditions were recorded on wetland determination data forms (Appendix C). Plants, soils, and hydrologic conditions were also analyzed and documented in adjacent upland areas. Based on collected data, a determination of wetland or upland was made for each area examined.

Following confirmation of wetland conditions in a given area, the wetland boundary was delineated by placing sequentially-numbered, flagging along the wetland perimeter. Test plot locations were also marked with flagging. The locations of wetland boundaries and test plots were subsequently surveyed by the City of Bellevue.

3.3.1.3 Wetland Classification, Rating, and Functional Assessment

This section provides information on the methods used to classify the wetlands, determine rating categories, and assess functions provides by the wetlands.

Wetland Classification

Wetlands observed on the study area were classified according to the U.S. Fish and Wildlife Service classification system (Cowardin et al. 1979). This system is based on an evaluation of attributes such as vegetation class, hydrologic regime, salinity, and substrate. The wetlands were also classified according to the hydrogeomorphic (HGM) system, which is based on an evaluation of attributes such as the position of the wetland within the surrounding landscape, the source and location of water just before it enters the wetland, and the pattern of water movement in the wetland (Brinson 1993).

Wetland Rating

Wetlands were rated using the *Washington State Wetland Rating System for Western Washington-Revised* (Hruby 2004), hereafter referred to as the Ecology rating system. The Ecology rating system categorizes wetlands according to specific attributes such as rarity; sensitivity to disturbance; hydrologic, water quality, and habitat functions, and special characteristics (e.g., mature forested wetland, bog). The total score for all functions determines the wetland rating. The rating system consists of four categories, with Category I wetlands exhibiting outstanding functions and/or special characteristics and Category IV wetlands exhibiting minimal attributes and functions. The rating categories are used to identify permitted uses in the wetland and its buffer, to determine the width of buffers needed to protect the wetland from adjacent development, and to identify the mitigation ratios required to compensate for potential impacts on wetlands. The City of Bellevue requires the use of the Ecology rating system [LUC 20.25H.095].

Wetland Functional Assessment

Wetland functions are those processes that occur within a wetland, such as the storage of water, cycling of nutrients, and maintenance of diverse plant communities and habitat which benefits wildlife. Wetland functions can be grouped into three broad categories: habitat functions, hydrologic functions, and water quality functions.

Habitat functions include providing food, water, and shelter for fish, shellfish, birds, amphibians, and mammals. Wetlands also serve as a breeding ground and nursery for numerous species. Hydrologic functions include reducing the velocity of stormwater, recharging and discharging groundwater, and providing flood storage. Water quality functions include the potential for removing sediment, nutrients, heavy metals, and toxic organic compounds.

Wetland functions were assessed using the *Washington State Wetland Rating System for Western Washington-Revised* (Hruby 2004), which is approved by the Washington State Department of Ecology for evaluating wetland functions in Washington. This system generates a score for each function based on the wetland's potential and opportunity for providing the function. Using the scores on the wetland rating forms, a qualitative functional rating (high, moderate, or low) was derived for each of the functions (water quality, hydrology, and habitat) provided by each wetland, based on supplemental guidance provided by Ecology (2008a).

3.3.1.4 Stream Delineation and Classification

Streams are considered to be one type of regulated water body according to the City of Bellevue Code (LUC 20.25H.075). Stream boundaries and buffers were determined according to guidance in the Bellevue code.

The ordinary high water marks (OHWMs) of streams within the study area were delineated using the definition provided in the WAC, Section 222-16-010, which has been adopted by the City of Bellevue. According to this definition, the OHWM of streams is "that mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegetation." In addition, methods in the publication *Determining the Ordinary High Water mark on Streams in Washington State* (Ecology 2008) were applied.

To delineate the OHWM, the bed and adjacent banks of streams in the study area were examined for indications of regular high water events. Factors considered when assessing changes in vegetation include:

- Scour (removal of vegetation and exposure of gravel, sand, or other soil substrate)
- Drainage patterns
- Elevation of floodplain benches
- Changes in sediment texture across the floodplain
- Sediment layering

- Sediment or vegetation deposition
- Changes in vegetation communities across the floodplain

Herrera placed flagging on the site, indicating the horizontal and vertical location of the OHWM along the stream(s). The locations of OHWM flags were subsequently surveyed by CTS Engineers, Inc.

Streams on the site were classified using the criteria in the City of Bellevue Code (LUC 20.25H.075). This system is based primarily on fish, wildlife, and human use, and consists of four stream types: Type S, F, N, or O. Type S streams are those surface waters which are inventoried as “Shorelines of the State” under the Shoreline Management Master Program for the City of Bellevue, pursuant to RCW Chapter 90.58. Type S waters contain salmonid fish habitat**.** Type F streams are those surface waters which contain habitat for salmonid fish, game fish, and other anadromous fish. Type N streams are those surface waters which do not contain fish habitat, but are connected to Type F waters through an above-ground channel. Type O streams are those surface waters which do not contain fish habitat, and are not connected to Type F waters through an above-ground channel.

3.3.2 Results

This section discusses the results of the wetland and stream delineations, including a review of information obtained from various references, and an analysis of wetland and stream conditions in the study area as observed during field investigations.

3.3.2.1 Analysis of Available Information

The available existing information compiled for this wetland and stream delineation is summarized in the following subsections.

Previously Mapped Wetlands and Streams

The National Wetlands Inventory indicates palustrine scrub-shrub (PSS), and forested (PFO), seasonally-flooded wetlands located just downstream of the project area in the East Creek project area (Figure 3).

The hydrography geographic information system (GIS) data for the study area indicates a stream (Sunset and Richards Creek) flowing north and east through the study area (Figure 2). The stream then continues east to its confluence with East Creek that flows to the north under a bridge under Kamber Road (Bellevue 2010).

Figure 3.
Previously mapped wetlands and streams for the Sunset Creek/ Richards Creek Flood Control and Habitat Management Project.

Legend

Approximate project area

Stream alignment

Approximate historical stream alignment

NWI wetland type

PSSC Palustrine, scrub-shrub, seasonally-flooded

PFOC Palustrine, forested, seasonally-flooded

PUBHx Palustrine, unconsolidated bottom, permanently flooded, excavated

N

0 100 200 400 Feet

HERRERA ENVIRONMENTAL CONSULTANTS

Aerial photograph: City of Bellevue, 2007
Wetlands: USFWS, 1981
Stream network: King County, 2008

Produced By: GIS
Project: K:\Projects\09-04582-000\Project\Wetlands_and_Streams.mxd

Mapped Soils

Two types of soil are mapped within the study area (NRCS 2010b) (Figure 4):

- Urban land
- Everett-Alderwood gravelly sandy loam (6 to 15 percent slopes)

Urban land is soil that has been modified by disturbance of the natural layers with additions of fill material several feet thick, often to accommodate large industrial and housing development.

Everett gravelly sandy loam is a somewhat excessively-drained soil formed glacial outwash terraces and terrace escarpments. This soil occurs primarily on uplands. A typical soil profile includes a 49 inch-deep topsoil composed of very dark brown (10 YR 2/2) or a dark yellowish brown (10 YR 3/4) very gravelly sandy loam, which lies over a dark brown (7.5YR 3/4) extremely gravelly coarse sandy loam and an olive brown (2.5Y 4/4) extremely gravelly sand. This soil is not considered a hydric soil by the NRCS (NRCS 2010b).

Topography

The project area is relatively flat with a slope of 3 to 4 percent from the upstream end to the downstream end. The Sunset Creek portion of the project area ranges in elevation from 70 feet at the southern (upstream) end of the reach to 60 feet at the northern (downstream) end. The Richards Creek portion of the project ranges from 60 feet at the western (upstream) end to 55 feet at the eastern (downstream) end of the reach.

3.3.2.2 Analysis of Wetland and Stream Conditions

Wetland and stream delineation field activities were conducted by Herrera biologists Kris Lepine and Erik Schwartz. The lead biologist (Kris Lepine) is certified by the Society of Wetland Scientists as a Professional Wetland Scientists (PWS). The wetland delineation was conducted on June 21, 2010. The weather conditions during the fieldwork consisted of: daytime high temperatures of approximately 65 degrees Fahrenheit (°F), with cloudy conditions. It was determined that the growing season (as defined in Appendix B) had begun, because plants were in full leaf out.

Herrera biologists delineated wetlands and stream OHWM on both sides of the stream in the project area that were considered to be all part of one large wetland unit, referred to as Wetland A, that was connected to the wetlands delineated in the downstream East Creek project area (Table 3) and two connected streams, Sunset Creek and Richards Creek (Table 4). The locations and extents of the wetlands, stream and their buffers are shown in Figure 5 and on engineering plans in Appendix A. Detailed descriptions of the wetlands are provided in Table 5. The biologists completed wetland delineation data forms (Appendix C) and a Department of Ecology wetland rating form (Appendix D) for each of the wetlands delineated in the project area. Representative photographs of the wetlands in the project area are included in Table 5.

Table 3. Wetlands delineated in the study area.

Wetland Name	Wetland Size (acre)	USFWS Classification [a]	Hydrogeomorphic Classification [b]	Department of Ecology Rating Category [c]	City of Bellevue Buffer Width (feet) [d]
A	>2.7	PFO	Riverine/Depressional	III	60

[a] U.S. Fish and Wildlife Service classification is based on Cowardin et al. (1979): palustrine forested (PFO)

[b] Hydrogeomorphic classification is based on Brinson (1993).

[c] Wetland category is based on the Department of Ecology wetland rating system (Hruby 2004), which is required by the City of Bellevue.

[d] Wetland buffer widths are based on the Department of Ecology wetland rating, per the City of Bellevue Code.

Table 4. Sunset Creek/Richards Creek stream summary table.

Stream Name	**Sunset/Richards Creek**
WRIA Stream Catalog #	**08-0056**
	
Local Jurisdiction	City of Bellevue
DNR Stream Type	Type F
Local Stream Rating	Type F
Local Jurisdiction Buffer Width	100
Documented Fish Use	Documented presence of fall Chinook, coho, and sockeye (WDFW 2010).
Connectivity (where stream flows from/to)	Sunset Creek flows north originating on the developed slopes south of I-90. Richards Creek joins Sunset Creek from the west approximately 500 feet downstream of SE 30th Street. Richards Creek turns at a 90 degree turn to the east at the Optiva Curve and flows east to East Creek. East Creek and Richards eventually discharge into Kelsey Creek which ultimately flows to Lake Washington via Mercer Slough. In addition, the stream is hydrologically connected to Wetland A.
Location of Stream Relative to Project Corridor	The project extends a total of about 900 feet downstream of the Phase 1 project (or about 1,000 feet downstream of the SE 30th Street crossing), including channel work along 390 feet of Sunset Creek (to the confluence with Richards Creek) and about 380 feet of Richards Creek (downstream of the confluence with Sunset Creek) (Appendix A – Project Engineering Plans).
Riparian/Buffer Condition	Existing in-stream habitat is poor with limited rearing pools; gravel substrates that have been imbedded with sediment. In East Creek just downstream of the project area there is a large, impassible water fall that continually moves upstream as incision of the stream progresses. Although there are areas where vegetation has been damaged or eliminated due to erosion, there are still large swaths of overhanging, native vegetation that primarily consist of willows, red-osier dogwood (*Cornus sericea*), and red alder (*Alnus rubra*). There are small patches of English ivy, Japanese Knotweed (*Polygonum japonica*), and to a greater extent, Himalayan Blackberry (*Rubus armeniacus*). Japanese Knotweed is concentrated on the north and south sides of Richards Creek immediately east of the Optiva curve.

Figure 4.
Soil map for the Sunset Creek/ Richards Creek Flood Control and Habitat Management Project.

Legend

Approximate project area

Stream alignment

Approximate historical stream alignment

Soil classification (NRCS)

AgD Alderwood gravelly sandy loam, 15 to 30% slope

AmC Arents, Alderwood material, 6 to 15 percent slopes

EvD Everett gravelly sandy loam, 15 to 30 percent slopes

EwC Everett gravelly sandy loams, 6 to 15 percent slopes

RdE Ragnar-Indianola association, moderately steep

Sk Swantown loam, 0 to 5 percent slopes

Ur Urban land

N

0 100 200 400 Feet

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Aerial photograph: City of Bellevue, 2007
Wetlands: USFWS, 1981
Stream network: King County, 2008

Produced By: GIS
Project: K:\Projects\09-04582-000\Project\Soils_Updated.mxd

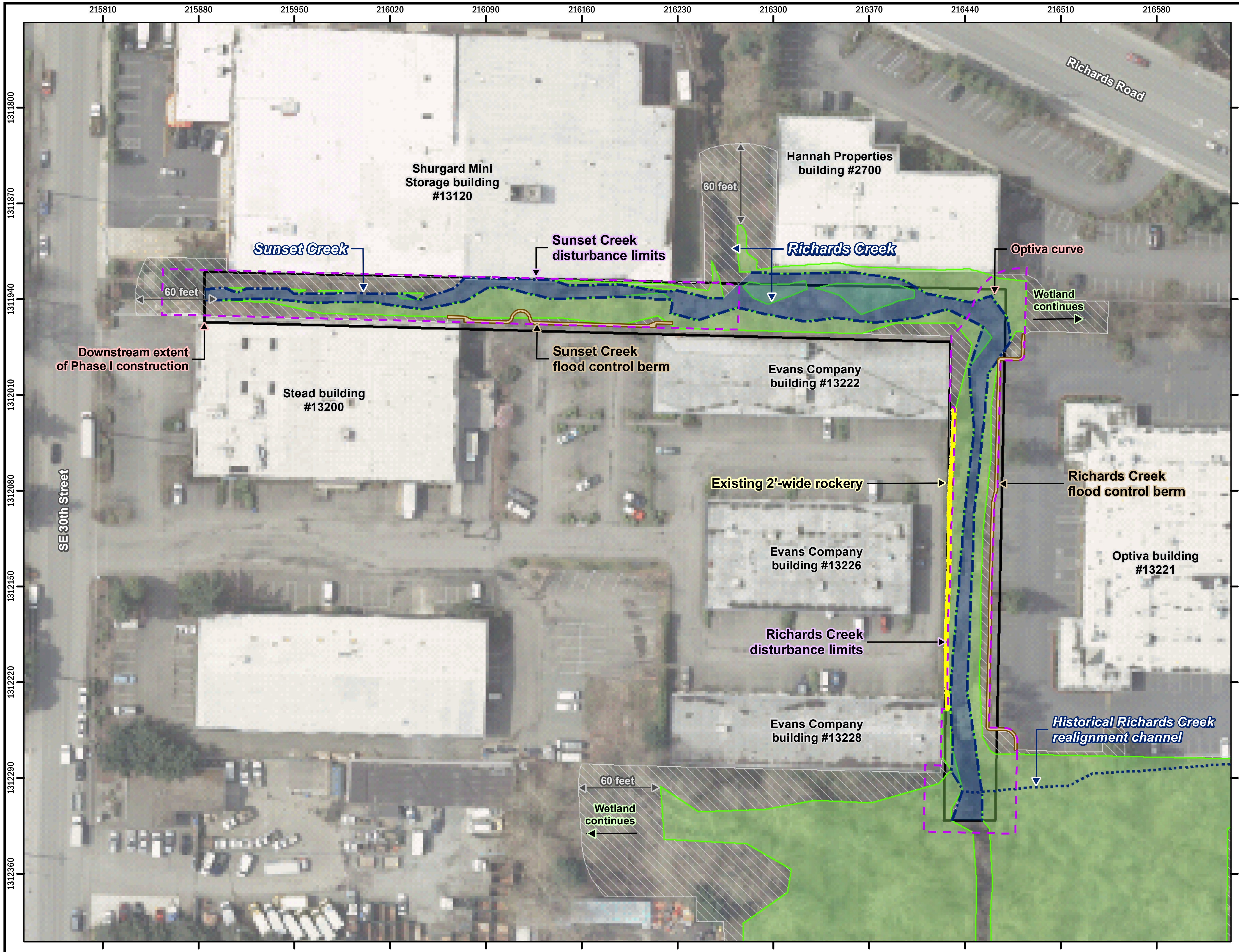

Figure 5.
Delineated wetland and stream map, Sunset/Richards Creek Flood Control and Habitat Improvement project.

Legend
- Approximate project area
- Wetland
- 60-foot wetland buffer
- Limits of grading
- Flood control berm
- Rockery
- Historic channel (Richards Creek)
- Ordinary high water mark

N

0 35 70 140 Feet

HERRERA ENVIRONMENTAL CONSULTANTS

Coordinates: NAD 83 Washington StatePlane North (feet)
Aerial: City of Bellevue, 2007

Produced By: GIS (rdr)
Project: K:\Projects\09-04582-000\Project\survey_wetlands_and_stream.mxd

Table 5. Summary for Wetland A.

Wetland name	**Wetland A**
Location	**Northwest quadrant of the study area, from gravel spur road to north boundary**
	
Local jurisdiction	City of Bellevue
WRIA	8
Wetland rating	Category III
City of Bellevue buffer width	60 feet
Cowardin classification	Palustrine forested
Hydrogeomorphic classification	Riverine/ Depressional
Wetland data form(s)	Appendix C, DP WL A
Upland data form(s)	Appendix C, DP UPL-A
Size of entire wetland	The wetland was not delineated in entirety. It extends north, east, and west of the study area. The wetland area within the project area is approximately 0.29 acres in size and is part of a larger wetland that is more than 2.7 acres in size.
Dominant vegetation	Wetland A is dominated by a forested community of red alder (*Alnus rubra*) and black cottonwood (*Populus balsamifera*) with a shrub understory of willow (*Salix sitchensis*, *Salix lucida* spp. *lasiandra*), red-osier dogwood (*Cornus sericea*), salmonberry (*Rubus spectabilis*); and an herbaceous understory of lady fern (*Athyrium filix-femina*), big leaf sedge (*Carex amplifolia*), slough sedge (*Carex obnupta*), giant horsetail (*Equisetum telmateia)*, creeping buttercup (*Ranunculus repens*), small fruited bulrush (*Scirpus microcarpus*), and piggyback plant (*Tolmiea menziesii*). Non-native vegetation is also prevalent in the project area and includes Himalayan blackberry, Japanese knotweed, and English ivy.
Soils	The soil for WL A-TP1 was examined to an 18-inch depth and exhibited hydric characteristics. The top 14 inches of soil was black (10YR 2/1) sandy muck overlying a 4 inch layer of gley soils (5B 5/1) with redoximorphic concentrations (7.5 YR 4/6, 2 percent in the matrix). This profile meets the criteria for the hydric soil indicator of sandy mucky mineral (S1).
Hydrology	WL A-TP1 exhibited soils saturated to the surface, and a water table at 18 inches. Hydrologic inputs to this wetland include precipitation, groundwater, runoff from surrounding uplands, and flooding from adjacent Sunset and Richards Creeks. The wetland outlet discharges into both East Creek and Richards Creek which flow north downstream of the project area.
Rationale for delineation	All three wetland parameters are met.
Rationale for local rating	The City of Bellevue Code classifies wetlands according to the current Department of Ecology rating system, which rates Wetland A as a Category III.
Buffer condition	The buffer surrounding the wetland consists primarily of parking lots, and low-lying, large commercial buildings. Existing buffers provide flood control, limited wildlife habitat, and water quality functions.

3.3.3 Probable Cumulative Impacts

As a result of the proposed Sunset Creek/Richards Creek Flood Control and Habitat Improvement Project, there will be temporary effects on the Sunset Creek and Richards Creek streambeds, and temporary and permanent impacts to adjacent wetlands, and temporary impacts to the buffers of the stream and wetlands. These effects are summarized in Table 6, depicted graphically in Figure 6, and described in more detail below.

Table 6. Impacts to Sunset Creek/Richards Creek stream channel, wetlands, and buffers.

Resource	Temporary Impacts	Permanent Impacts
Sunset Creek channel (below OHWM)	2,033 square feet (0.047 acre)	None
Richards Creek Channel	1,828 square feet (0.042 acre)	None
Wetland A	11,184 square feet (0.26 acre)	1,567 square feet (0.036 acre)
Stream and Wetland Buffers	8,270 square feet (0.19 acre)	None
Total	19,793 square feet (0.45 acre)	1,567 square feet (0.036 acre)

OHWM: Ordinary High Water Mark

The temporary impacts to Sunset and Richards Creeks channel beds will result from excavating the channel to deepen it and laying back the stream banks and installing rock and logs with rootwads. Also, large woody debris and grade control structures will be placed within the stream channel. Once the construction is complete, the stream will be returned to its slightly modified course. The stream channel will be lower and wider than in its current condition.

The temporary impacts to the wetlands along the streams will result from excavating the banks along the stream, installation of rock and rootwads along the reconstructed channel and rebuilding the stream banks. Permanent impacts to wetlands will result from filling in the wetland in order to build up the stream banks to prevent flooding of adjacent buildings and excavating the wetland to create more instream habitat. The reconstructed wetland and riparian area will be revegetated and will perform equivalent or better functions as those provided by existing wetlands.

In addition to the functional lift that will be provided by restoring the stream and wetland areas, compensatory mitigation for permanent wetland impacts will also occur. To compensate for the permanent wetland impacts of 0.036 acre, approximately 0.08 acre of wetland will be enhanced within the project area. This results in a mitigation ratio of 2.25 acres enhanced wetland to 1 acre wetland impact.

The impacts to the stream and wetland buffers will be the result of temporary construction access and selective clearing. All cleared vegetation and disturbed soils will be restored to pre-project conditions. There will be no permanent impacts to wetland and stream buffers.

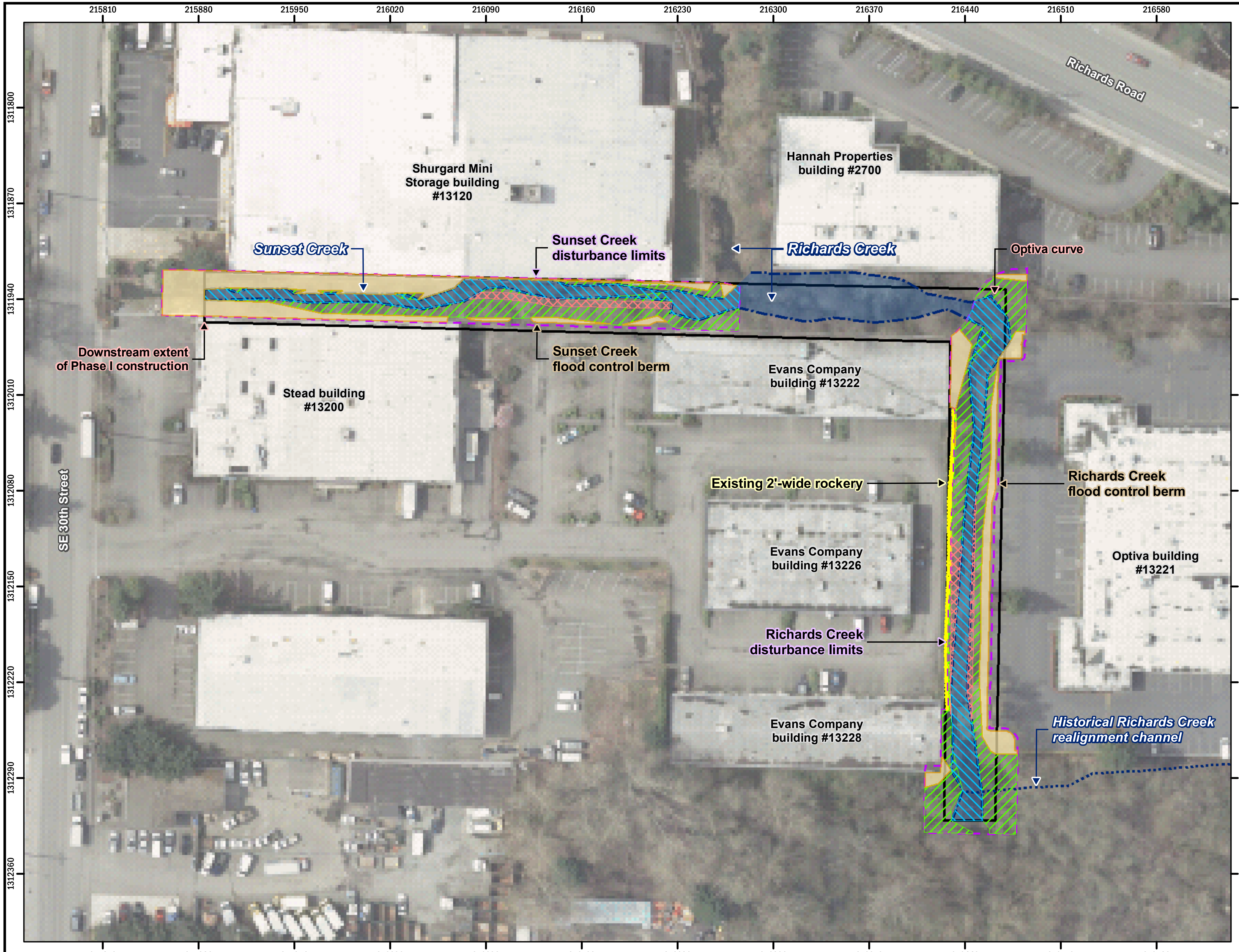

Figure 6.
Wetland and stream impacts, Sunset/Richards Creek Flood Control and Habitat Improvement project.

Legend

- Permanent wetland impacts (0.036 acre)
- Temporary stream impacts (0.089 acre, 784 lineal feet)
- Temporary wetland impacts (0.26 acre)
- Temporary wetland and stream buffer impacts (0.19 acre)
- Limits of grading (0.69 acre)
- Approximate project area
- Rockery
- Historic channel (Richards Creek)
- Ordinary high water mark

N

0 35 70 140 Feet

HERRERA
ENVIRONMENTAL CONSULTANTS

Coordinates: NAD 83 Washington StatePlane North (feet)
Aerial: City of Bellevue, 2007

Produced By: GIS (rdr)
Project: K:\Projects\09-04582-000\Project\stream_wetland_impacts.mxd

3.3.4 Wetland and Stream Functions and Values Protection Assessment

3.3.4.1 Existing Functions and Values Provided by Affected Wetlands and Streams

Wetland Functions

Wetland functions for the wetland within the project area was evaluated according to data in the Ecology wetland rating forms (Hruby 2004), and supplemental qualitative ratings (high, medium, low) were determined based on Ecology guidance (Ecology 2008a). This methodology entails rating the entire wetland unit which includes a substantial amount of wetland that is outside the project site. Conditions within the project site are more degraded than in the rest of the wetland to the east of the project area. Therefore, the portion of the wetland in the project area may not be providing as high a level of functions as the rest of the wetlands. A summary of the function scores, the total wetland score, and the associated rating (category) for Wetland A is provided (Table 7). Qualitative and quantitative scores for both potential and opportunity for Wetland A to provide water quality, hydrologic, and habitat functions is provided.

Table 7. Wetland function scores.

Wetland Name	Water Quality Functions – Qualitative Rating [a] (numerical score in parentheses)		Hydrologic Functions – Qualitative Rating [a] (numerical score in parentheses)		Habitat Functions – Qualitative Rating [a] (numerical score in parentheses)		Total Score	Department of Ecology Rating Category [b]
	Potential	Opportunity	Potential	Opportunity	Potential	Opportunity		
A	Moderate (8)	Yes	Moderate (6)	Yes	Moderate (12)	Moderate (7)	47	III

[a] Qualitative ratings are based on the Department of Ecology "Using the Wetland Rating System in Compensatory Mitigation" focus sheet (Ecology 2008a)

[b] Wetland category is based on the Department of Ecology rating system (Hruby 2004).

Wetland A, a riverine-open depressional wetland, has a moderate potential to improve water quality through persistent, ungrazed vegetation equal to or greater than 95 percent of the wetland area. Surface water primarily exits the wetland through surface flow into Sunset, Richard, and East Creeks. Because the surface flow is unconstricted, the effectiveness of dense vegetation as a sediment trap and water filter is somewhat lessened due to the lack of water retention within the wetland. The location of Wetland A provides opportunity to improve water quality—it is located in an area that is subject to untreated stormwater from adjacent commercial properties containing large, paved parking lots. The wetland has moderate potential to improve hydrologic functions, because the height of ponding within the wetland above the outlet (Richards Creek) is approximately 6 inches, and the ratio of surface water contribution to the area of wetland is less than 100 times the area of the unit. The wetland has the opportunity to reduce flooding and erosion because it drains to a stream that has documented flooding problems and it is located within a FEMA-designated floodplain. The portion of the wetland within the project area has aggraded 2 to 3 feet above the streambed and is less frequently flooded by the stream as the rest of the wetland.

Wetland A is ranked as moderate in potential habitat functions because it contains only one vegetative community class (forested) and has limited vegetation structure diversity. Also it has three hydroperiods: seasonally flooded, saturated, and a permanently flowing stream bisecting the wetland. The high diversity of plant species, moderate interspersion of habitat types, and presence of a variety of habitat features, (i.e., standing wood snags, large downed wood) increases the rating for habitat functions. However, non-native invasive species have taken over much of the project area, particularly Japanese knotweed along the Richards Creek segment. The opportunity for the wetland to improve habitat functions is moderate because the buffers are highly disturbed by the encroaching commercial development. Buildings and parking lots in some places along the project area are within only a few feet from the wetland edge. The condition of the buffers and adjacent riparian areas is described in more detail under the stream and riparian functions section.

Stream and Riparian Functions

Before historic hydromodification of the stream network in the project vicinity, stream channels within the project area would have naturally aggraded and shifted location across an alluvial fan, occupying the course of least resistance. Development related hydromodification halted the natural process of channel migration and restricted the natural process of sediment deposition to the established channel corridors. Concurrent development of headwater areas of the drainage proceeded without adequate stormwater detention, resulting in an increased sediment supply rate that has proven difficult to mitigate. Prior to installation of the Phase 1 sediment trap in 2009, sediment aggradation in the project vicinity exceeded transport capacity, resulting in chronic sediment deposition that reduced channel capacity and promoted flooding. As a consequence, the City had been dredging the Sunset Creek active channel annually to maintain flood conveyance. While considered an allowable use under LUC 20.25H.055.B, this activity nonetheless contributes to chronic disturbance of the channel and channel buffer. The functions and values provided by the area proposed for modification are mixed. Under natural conditions, this alluvial fan reach likely provided prime spawning habitat for resident and migratory fish, including salmon and steelhead. Even in its current degraded state, the aggraded stream reach downstream of SE 30th Street at its confluence with Richards Creek continues to provide important spawning habitat. However, the inability of the channel to migrate in response to sediment deposition has created an overly shallow channel condition that limits the quality and quantity of useable spawning habitat and presents a low flow passage barrier. Protecting and enhancing remaining spawning habitat in the Kelsey Creek watershed is considered a central objective of critical areas management by the City. Spawning habitat is limited in this system (Paulsen 2007), meaning that salmonid productivity in the system is constrained by the amount of available habitat suitable for spawning. Preserving existing spawning habitat and increasing its function will directly benefit species of local interest. The Phase 1 project has improved the riparian and Sunset Creek instream condition in the area surrounding the culvert replacement at SE 30th Street however, more improvements downstream are needed. In fact, the sediment trap constructed as part of Phase 1 will not function as designed until the Phase 2 project has been constructed. In the current condition, the sediment trap is backwatered by the aggraded sediment in the Phase 2 Sunset Creek Reach and as such, is being filled by a higher percentage of fine-grained sediment than designed. Construction of the Phase 2 channel enlargement and increased conveyance capacity will encourage suspended sediment to remain in suspension per the Flood Control and Sediment Management Plan (Herrera 2008).

Existing riparian conditions in the Sunset Creek portion of the project area is degraded. The surrounding area was developed for commercial and light industrial uses during the 1960s and 1970s, prior to the establishment of critical areas protections. To accommodate this development, much of the existing channel network was relocated, straightened, and contained within riprap armored channels. Property development was allowed to encroach upon the streams, limiting the effective riparian buffer to less than 20 feet on either side of the stream in most of the project area. The remaining riparian buffer is composed of a mix of ornamental, invasive, and native vegetation.

Habitat in the stream and riparian area from the confluence of Richards Creek and Sunset Creek to approximately 25 feet downstream of the Optiva curve is high quality and higher functioning than in the rest of the project area. The riparian vegetation (although narrow) is primarily native and overhanging, and is a mix of large mature willow trees with an understory of native shrubs. The instream habitat contains spawning gravel that is relatively free of sediment. Also, the channel contains several pieces of woody debris that has formed a few pools and cover for fish and other aquatic organisms. Due to the relatively high quality riparian and fish habitat, this reach will be preserved and have no project impacts.

The riparian area of the Richards Creek portion of the project is similar to that described for Sunset Creek. While there are more large trees in the reach of the stream, invasive species such as Japanese knotweed, reed canarygrass, and Himalayan blackberry comprise more than 25 percent of the vegetation.

The habitat value of the stream and the riparian area is low to moderate due to the close proximity of adjacent development, the large percentage of non-native vegetation, and the eroding stream channel and banks. These areas provide limited cover for small mammals and amphibians, and nesting, cover and food sources for urban birds. The stream in the project area also provides limited food sources for aquatic species including macroinvertebrates, leaf litter, and other organic inputs. The Sunset/Richards and East Creek stream system supports a variety of native fish species, including anadromous salmonids (coho, Chinook, and possibly steelhead trout). However, as discussed earlier fish passage has been blocked downstream of the project area by a waterfall formed due to downcutting of the stream channel. The instream and riparian functions are not properly functioning and would be improved due to the proposed project.

3.3.4.2 Projected Future Conditions: Proposed Action Permitted

If the project is approved, there will be temporary disturbances to the streambeds, wetlands, and their buffers due to grading in and along Sunset and Richards Creeks. These temporary impacts will be restored as part of the project. The primary vegetation that will be removed includes willow trees, cottonwoods, native shrubs, and non-native invasive shrubs. Where possible, vegetation will be salvaged and retained on site for replanting following project construction. Also, where feasible large trees (8 inch dbh or greater) will be retained (see Sheet C-2).

A small amount of wetland will be permanently impacted and converted to upland riparian habitat or streambed. As mitigation for these impacts, wetland benches will be constructed along the channel that will frequently be wetted by the overflow from the stream. This will achieve a more frequent connection of the stream to its floodplain wetlands and also provide higher levels of flood control and water quality functions than in the existing condition. Riparian areas (buffers) to the landward side of the wetlands will be reconstructed and revegetated. The removal of non-native vegetation and replacement with native vegetation will have a positive benefit of providing more diverse habitat for native birds and other animals. Planted vegetation in both wetland and riparian areas will provide bank stability, shading of the stream, and food sources for fish and other aquatic organisms. The restored riparian areas (wetland buffer) will provide the same improved habitat and water quality functions as the wetlands. The combined restoration of wetlands and riparian areas will result in an improvement of wetland functions within the project area.

If the project is approved there will be temporary modifications to the instream habitat of Sunset and Richards Creeks. The channels will be restored and improved through installation of log grade structures and logs with rootwads. The log structures and logs with rootwads are designed to enhance stream functions in Sunset and Richards Creeks by stabilizing the channel, reducing the risk of downcutting and erosion, and creating habitat diversity and cover for fish and other aquatic organisms.

3.3.4.3 Projected Future Conditions: Proposed Action Denied

If the project is denied, there will be no temporary or permanent impacts to the Sunset and Richards Creeks or the adjacent wetlands and buffers. Sunset and Richards Creeks will remain at risk of major channel downcutting, increased numbers of non-native invasive plants, and flooding of adjacent properties at higher levels and with more frequency.

3.3.4.4 Applicable Performance Standards

Public flood protection measures, instream structures, habitat improvement projects and stabilization measures are allowed in wetland or wetland critical area buffers if specified performance standards are incorporated in design of the development per LUC 20.25H.100. The following performance standard is applicable to this project:

- The outer edge of the wetland critical area buffer shall be planted with dense vegetation to limit pet or human use

Also these projects are allowed in Type S or F streams and stream buffers if the following applicable performance standards are met (LUC 20.25H.080):

- The outer edge of the stream critical area buffer shall be planted with dense vegetation to limit pet or human use

The performance standards listed above that apply to this project are the same for both wetlands and streams. After construction is complete, native plants will be densely planted within the combined wetland/stream buffer. Shrubs will be planted at 3 feet on center, so that dense vegetative cover will be established.

Pursuant to Bellevue LUC 20.25H.055.C3.d: "Instream structures may be permitted only in accordance with a design prepared by a qualified professional and where the applicant demonstrates measurable benefits, such as decreased erosion, peak flow reduction, improved water quality, stream stabilization or improved habitat from the proposal. The applicant shall obtain any required state or federal permits prior to undertaking development". As discussed above under the Projected Future Conditions: Proposed Action Permitted section, the proposed project will decrease erosion through soft armoring and densely planting the banks, provide more flood capacity in the stream channel, improve water quality over time, and improve habitat through creating diverse fish habitat and removing non-native invasive species.

Also stabilization measures will use "soft stabilization" techniques as described above and therefore will meet the performance standards for stabilization measures set forth in LUC 20.25H.055.C3.m.

Habitat improvement projects are allowed within wetland, streams, and their buffers if they are public-sponsored projects and demonstrate improved functions and values in these areas. The following sections provide a discussion of the functional improvement that would result from the project.

3.3.5 Impact Avoidance, Minimization, and Mitigation Measures

The project impacts were evaluated during the design process to first avoid and then minimize impacts to Sunset and Richards Creeks, the wetlands, and their buffers. Impacts to the wetlands, streambed, and riparian areas were avoided by preserving the area of the project that contained the highest quality and highest functioning habitat within the project area to remain undisturbed. Alternative "soft-site" restoration design techniques were incorporated into the project design to minimize impacts and to improve functions. These include:

- Adding woody debris to the channel
- Using wood in grade control structures
- Coir matting and aggressive wetland and riparian planting efforts
- Establishment of a wetland bench area that connects the stream to the floodplain
- Aggressively removing non-native vegetation and revegetating with native vegetation in all disturbed areas

3.3.6 Wetland and Stream Mitigation for Temporary and Permanent Impacts

This section describes conceptual mitigation for both temporary impacts to streams and buffer and for temporary and permanent impacts to wetlands and buffers. A detailed wetland mitigation plan will be provided under separate cover. According to LUC20.25H.105 permanent impacts to wetlands may be mitigated through wetland enhancement of existing degraded wetlands if it will increase the functions of the degraded wetland. The following section discusses both the acreage of wetland enhancement and the functional lift that will occur due to the mitigation actions.

Temporary impacts to wetlands and their buffers will be provided through invasive species removal and replanting.

Compensatory mitigation for permanent impacts to wetlands will be provided by enhancing wetlands within the project area. Approximately 0.08 acre of wetland will be enhanced through non-native plant removal and replanting with native vegetation (Table 8). Compensation will occur at a ratio of 2.25 acres of enhancement to 1 acre of wetland impact.

Table 8. Impacts to wetlands and mitigation within the project area.

Resource	Permanent Impacts	Mitigation	Mitigation Ratio Enhanced Wetland: Wetland Impact
Wetland A	1,567 square feet (0.036 acre)	3,522 square feet (0.08 acre)	2.25:1

Additionally, the project and enhancement of the mitigation wetland will maintain or improve all the functions of the wetland and improve stream habitat as well. Flood control, instream structures, bank stabilization, and habitat improvement projects are allowed uses in wetlands, streams, and their buffers, if they provide improved functions and values. One of the goals of the project and of the wetland and stream mitigation is to provide an improvement to functions and values of the wetland and streams and their buffers. Table 9 shows that in the current condition the wetland provides moderate water quality, moderate hydrologic, and moderate habitat functions. The water quality functions of the wetland will stay the same. The hydrologic functions will be improved because the wetland will be engaged by the stream channel more frequently and because the wetland will be able to store more water for longer periods. Once the vegetation has had a chance to become established and maintenance is completed to eradicate the non-native invasive species, the habitat value will also improve. Conifers that do not exist in the riparian and wetland areas at this time will be planted and will improve species richness and diversity. The wetland benches will also occasionally provide resting habitat and habitat diversity for fish during high flow periods.

Table 9. Wetland function and values scores comparison between existing and proposed wetlands.

Wetland Rating Before and After Project	Water Quality Functions – Qualitative Rating [a] (numerical score in parentheses)		Hydrologic Functions – Qualitative Rating [a] (numerical score in parentheses)		Habitat Functions – Qualitative Rating [a] (numerical score in parentheses)	
	Potential	Opportunity	Potential	Opportunity	Potential	Opportunity
Rating before	Moderate	Yes	Moderate	Yes	Moderate	Moderate
Rating after	Moderate	Yes	High	Yes	High	Moderate
Rating change	No Change	No Change	Moderate to High	No Change	Moderate to High	No Change

[a] Qualitative ratings are based on the Department of Ecology "Using the Wetland Rating System in Compensatory Mitigation" focus sheet (Ecology 2008a).

[b] Wetland category is based on the Department of Ecology rating system (Hruby 2004).

3.4 Special Flood Hazard Area Assessment

The contents of this subsection satisfies requirements specified under CAR reporting requirements provided in LUC 20.25H.250.B 4 through 8.

3.4.1 Introduction

Flood hazard areas are those subject to 100-year floods (identified on FEMA Flood Insurance Rate Maps). These areas are designated to protect development from flooding and to protect the inherent functions of floodplains. Undeveloped floodplains store water and slow the downstream delivery of flood flows, reducing the impacts of a flood and recharging wetlands, streams and underground aquifers. Floodplain development reduces the floodplain’s water storage capacity and puts valued property and infrastructure in the path of floodwaters. Runoff from impervious surfaces changes flood size and frequency and can degrade water quality.

The project area falls within a special flood hazard area because it lies within the 100-year floodplain (City of Bellevue 2010) (Figure 7). The City of Bellevue Code (LUC 20.25H.180) restricts development in the flood hazard areas. Since this project does not propose development in the project, most of the code does not apply. The provision in the code that will be affected beneficially by the project is that no rise in the Base Flood Elevation (BFE) must occur as a result of the project. This project will create more flow capacity and flood storage and therefore will result in a decrease in the BFE, thus meeting the requirements of the code.

3.4.2 Probable Cumulative Impacts

The project will have beneficial effects to flood hazard areas. The project will result in greater channel conveyance storage than in the current condition as well as improve poor fish habitat and riparian habitat. The project will also prevent further downcutting of the stream bed, further preventing flashy hydroperiods and flooding.

3.4.2.1 Existing Functions and Values Provided by Affected Critical Area

Flood hazard areas are those subject to 100-year floods (identified on FEMA Flood Insurance Rate Maps). These areas are designated to protect development from flooding and to protect the inherent functions of floodplains. Undeveloped floodplains store water and slow the downstream delivery of flood flows, reducing the impacts of a flood and recharging wetlands, streams and underground aquifers. Floodplain development reduces the floodplain’s water storage capacity and puts valued property and infrastructure in the path of floodwaters. Runoff from impervious surfaces changes flood size and frequency and can degrade water quality.

3.4.2.2 Projected Future Conditions: Proposed Action Permitted

Flooding of adjacent properties will be prevented and BFE will be lowered. Instream improvements will prevent the channel from further downcutting and therefore create a stable stream system that does not flash flood and then dry out. The project is designed to reduce the frequency and level of flooding of adjacent properties. Log grade structures will be placed within the streambed in order to prevent further incision of the stream.

3.4.2.3 Projected Future Conditions: Proposed Action Denied

Flooding of adjacent properties will continue to occur. The stream will continue to down cut from the downstream extent of the project area and continue upstream, causing more flooding and flashy hydroperiods. The flood storage capacity of the stream may be reduced as the channel incises and becomes narrower.

3.4.3 Regulatory Implications

3.4.3.1 Applicable Performance Standards

Public flood protection measures, instream structures, habitat improvement projects and stabilization measures are allowed in special flood hazard areas because they will meet the performance standards described in LUC 20.25H.180.C. The applicable performance standards include: obtaining an elevation certificate following construction to indicate that the BFE has not been exceeded and the project will not result in a rise in BFE.

Another performance measure related to flood control projects in flood hazard areas is provided in LUC 20.25H.180.D.5. This code provision states that public flood protection projects may increase BFE as long as the project would also produce measurable benefits, such as decreased sedimentation, peak flow reduction, improved water quality, improved aquatic and riparian habitat. The project will actually lower the BFE, but all of these benefits would also result from the project.

3.4.3.2 Restoration and Mitigation Requirements

One of the main objectives of the proposed project is to prevent flooding in this flood hazard area. The elements of the project as described in this report are flood mitigation measures that will be implemented to improve conveyance capacity and to prevent flooding of adjacent properties.

3.5 Habitat Assessment

The contents of this subsection satisfies habitat assessment report requirements specified under LUC 20.25H.165.A and CAR reporting requirements provided in LUC 20.25H.250.B 4 through 8.

3.5.1 Introduction

Species of local importance are specifically recognized local populations of native species that are at risk of being lost from Bellevue—western pond turtle, Oregon spotted frog, western toad,

Figure 7.
Floodplain for the Sunset Creek/ Richards Creek Flood Control and Habitat Management Project.

Legend

- Approximate project area
- Stream alignment
- Approximate historical stream alignment
- Floodplain

N

0 100 200 400 Feet

HERRERA ENVIRONMENTAL CONSULTANTS

Aerial photograph: City of Bellevue, 2007
Floodplain: King County, 2010
Stream network: King County, 2008

Produced By: GIS
Project: K:\Projects\09-04582-000\Project\Floodplain_Map.mxd

Chinook salmon, bull trout, coho salmon, river lamprey, bald eagle, peregrine falcon, common loon, pileated woodpecker, Vaux's swift, merlin, western grebe, great blue heron, osprey, green heron, red-tailed hawk, western big-eared bat, Keen's myotis (bat), long-legged myotis (bat), and long-eared myotis (bat)—and whose presence can be an indicator of environmental health. Only Chinook salmon, coho salmon, green heron, pileated woodpecker, and red-tailed hawk may use the project area or the area downstream of the project.

To evaluate habitat conditions in the project area and vicinity, biologists surveyed the area to identify dominant species, forest maturity, concentrations of native an invasive plant populations, other habitat features (e.g., snags, logs), habitat potential to support protected wildlife species and indications of use by these species. In addition, Herrera reviewed information provided by WDFW's Priority Habitats and Species (PHS) Program (WDFW 2010a), fish usage information from the Salmonscape mapping program (WDFW 2010b), and fish survey data collected in 2008 (Watershed Company 2001).

There are no PHS areas or documented occurrences of protected species in the project vicinity (WDFW 2010a), except for coho and Chinook salmon, and pileated woodpeckers.

3.5.2 Vegetation On and Adjacent to the Site

The project area is located in a stream channel that flows between buildings and parking lots, but still has some habitat diversity and mature trees. Dominant tree species include Pacific willow, sitka willow, red alder, and black cottonwood. The most common understory shrub species includes willows and red-osier dogwood, and Himalayan blackberry. The dominant herbaceous species is reed canarygrass. As stated earlier, invasive non-native plants such as English ivy and Japanese knotweed are also found in patches within the project area. The forested wetland and riparian areas extend off-site to the east and north, where East Creek is located. The Phase 1 planted areas on Sunset Creek are located south of the site.

3.5.3 Species of Local Importance with Primary Habitat Association

Chinook salmon use of the impact area is described in detail in the Biological Assessment (BA). Puget Sound Chinook Salmon are known to have historically used this system. Before hydrological modification and subsequent changes in downstream habitat conditions, known or likely distribution in Sunset Creek extended up to (and perhaps beyond) SE 30th Street.

Coho spawning and rearing has been documented in the Richards and Sunset Creek channels up to and immediately upstream of SE 30th Street (Paulsen 2007; WDFW 2007a, 2007b). Neither species has been documented in the impact area in recent years, as a result of two factors: depressed population abundance; and partial barriers to fish passage created by beaver activity in downstream areas of Richards Creek (Paulsen 2007).

While not currently considered a species of local importance, steelhead trout are listed as threatened under the ESA (72 FR 26722-26735) and are of special concern from a state and federal permitting perspective. This species has been historically documented in the Kelsey Creek system and could potentially occur in the impact area. Before hydrological modification and subsequent changes in downstream habitat conditions, steelhead had a known or likely distribution in Sunset Creek extended up to (and perhaps beyond) SE 30th Street.

There is no habitat for bald eagles, peregrine falcons, merlins, osprey, or red-tailed hawks due to the closed canopy and dense vegetation that would preclude access. However, some habitat for red-tailed hawk may exist on the periphery of the project area or in the wetlands surrounding East Creek to the east of the project area.

There is no habitat for common loons, purple martins, or western grebes which requires lake-shore habitat.

There is possible nesting habitat for Vaux's swifts in hollows of snags at the site, however, there are only two snags within the project area, so it is unlikely this species would use the site.

Since the buildings and parking lots are so close, there is poor habitat for great blue and green herons. They can hunt along riparian corridors, however they are more likely to be found in the wetlands to the east or the north where the water ponds and is more quiescent. There is no breeding or congregation habitat for these species within the project area.

There is poor habitat for the protected bat species (western big-eared bat, Keen's Myotis, long-legged Myotis, and Long-eared Myotis) since there are only two snags in which they could potentially roost. These bats roost in cavities in large trees and sangs which are present and forage over a variety of habitats for prey (insects). These bats prefer roosting in conifers, which are not present in the project area.

There is poor habitat for Oregon spotted frogs, western pond turtles, and western toads in the project area, and they are not likely to be in the project area. Better habitat with pools and more quiescent waters is present immediately downstream near East Creek, so these amphibians may be near the east end of the project.

Habitat for pileated woodpeckers for foraging is present but limited, due to only two snags. The snags at the Optiva Curve will be retained and will continue to provide potential foraging for the woodpecker. They also forage on standing live trees. Habitat is limited since they often forage on conifers and they do not exist in the project area. Pileated woodpecker workings were observed in the snags in the project area.

3.5.4 Federal, State, or Local Management Recommendations

The project will improve the stream, wetland, and their buffers. These improvements would meet the recommendations provided by WDFW for priority habitats and species. Any conditions that are specified by federal and state agencies for this project will be followed.

3.5.5 Direct and Indirect Impacts

Direct and temporary impacts to habitat would occur due to the project. Approximately 0.26 acre of forested wetlands and 0.19 acre of forested stream and wetland buffer will be temporarily cleared and graded, and then reconstructed due to this project. If any of the sensitive species are in the project area at the time of construction they would move away from during active work periods, but are expected to return once work is completed and vegetation has been established. Twenty one (21) mature trees that are greater than 8 inches dbh will be retained, where possible. The wetlands and buffer areas will be restored as discussed above and shown on Sheets P-1 through P-4 in Appendix A. Non-native vegetation will be removed. Since most species of local importance, except pileated woodpeckers are not likely to occur in the project area due to lack of habitat, they will not be affected by the project. Work will occur in the summer, after pileated woodpecker breeding is complete. The addition of large woody debris in the stream as part of the project will enhance pileated woodpecker foraging habitat, as downed logs are a common feeding location for this species.

Also, approximately 0.089 acre of stream habitat will be graded, reconstructed, and improved. During construction the channel will be dewatered and all flow bypassed to the outlet culvert. Fish that may be in the project areas will be relocated following WDFW (2009) protocols. After construction, water quality will be monitored and turbid water will be discharged to the sewer. Only after turbidity has been reduced to meet water quality standards will the flow be directed to downstream receiving waters. Therefore no effect on downstream water quality is anticipated to occur.

3.5.6 Probable Cumulative Impacts

There are no cumulative impacts anticipated as a result of the proposed project, since the project area will be fully restored to an improved condition.

3.5.6.1 Projected Future Conditions: Proposed Action Permitted

While there will be a temporal loss of forested habitat that may affect the pileated woodpecker, the future condition of the project area will provide improved forest habitat. Non-native invasive species will be removed and native species diversity and structural diversity will be increased. The addition of large wood to the stream channel will enhance in-stream habitat and create habitat diversity and cover for fish. Also, restored riparian and wetland habitat will provide shade for the stream, potential food sources (aquatic insects and other fauna) for fish and other aquatic species.

3.5.6.2 Projected Future Conditions: Proposed Action Denied

If the project is denied, the channel will continue to be at risk of down cutting, which will degrade habitat functions in the project area, as well as downstream. In addition, there will continue to be no wood in the channel, limiting the habitat potential for this area. Also, non-native invasive species in wetland and riparian areas would be expected to increase.

3.5.7 Impact Avoidance, Minimization, and Mitigation Measures

The project impacts were evaluated during the design process to reduce impacts to Sunset and Richards Creeks, the wetlands, and their buffers. The same mitigation measures described for wetlands and streams would apply for wildlife habitat areas.

3.6 Conclusions

The proposed Sunset and Richards Creek flood control and habitat improvement project will improve flood control, stabilize the stream’s channel and banks, and provide long-term habitat protection within the project area and downstream. In addition, the placement of large wood in the stream will enhance habitat conditions in the stream. Also, downcutting of the stream will be prevented by installation of log grade control structures. The instream improvements will also improve and restore fish passability. The reconstruction and restoration of wetland and riparian areas will provide improved flood control and wildlife habitat functions.

Although there will be temporary effects to wetlands, riparian areas, and the stream, these areas will be restored to an improved condition compared to their current condition. Permanent impact to wetlands will be compensated for through enhancement of wetlands that have been degraded by non-native invasive plant species and adjacent development.

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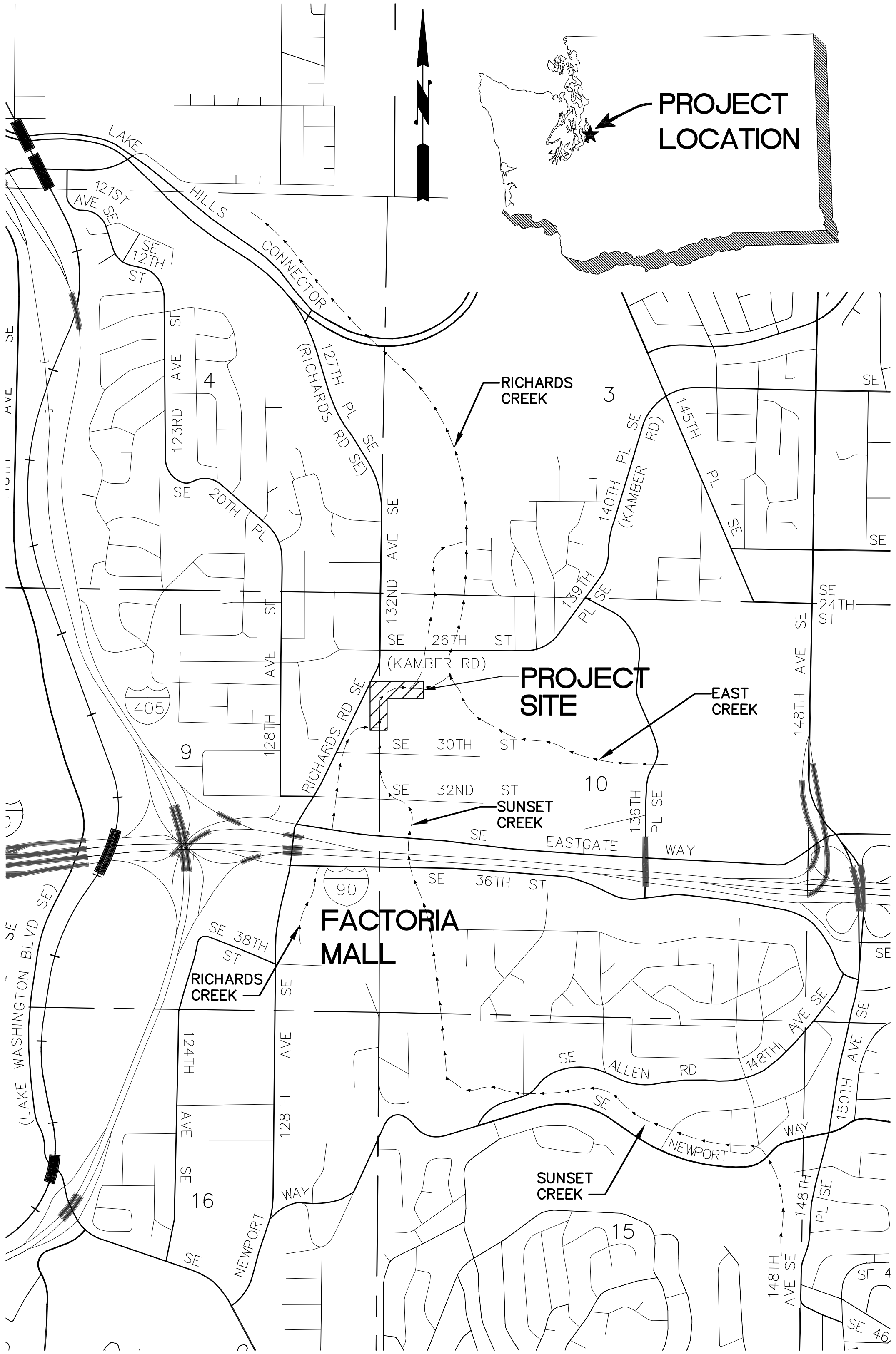
APPENDIX A

Project Engineering Plans

CITY OF BELLEVUE
SUNSET CREEK PHASE II/RICHARDS CREEK
FLOOD CONTROL AND HABITAT IMPROVEMENT PROJECT

BELLEVUE, WASHINGTON



VICINITY MAP
SCALE: 1"=1000'

SHEET INDEX		
SHEET NO.	DRAWING NO.	SHEET DESCRIPTION
1	G-1	TITLE SHEET, INDEX, AND VICINITY MAP
2	G-2	GENERAL NOTES
3	G-3	ABBREVIATIONS AND LEGEND
4	C-1	SITE PLAN AND KEY MAP
5	C-2	SITE PREPARATION PLAN
6	C-3	UPSTREAM SUNSET CREEK PLAN AND PROFILE
7	C-4	DOWNSTREAM SUNSET CREEK PLAN AND PROFILE
8	C-5	UPSTREAM RICHARDS CREEK PLAN AND PROFILE
9	C-6	DOWNSTREAM RICHARDS CREEK PLAN AND PROFILE
10	C-7	SECTIONS
11	C-8	REVETMENT STRUCTURE DETAILS
12	C-9	DETAILS
13	ESC-1	TEMPORARY EROSION AND SEDIMENT CONTROL PLAN
14	ESC-2	TESC DETAILS
15	WM-1	FLOW DIVERSION AND FISH EXCLUSION DETAILS
16	P-1	PLANTING PLAN – SUNSET CREEK
17	P-2	PLANTING PLAN – RICHARDS CREEK
18	P-3	PLANT MATERIAL LIST
19	P-4	PLANTING DETAILS

1 / C-3 — DETAIL REFERENCE NUMBER; DRAWING ON WHICH DETAIL IS SHOWN

DETAIL
SCALE: NTS

1 / C-1 — DETAIL REFERENCE NUMBER; DRAWING FROM WHICH DETAIL WAS TAKEN

A / C-4 — SECTION REFERENCE LETTER; DRAWING ON WHICH SECTION IS SHOWN

SECTION
SCALE: NTS

A / C-2 — SECTION REFERENCE LETTER; DRAWING FROM WHICH SECTION WAS TAKEN

"–" INDICATES THAT THE DETAIL/SECTION IS SHOWN ON THE SAME SHEET

"TYP" INDICATES THAT THE DETAIL/SECTION IS UNIFORMLY TYPICAL THROUGHOUT PROJECT EXCEPT WHERE OTHERWISE NOTED

"VAR" SPECIFIES THAT DETAIL/SECTION WAS TAKEN FROM SEVERAL DRAWINGS

NOTE AND DETAIL/SECTION REFERENCING

DATUM
NAVD 88/NAD 83

811 Know what's below. Call before you dig.

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

PERMIT SET - NOT FOR CONSTRUCTION

Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\G-1.dwg
Plot Date: 7/13/2010 5:47 PM   Cad User: Laura Turnidge

NO	DATE	BY	APPR	REVISIONS

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SUNSET CREEK/RICHARDS CREEK FLOOD CONTROL AND HABITAT IMPROVEMENT PROJECT

Approved By

DESIGN MANAGER — DATE
PROJECT MANAGER — DATE

C. AVOLIO/M. STRAZER 07/2010
DESIGNED BY — DATE
T. PRESCOTT 07/2010
DRAWN BY — DATE
M. EWBANK 07/2010
CHECKED BY — DATE

City of Bellevue UTILITIES

TITLE SHEET, INDEX, AND VICINITY MAP

DRAWING G-1   SHT 1 OF 19

GENERAL NOTES:

1. MATERIAL SHALL NOT BE STORED OUTSIDE OF IDENTIFIED STAGING AREAS, UNLESS APPROVED BY OWNER OR ENGINEER.
2. ALL EQUIPMENT SHALL USE ONLY BIODEGRADABLE HYDRAULIC FLUIDS.
3. CONTRACTOR SHALL LIMIT MACHINERY MOVEMENT TO PROJECT LIMITS DEFINED ON SITE PLAN OR IDENTIFIED AS ACCEPTABLE BY ENGINEER.
4. CLEARING LIMITS FOR TEMPORARY ACCESS ROAD AND PROPOSED STRUCTURES SHALL BE LIMITED TO THE AREA REQUIRED FOR SAFE EQUIPMENT OPERATION. CLEARING LIMITS SHALL BE STAKED BY CONTRACTOR AND APPROVED BY ENGINEER AT LEAST 3 DAYS PRIOR TO CLEARING ACTIVITIES. CLEARING LIMITS SHALL BE STAKED TO MINIMIZE THE AREA OF DISTURBANCE.
5. CONTRACTOR SHALL PROVIDE 24 HOURS ADVANCE NOTICE TO THE ENGINEER PRIOR TO ANY REQUIRED INSPECTION.
6. CONTRACTOR SHALL SUBMIT A CONSTRUCTION SEQUENCE PLAN FOR APPROVAL AT LEAST 5 DAYS PRIOR TO SITE WORK.
7. APPROVED CONSTRUCTION SEQUENCE PLAN SHALL NOT BE ALTERED UNLESS APPROVED BY ENGINEER.
8. EQUIPMENT USED FOR THIS PROJECT SHALL BE FREE OF EXTERNAL PETROLEUM-BASED PRODUCTS WHILE WORKING AROUND THE STREAM. ACCUMULATION OF SOILS OR DEBRIS SHALL BE REMOVED FROM THE DRIVE MECHANISMS (WHEELS, TRACKS, TIRES, ETC.) AND UNDERCARRIAGE OF EQUIPMENT PRIOR TO ITS WORKING WITHIN THE CHANNEL.
9. EQUIPMENT SHALL BE CHECKED DAILY FOR LEAKS, AND ANY NECESSARY REPAIRS SHALL BE COMPLETED PRIOR TO COMMENCING WORK ACTIVITIES.
10. THE CONTRACTOR IS RESPONSIBLE TO ENSURE THAT NO PETROLEUM PRODUCTS, HYDRAULIC FLUID, SEDIMENTS, SEDIMENT-LADEN WATER, CHEMICALS, OR ANY OTHER TOXIC OR DELETERIOUS MATERIALS ARE ALLOWED TO ENTER OR LEACH INTO THE STREAM.
11. IF AT ANY TIME, AS A RESULT OF PROJECT ACTIVITIES, FISH ARE OBSERVED IN DISTRESS, A FISH KILL OCCURS, OR WATER QUALITY PROBLEMS DEVELOP (INCLUDING EQUIPMENT LEAKS OR SPILLS), OPERATIONS SHALL CEASE AND THE ENGINEER SHALL BE NOTIFIED IMMEDIATELY. WASHINGTON DEPARTMENT OF FISH AND WILDLIFE AND WASHINGTON DEPARTMENT OF ECOLOGY SHALL BE CONTACTED IMMEDIATELY BY THE ENGINEER OR BY HIS/HER DESIGNEE. WORK SHALL NOT RESUME UNTIL FURTHER APPROVAL BY OWNER'S REPRESENTATIVE.
12. EROSION CONTROL METHODS SHALL BE USED TO PREVENT SILT-LADEN WATER FROM ENTERING THE CREEK. INITIAL EROSION CONTROL MEASURES ARE SHOWN ON DRAWINGS ESC-1 AND ESC-2. THE CONTRACTOR SHALL SUBMIT A TEMPORARY EROSION AND SEDIMENT CONTROL PLAN SHOWING ADDITIONAL SITE SPECIFIC EROSION AND SEDIMENT CONTROL TECHNIQUES AND METHODS.
13. IF HIGH FLOW CONDITIONS THAT MAY CAUSE SILTATION OR EROSION OCCUR DURING CONSTRUCTION, WORK SHALL STOP UNTIL THE FLOW SUBSIDES.
14. CONTRACTOR IS RESPONSIBLE FOR CALLING "ONE CALL" FOR UTILITY LOCATES 72 HOURS PRIOR TO CONSTRUCTION. 1 (800) 424-5555 OR 811.
15. THE EXISTING FEATURES AS SHOWN ON THE EXISTING CONDITIONS PLAN WERE PROVIDED BY THE CITY OF BELLEVUE AND FROM SUPPLEMENTAL FIELD WORK PERFORMED BY APS.
16. ALL DIMENSIONS SHOWN SHALL BE FIELD VERIFIED FOR FIT-UP.
17. LOCAL PROJECT BENCHMARK LOCATIONS:
    - CHISELED "X" ON WEST FLANGE BOLT OF FIRE HYDRANT LOCATED ON NORTH SIDE OF SE 30TH ST., APPROX. 370' EAST OF MAIN STREAM CHANNEL. ELEV.=73.66'
    - CITY OF BELLEVUE CHANNEL MONITORING PK #520400 LOCATED IN PARKING LOT APPROX. 60' NORTH OF STEAD BUILDING AND APPROX. 18' EAST OF CURB. ELEV.=64.91', N: 216125.72, E: 1311976.03
    - CITY OF BELLEVUE CHANNEL MONITORING PK #5538 LOCATED ON ASPHALT APPROX. 44' WEST AND 10' SOUTH OF SE CORNER OF OPTIVA BUILDING. ELEV.=62.83, N: 216504.21, E: 1312174.30

LOG NOTES:

1. DECKED LOGS SHALL BE ACCESSIBLE FOR INSPECTION.
2. LOG TYPE IDENTIFICATION SHALL BE PAINTED ON ALL LOGS IN A PLACE VISIBLE FOR INSPECTION PRIOR TO PLACEMENT WITH LEAD-FREE, BLAZE-ORANGE SURVEY MARKING PAINT.
3. SEE SPECIFICATIONS FOR LOG TYPE (SPECIES), DIAMETER AND LENGTH. EXCAVATIONS SHALL BE INSPECTED BY ENGINEER PRIOR TO PLACEMENT OF ANY WOOD.
4. LOG PLACEMENTS SHALL BE INSPECTED BY ENGINEER PRIOR TO BACKFILLING.

UTILITIES AND AGENCIES

CITY OF BELLEVUE

ABE SANTOS – PROJECT MANAGER

450 110TH AVENUE NE
BELLEVUE, WA 98004
(425) 452-6456

EMAIL: ASANTOS@BELLEVUEWA.GOV

KING COUNTY DEPARTMENT OF NATURAL RESOURCES, WASTEWATER TREATMENT DIVISION

ERIC DAVISON

201 S. JACKSON ST, MAIL STOP
KSC-NR-0508
SEATTLE, WA 98104-3855

(206) 684-1707
FAX: (206) 684-1710
ERIC.DAVISON@KINGCOUNTY.GOV

BELLEVUE WATER DISTRICT #1

KIPP FOCKLER – OPERATING & WATER MAINTENANCE
(425) 452-2923

GREG KNIGHT
(425) 452-4493

BELLEVUE FIRE DEPARTMENT

NON-EMERGENCY GENERAL
(425) 452-6892

FIRE PREVENTION PLAN REVIEW DESK
(425) 452-4122

BELLEVUE POLICE DEPARTMENT

(425) 452-6917

CITY OF BELLEVUE – TRANSPORTATION DEPARTMENT

JON REGALIA

450 110TH AVENUE NE
BELLEVUE, WA 98004
(425) 452-4599

EMAIL: JREGALIA@BELLEVUEWA.GOV

CITY OF BELLEVUE – PERMIT CENTER

TRAVIS RIPLEY
(425) 452-6042

PUGET SOUND ENERGY (PSE CONSTRUCTION)

JEANNE COLEMAN – MUNICIPAL CONSTRUCTION PLANNER

P.O. BOX 97034
MAIL STOP: EST-11W
BELLEVUE, WA 98009-9734

(425) 462-3488
EMAIL: JEANNE.COLEMAN@PSE.COM

COMCAST (FORMERLY AT&T BROADBAND)

JILL LOOK

1525 75TH ST. SW, SUITE 200
EVERETT, WA 98203

(425) 263-5346
FAX: (425) 263-5352
MOBILE: (206) 396-6032
EMAIL: JILL_LOOK@CABLE.COMCAST.COM

QWEST (US WEST COMMUNICATIONS)

VERN SAXTON

1550 NEWPORT WAY NW, ROOM #2
ISSAQUAH, WA 98027

(206) 345-1177
EMAIL: VERN.SAXTON@QWEST.COM

ONE CALL

UTILITY LOCATION
(800) 424-5555 OR 811

DATUM

NAVD 88/NAD 83

Know what's below. Call before you dig.

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

PERMIT SET - NOT FOR CONSTRUCTION

NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
Suite 1100
Seattle, Washington
98121-1820
206-441-9080
206-441-9108 FAX
http://www.herrerainc.com

SUNSET CREEK/RICHARDS CREEK FLOOD CONTROL AND HABITAT IMPROVEMENT PROJECT

Approved By
DESIGN MANAGER DATE
PROJECT MANAGER DATE

C. AVOLIO/M. STRAZER 07/2010
DESIGNED BY DATE
T. PRESCOTT 07/2010
DRAWN BY DATE
M. EWBANK 07/2010
CHECKED BY DATE

City of Bellevue
UTILITIES

GENERAL NOTES

DRAWING G-2 SHT 2 OF 19

Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\G-2.dwg Cad User: Laura Turnidge
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ABBREVIATIONS:

AC	ASPHALT CONCRETE
APPROX	APPROXIMATE(LY)
CB	CATCH BASIN
CDF	CONTROLLED DENSITY FILL
CIP	CAST IN PLACE
COB	CITY OF BELLEVUE
CONC	CONCRETE
CMP	CORRUGATED METAL PIPE
DBH	DIAMETER AT BREAST HEIGHT
DI	DUCTILE IRON
DIA, ø	DIAMETER
DWG	DRAWING
ESC	EROSION AND SEDIMENT CONTROL
EX	EXISTING
FAC	FACULTATIVE
FACU	FACULTATIVE UPLAND
FACW	FACULTATIVE WETLAND
FDC	FIRE DEPARTMENT CONNECTION
FH	FIRE HYDRANT
FT	FEET
HMA	HOT MIX ASPHALT
IN	INCHES
KC	KING COUNTY
LWD	LARGE WOODY DEBRIS
MH	MANHOLE
MIN	MINIMUM
NI	NO INDICATOR
OHP	OVERHEAD POWER LINE
OHWL	ORDINARY HIGH WATER LINE
PC	PRECAST CONCRETE
PSE	PUGET SOUND ENERGY
SDMH	STORM DRAIN MANHOLE
SP	STANDARD PLAN
SS	STAINLESS STEEL
TEL	TELEPHONE
TESC	TEMPORARY EROSION AND SEDIMENT CONTROL
TYP	TYPICAL
UGP	UNDERGROUND POWER LINE
UGT	UNDERGROUND TELEPHONE LINE
UPL	OBLIGATE UPLAND

LEGEND:

EXISTING BUILDING
EXISTING CURB
EXISTING CONTOURS (72)
EXISTING R.O.W.
EXISTING BANK SLOPE
EXISTING OVERHEAD POWER LINE (OHP)
EXISTING UNDERGROUND POWER LINE (UGP)
EXISTING WATER LINE (W)
EXISTING GAS LINE (G)
EXISTING STORM DRAINAGE (SD)
EXISTING SANITARY SEWER (S)
EXISTING SANITARY SEWER MANHOLE
EXISTING CATCH BASIN
EXISTING STORM DRAIN MANHOLE
EXISTING TELEPHONE J–BOX
EXISTING POWER VAULT
EXISTING GAS METER
EXISTING FIRE DEPT CONNECTION
EXISTING POWER POLE
EXISTING POWER TRANSFORMER
EXISTING TREES
EXISTING BOULDERS
EXISTING WETLANDS

CREEK FLOW LINE
HIGH VISIBILITY FENCE
SILT FENCE
EXCAVATION LIMITS
COIR WRAP
EXISTING GRADE
EXISTING ORDINARY HIGH WATER LINE
DIVERTED FLOW LINE
PROPOSED AVERAGE GRADE
SELECTIVE CLEARING AREA
CLEAR AND GRUB AREA
STREAMBED SEDIMENT
STREAMBED COBBLE
EXISTING GROUND
TEMPORARY STREAM ACCESS
EXCAVATED ALLUVIUM
STAGING AREA
STORM DRAIN INLET PROTECTION
1+00 CHANNEL THALWEG STATIONING (FT)
PROPOSED DEMOLITION
ECOLOGY BLOCKS
FLOOD CONTROL BERM
TREES TO BE REMOVED
TREES TO BE PROTECTED

BULK BAGS
STREAMBED BOULDERS
LOGS WITH ROOTWAD
LOGS WITHOUT ROOTWAD
LOGS WITH ROOTWAD BURIED
LOGS WITHOUT ROOTWAD BURIED
LOG SECTION
VEGETATION
LOG IDENTIFICATION # (#)
LOG CONTROL POINT
DUCK BILL ANCHOR
SOLDIER PILE (H)
GRADE CONTROL STRUCTURE (PLAN)
HABITAT STRUCTURE (PLAN)
REVETMENT STRUCTURE (PLAN)
GRADE CONTROL STRUCTURE (PROFILE)
HABITAT STRUCTURE (PROFILE)
REVETMENT STRUCTURE (PROFILE)

DATUM
NAVD 88/NAD 83

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SUNSET CREEK/RICHARDS CREEK FLOOD CONTROL AND HABITAT IMPROVEMENT PROJECT

Approved By

DESIGN MANAGER DATE
PROJECT MANAGER DATE

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DESIGNED BY	DATE
T. PRESCOTT	07/2010
DRAWN BY	DATE
M. EWBANK	07/2010
CHECKED BY	DATE

CITY OF BELLEVUE WASHINGTON
City of Bellevue UTILITIES

ABBREVIATIONS AND LEGEND

DRAWING G-3 SHT 3 OF 19

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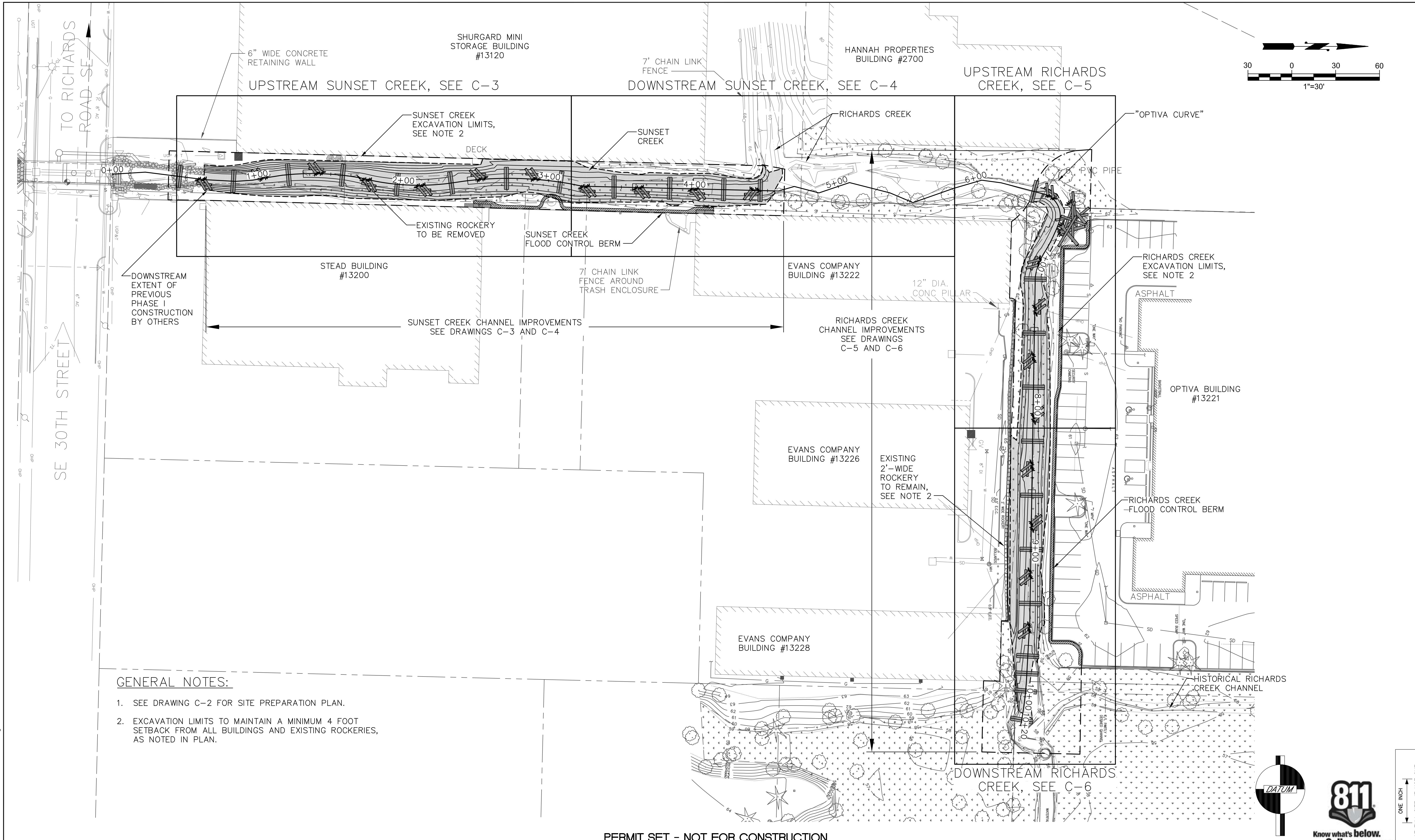

GENERAL NOTES:

1. SEE DRAWING C-2 FOR SITE PREPARATION PLAN.
2. EXCAVATION LIMITS TO MAINTAIN A MINIMUM 4 FOOT SETBACK FROM ALL BUILDINGS AND EXISTING ROCKERIES, AS NOTED IN PLAN.

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City of Bellevue UTILITIES

SITE PLAN AND KEY MAP

DRAWING C-1

SHT 4 OF 19

Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\C-1.dwg
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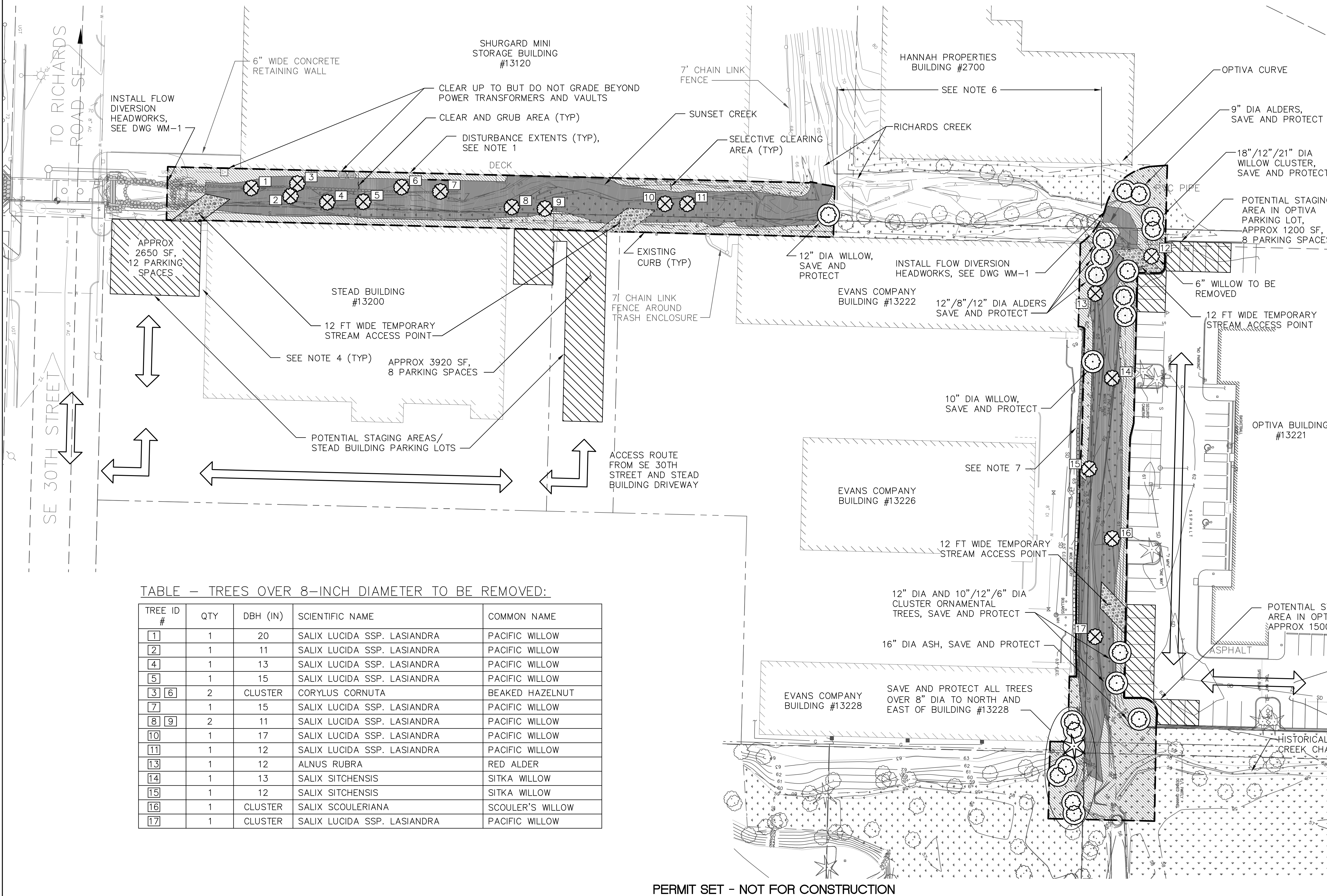

TABLE – TREES OVER 8-INCH DIAMETER TO BE REMOVED:

TREE ID #	QTY	DBH (IN)	SCIENTIFIC NAME	COMMON NAME
1	1	20	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW
2	1	11	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW
4	1	13	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW
5	1	15	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW
3 6	2	CLUSTER	CORYLUS CORNUTA	BEAKED HAZELNUT
7	1	15	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW
8 9	2	11	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW
10	1	17	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW
11	1	12	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW
13	1	12	ALNUS RUBRA	RED ALDER
14	1	13	SALIX SITCHENSIS	SITKA WILLOW
15	1	12	SALIX SITCHENSIS	SITKA WILLOW
16	1	CLUSTER	SALIX SCOULERIANA	SCOULER'S WILLOW
17	1	CLUSTER	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW

30 0 30 60
1"=30'

GENERAL NOTES:

1. CONTRACTOR SHALL FENCE THE PERIMETER OF THE CONSTRUCTION ZONE WITH A MINIMUM OF 6' TALL CHAINLINK FENCING PRIOR TO COMMENCEMENT OF ANY CONSTRUCTION ACTIVITIES.
2. PRIOR TO ANY CLEARING OR GRUBBING THE CONTRACTOR SHALL INSTALL TREE PROTECTION FOR ALL TREES DESIGNATED/FLAGGED BY THE CITY OF BELLEVUE TO REMAIN. TREE PROTECTION SHALL CONSIST OF ¾" 4'X4 PLYWOOD BOXES CENTERED ON THE TRUNK OF THE TREE OR APPROVED EQUAL.
3. EXISTING PARKING LOT CURBS AND PAVEMENT USED FOR ACCESS SHALL BE PROTECTED FROM DAMAGE BY THE CONTRACTOR. THE CONTRACTOR SHALL RESTORE ANY AREAS DISTURBED DURING CONSTRUCTION TO THEIR ORIGINAL APPROXIMATE CONDITION.
4. CONTRACTOR SHALL NOT BLOCK BUILDING EGRESS.
5. LOCATE AND PROTECT ALL DRAINAGE OUTFALLS TO CHANNEL, BUILDING FOOTINGS, AND UTILITIES PRIOR TO COMMENCEMENT OF AND DURING CONSTRUCTION ACTIVITIES, UNLESS OTHERWISE INDICATED IN DRAWINGS.
6. CONTRACTOR SHALL NOT DISTURB EXISTING WOODY DEBRIS, VEGETATION, OR CHANNEL HABITAT BETWEEN RICHARDS CREEK CONFLUENCE AND OPTIVA CURVE.
7. CONTRACTOR SHALL NOT DISTURB RETAINING WALL ROCKERY LOCATED TO THE NORTH OF THE EVANS COMPANY BUILDINGS.

DATUM
NAVD 88/NAD 83

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NO	DATE	BY	APPR	REVISIONS

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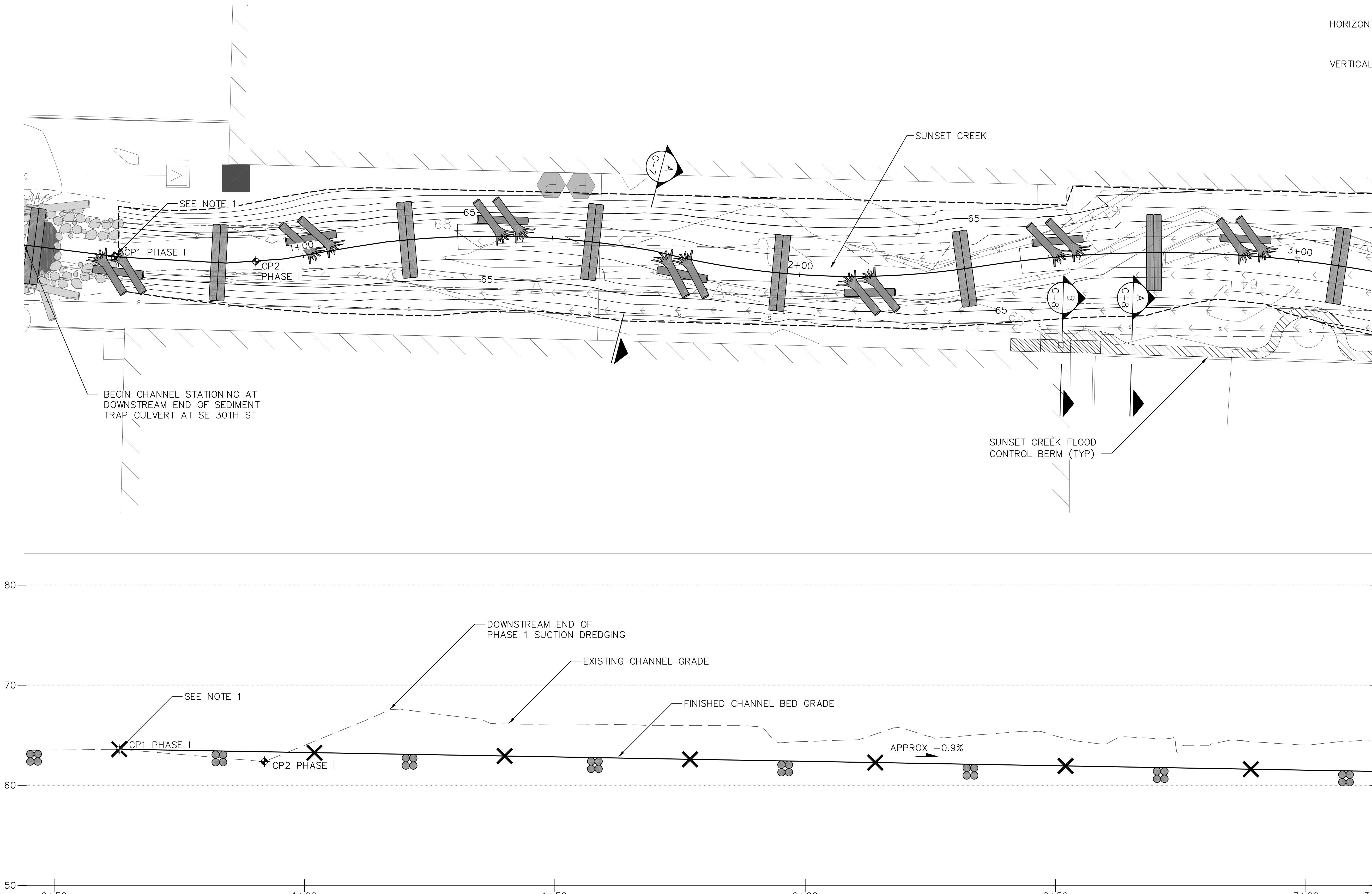
City of Bellevue
UTILITIES

SITE PREPARATION PLAN

DRAWING C-2

SHT 5 OF 19



NOTES:

1. PROPOSED GRADING PHASE I LOG/BOULDER WEIR AND CHANNEL PROFILE TO TIE INTO PHASE I CP1 AT APPROX CONSTRUCTION STATIONING 0+63 AND ELEVATION 63.6 FT.

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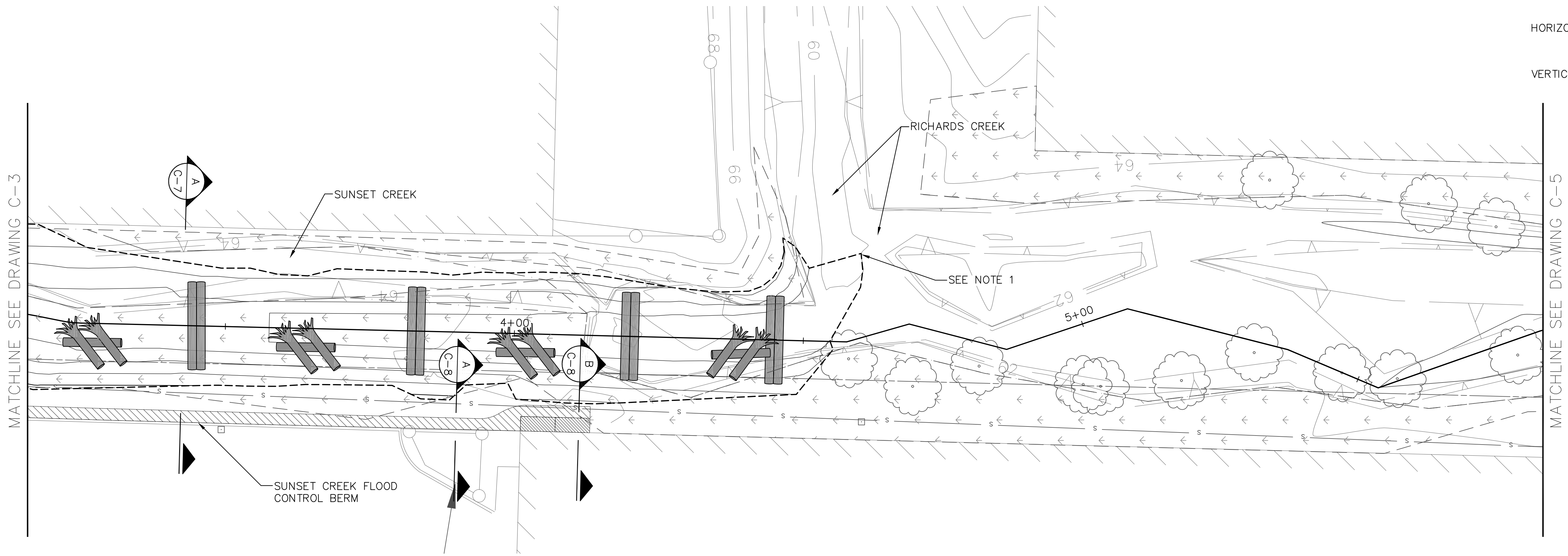
City of Bellevue UTILITIES

UPSTREAM SUNSET CREEK PLAN AND PROFILE

DRAWING C-3 SHT 6 OF 19

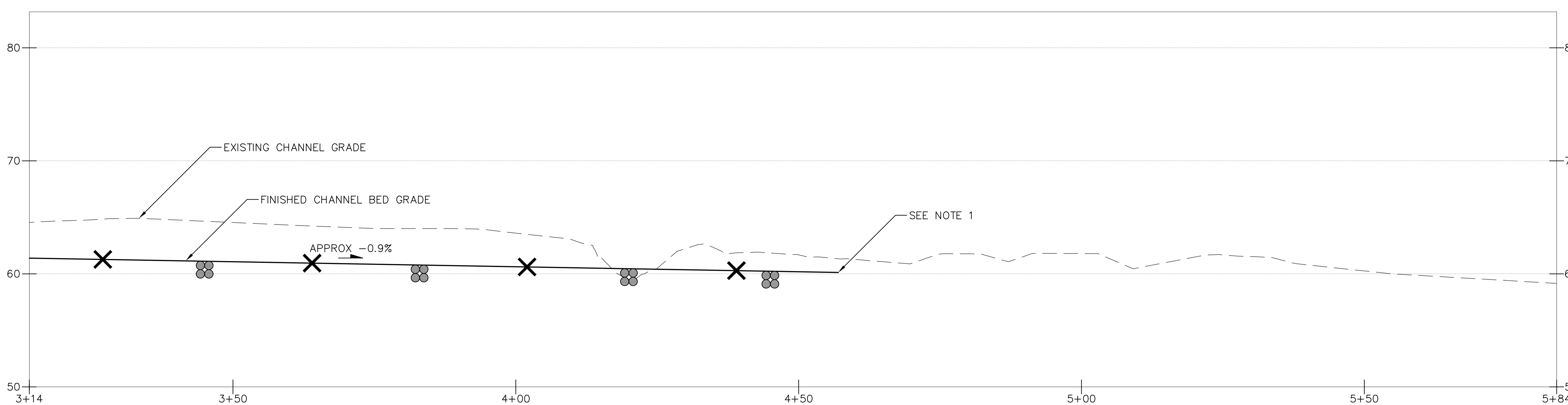


HORIZONTAL SCALE 1"=10'

VERTICAL SCALE 1"=5'

NOTES:

1. END SUNSET CREEK CHANNEL GRADING AT THE CONFLUENCE WITH RICHARDS CREEK AT STA 4+56 AND ELEVATION 60.1.



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M. EWBANK 07/2010
CHECKED BY — DATE

City of Bellevue UTILITIES

DOWNSTREAM SUNSET CREEK PLAN AND PROFILE

DRAWING C-4 — SHT 7 OF 19

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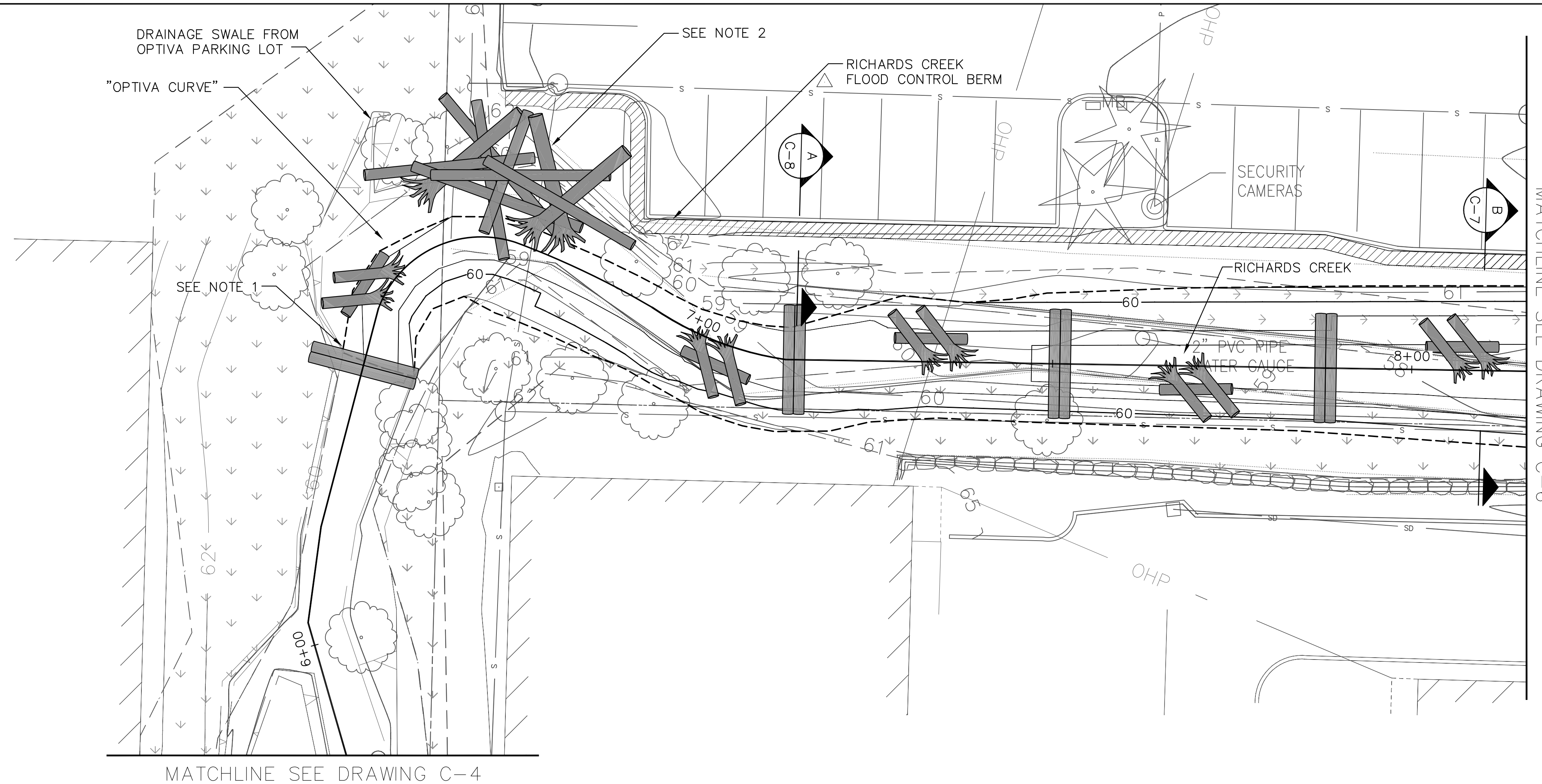
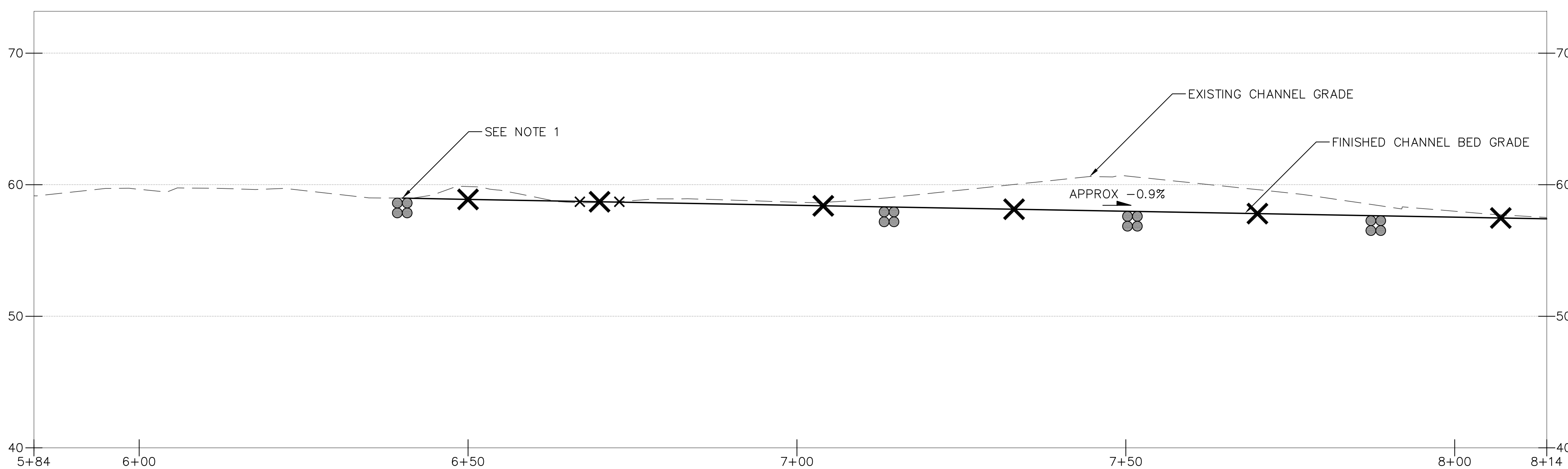


HORIZONTAL SCALE 1"=10'

VERTICAL SCALE 1"=5'

NOTES:

1. COMMENCE RICHARDS CREEK CHANNEL GRADING AT OPTIVA CURVE AT STA 6+40 AND ELEVATION 59.
2. OVEREXCAVATION FOR INSTALLATION OF REVETMENT STRUCTURE NOT TO PENETRATE BELOW ELEVATION 55.0' TO AVOID DAMAGE TO SANITARY SEWER PIPE.



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City of Bellevue UTILITIES

UPSTREAM RICHARDS CREEK PLAN AND PROFILE

DRAWING C-5 SHT 8 OF 19

Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\C-5.dwg Cad User: Laura Turnidge
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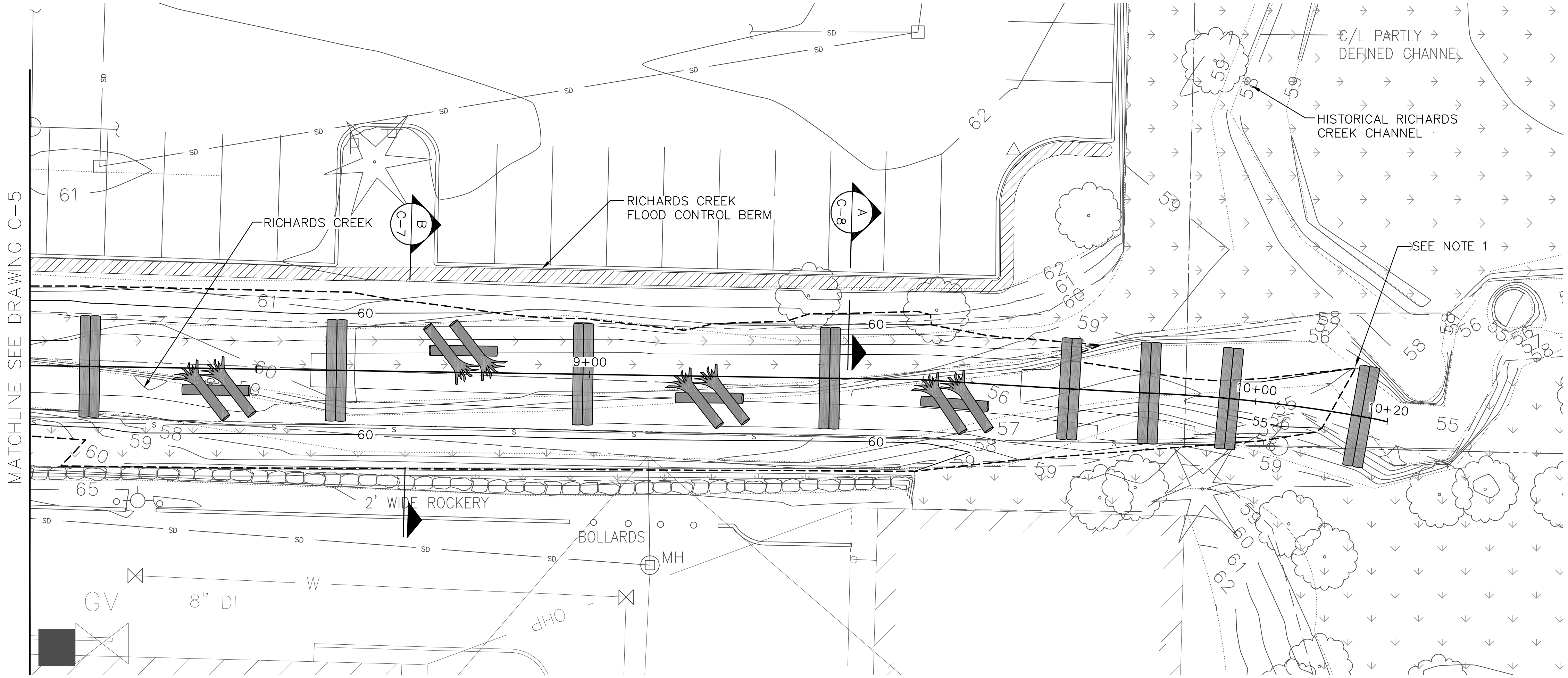
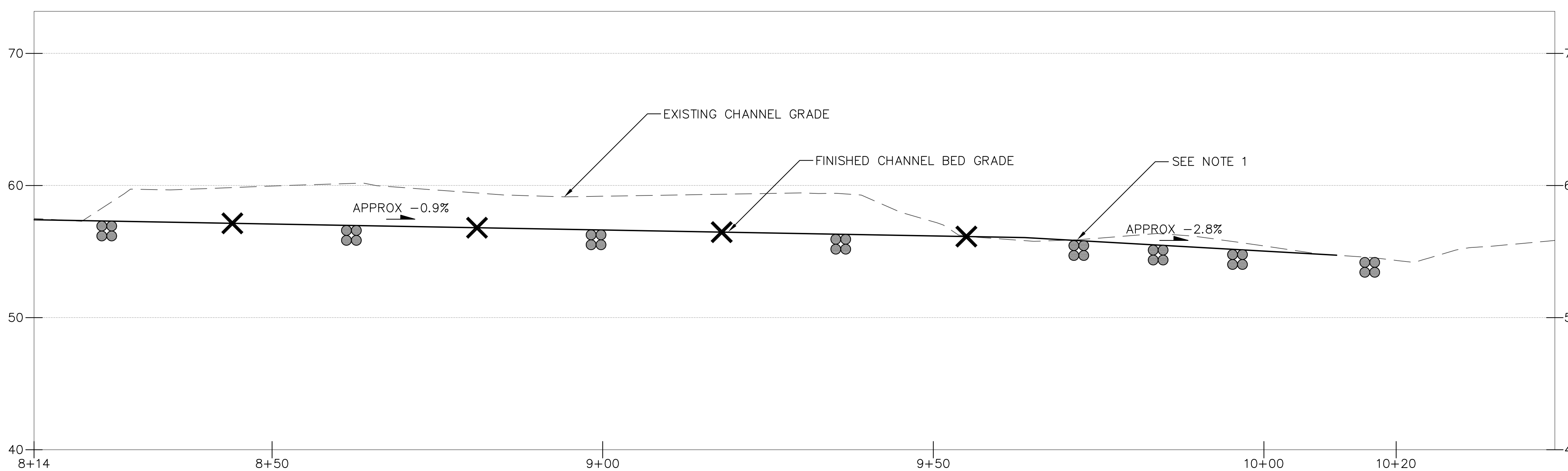
HORIZONTAL SCALE 10 0 10 20 1"=10'

VERTICAL SCALE 5 0 5 10 1"=5'



NOTES:

1. TAPER PROPOSED RICHARDS CREEK CHANNEL GRADING INTO EXISTING GRADES JUST UPSTREAM OF HISTORICAL RICHARDS CREEK CHANNEL LOCATION FROM APPROX STA 9+72 TO 10+16 AND ELEVATION 54.8'.



DATUM
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UTILITIES

DOWNSTREAM RICHARDS CREEK PLAN AND PROFILE

DRAWING C-6

SHT 9 OF 19

Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\C-6.dwg Cad User: Laura Turnidge
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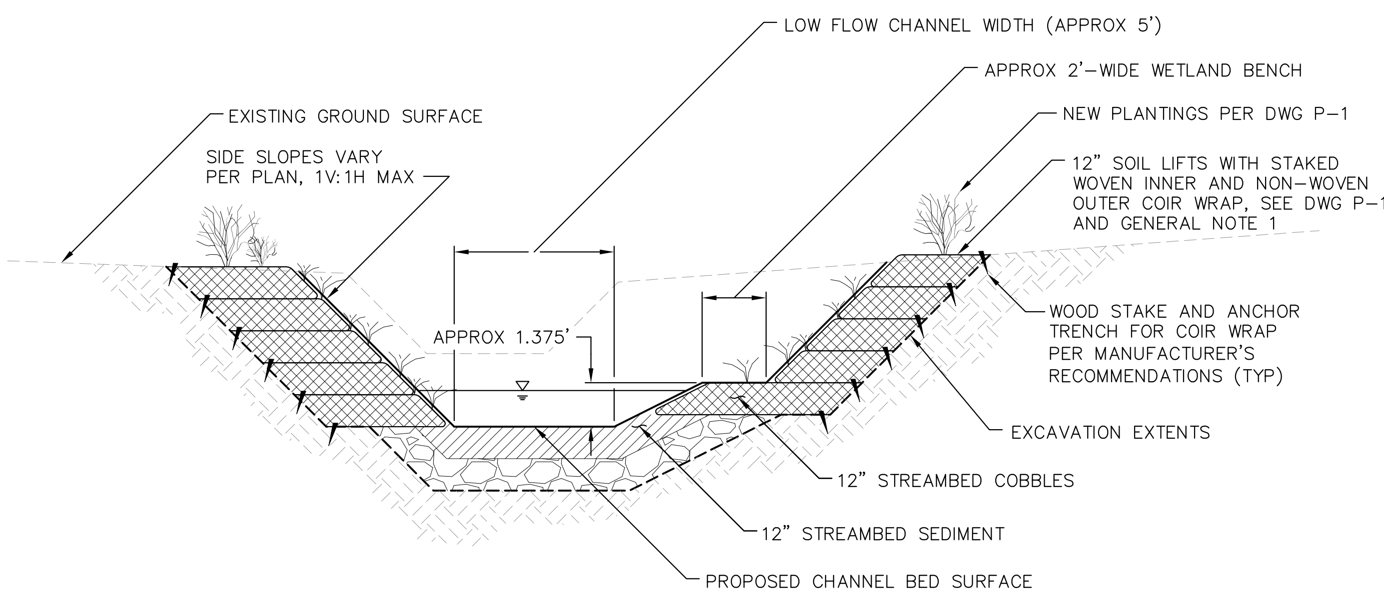
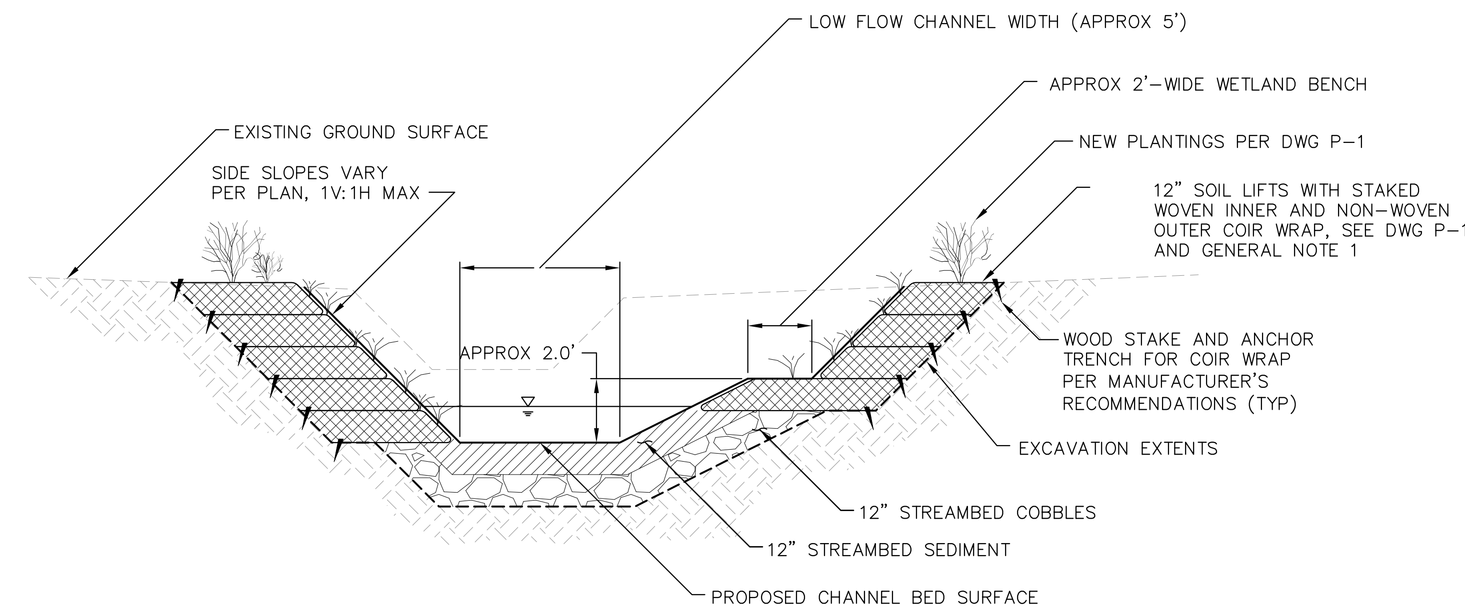
GENERAL NOTES:

1. WHERE TOP TWO COIR WRAP LIFTS COME WITHIN 4 FEET OF BUILDINGS, CURB, OR PERMANENT ROCKERIES, INSTALLATION AND STAKING REQUIREMENTS TO BE PROVIDED BY THE ENGINEER.



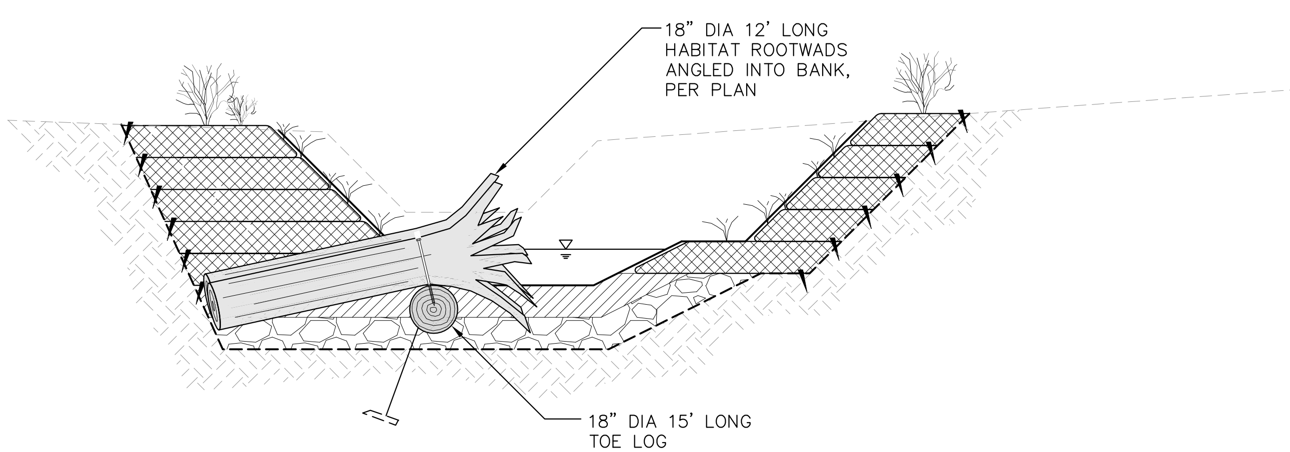
SECTION – TYPICAL SUNSET CREEK CHANNEL (A, C-3,C-4)

SCALE: 1"=3'



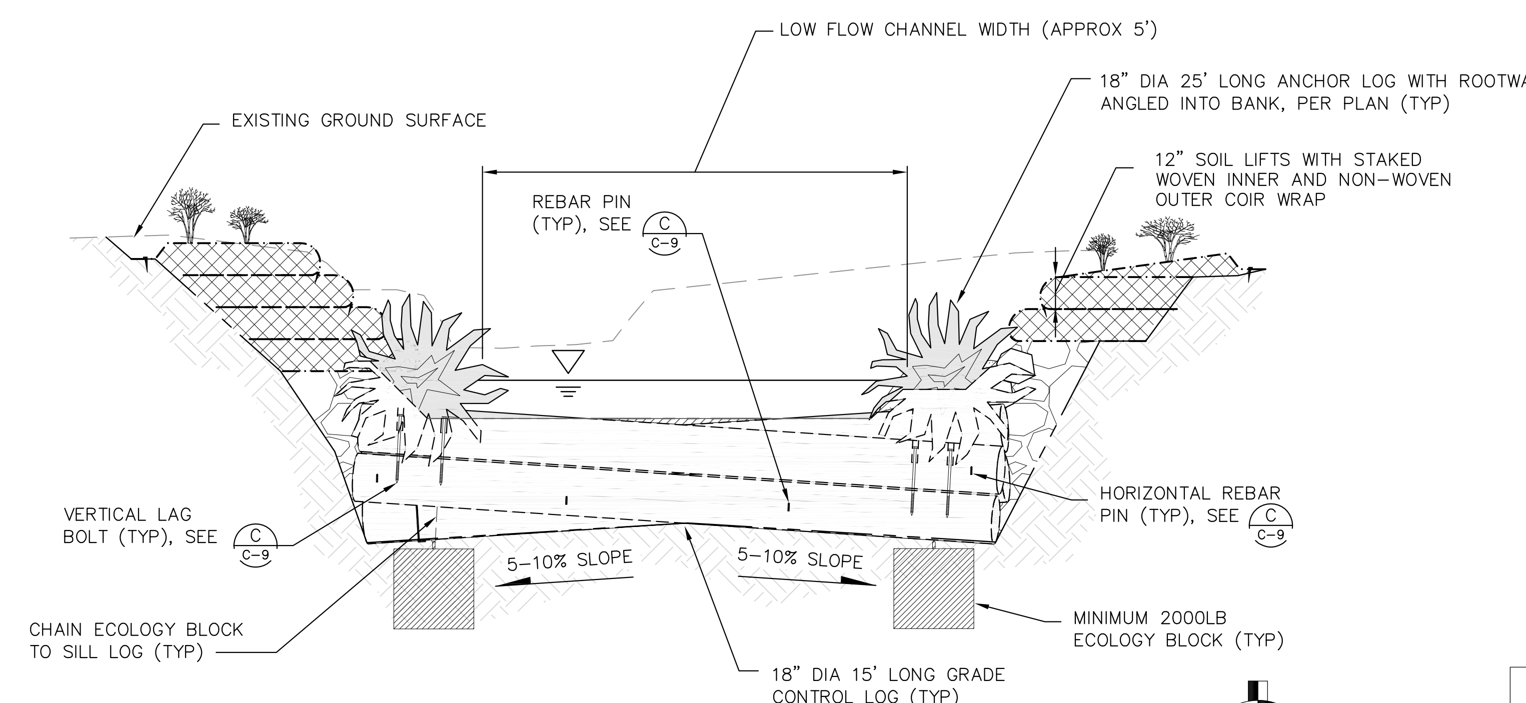
SECTION – TYPICAL RICHARDS CREEK CHANNEL (B, C-5,C-6)

SCALE: 1"=3'



SECTION – TYPICAL HABITAT STRUCTURE (C, C-3,C-4,C-5,C-6)

SCALE: 1"=3'



SECTION – TYPICAL GRADE CONTROL STRUCTURE (D, C-3,C-4,C-5,C-6)

SCALE: 1"=3'

DATUM NAVD 88/NAD 83

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CITY OF BELLEVUE WASHINGTON — City of Bellevue UTILITIES

SECTIONS

DRAWING C-7 — SHT 10 OF 19

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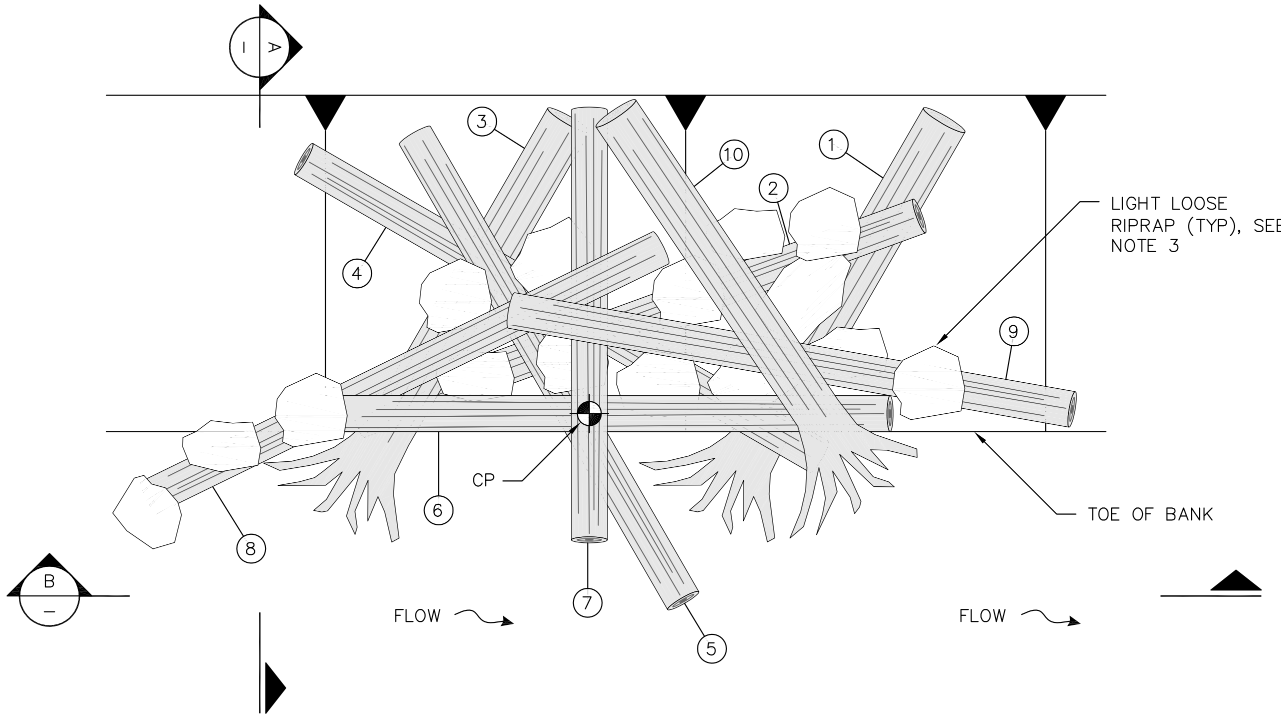
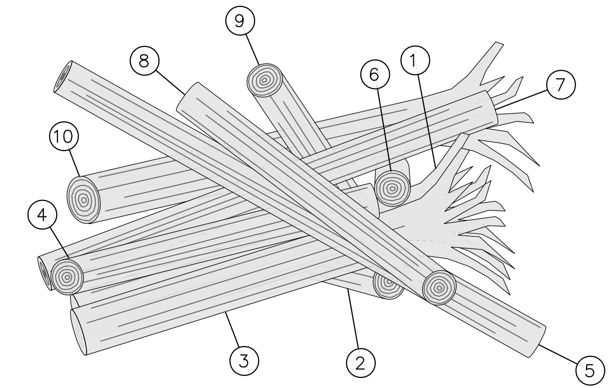
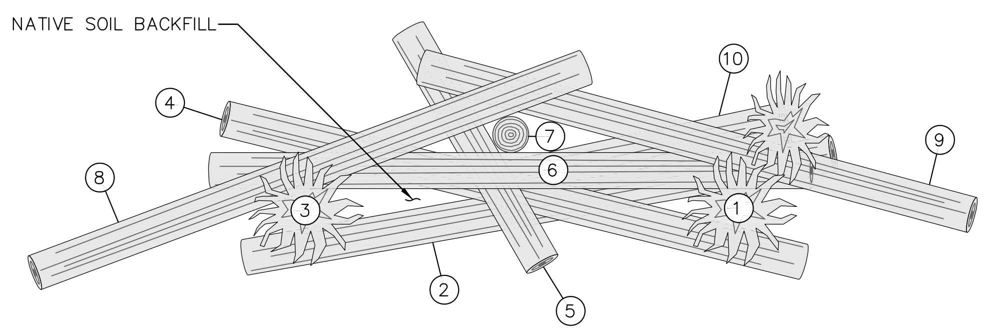


PLAN – REVETMENT STRUCTURE (1 / C-5)
SCALE:1"=4'



SECTION – REVETMENT STRUCTURE (A / –)
SCALE:1"=4'



SECTION – REVETMENT STRUCTURE (B / –)
SCALE:1"=4'

TABLE – LOG SCHEDULE:

LOG #	DIAMETER (IN)	LENGTH (FT)	ROOTWAD
1	24	20	YES
2	18	25	NO
3	24	20	YES
4	18	25	NO
5	18	25	NO
6	18	25	NO
7	18	20	NO
8	18	25	NO
9	18	25	NO
10	24	20	YES

NOTES:

1. CONTRACTOR SHALL MINIMIZE EXCAVATION INTO EXISTING BANK. MATERIAL EXCAVATED TO PLACE LOGS CAN BE REUSED ON REGRADED BANKS. CONTRACTOR SHALL PUSH LOGS INTO BANK USING EXCAVATOR WHEREVER POSSIBLE TO MINIMIZE EXCAVATION.
2. LOG IDENTIFICATION NUMBERS REPRESENT AN ORDER OF PLACEMENT/INSTALLATION. CORRESPONDING LOG DIMENSIONS SHOWN IN THE LOG SCHEDULE TABLE.
3. LIGHT LOOSE RIPRAP SHALL BE PLACED AND BURIED AMIDST THE INTERLOCKED LOGS AS DIRECTED BY THE ENGINEER.

DATUM
NAVD 88/NAD 83

811 Know what's below. Call before you dig.

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PERMIT SET - NOT FOR CONSTRUCTION

NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
Suite 1100
Seattle, Washington
98121-1820
206-441-9080
206-441-9108 FAX
http://www.herrerainc.com

SUNSET CREEK/RICHARDS CREEK FLOOD CONTROL AND HABITAT IMPROVEMENT PROJECT

Approved By
DESIGN MANAGER — DATE
PROJECT MANAGER — DATE

C. AVOLIO/M. STRAZER 07/2010
DESIGNED BY — DATE
T. PRESCOTT 07/2010
DRAWN BY — DATE
M. EWBANK 07/2010
CHECKED BY — DATE

City of Bellevue UTILITIES

REVETMENT STRUCTURE DETAILS

DRAWING C-8

SHT 11 OF 19

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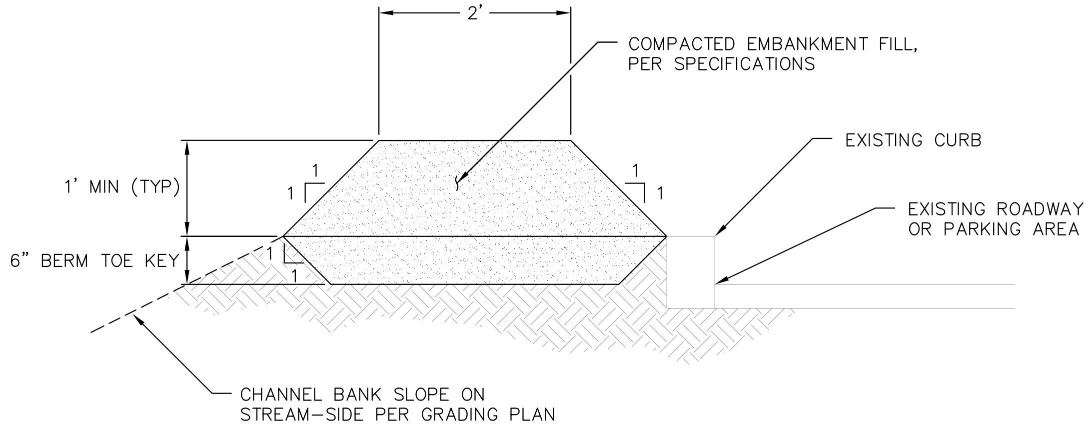
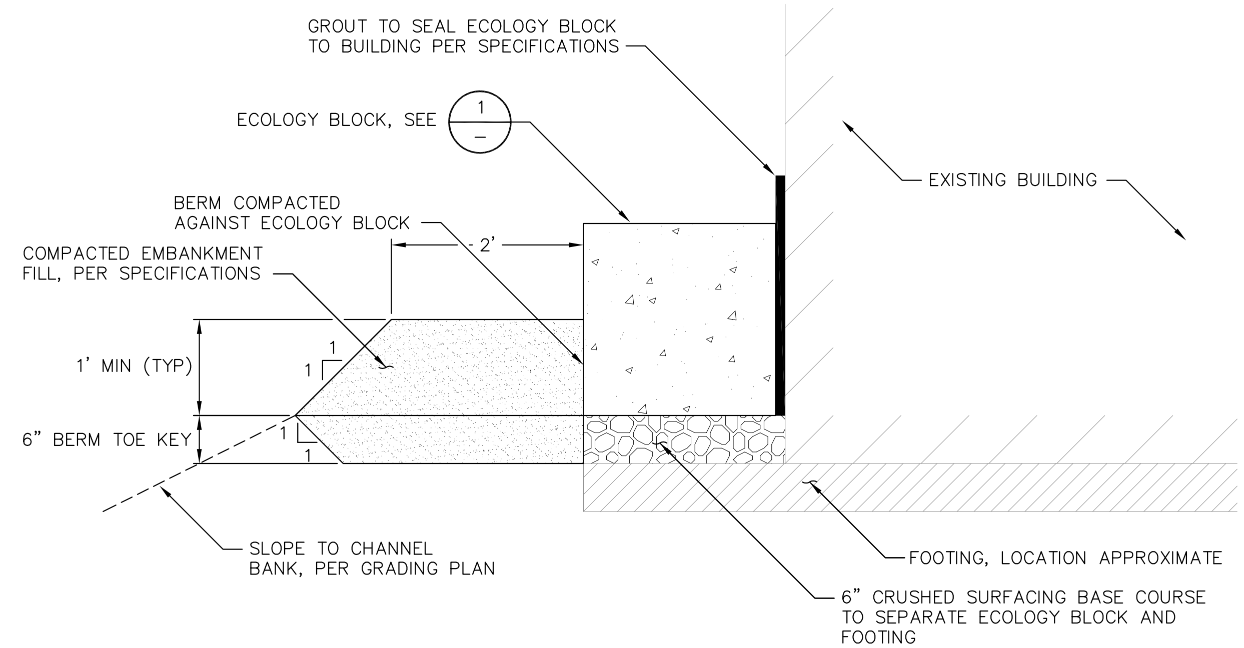


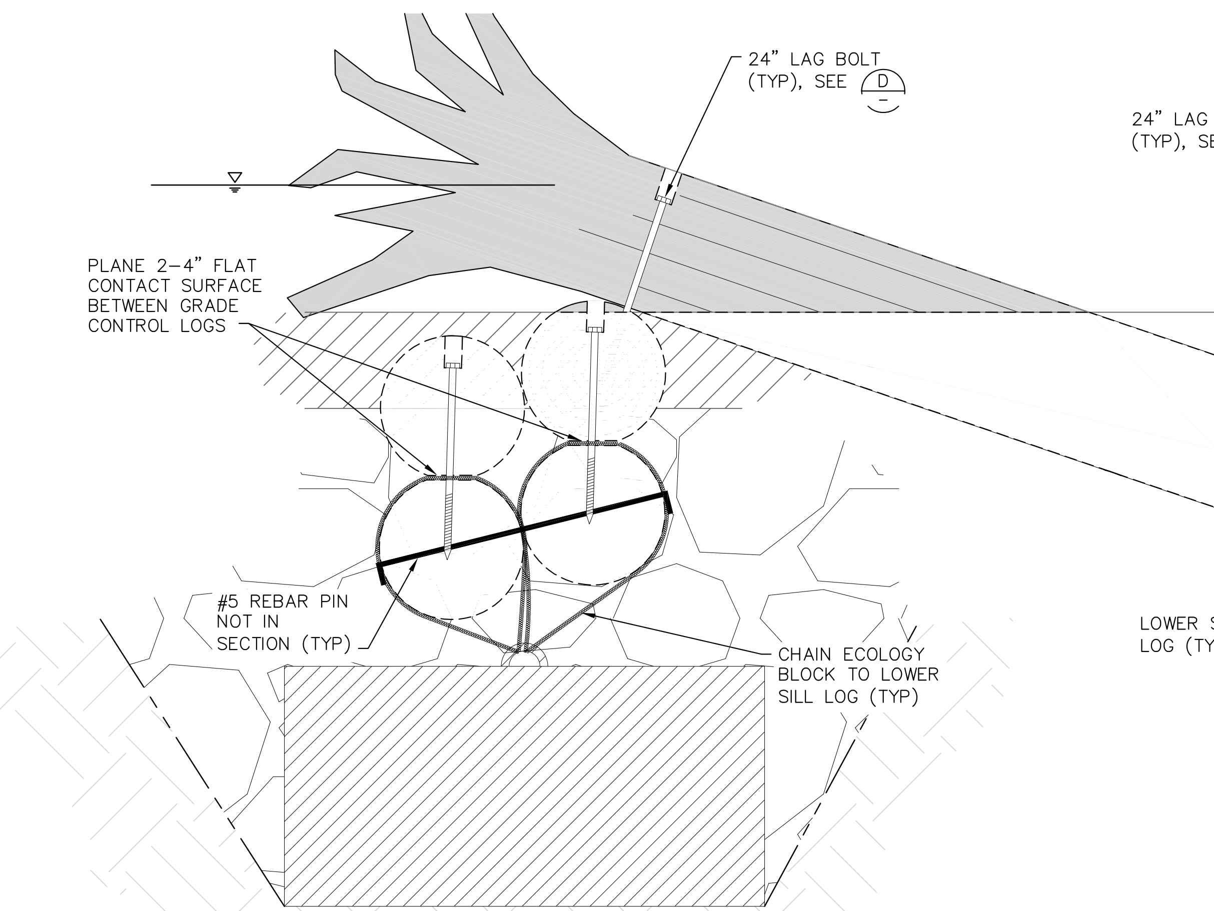
DETAIL – FLOOD CONTROL BERM NEAR CURB (A / VAR.)

SCALE: 1"=1'



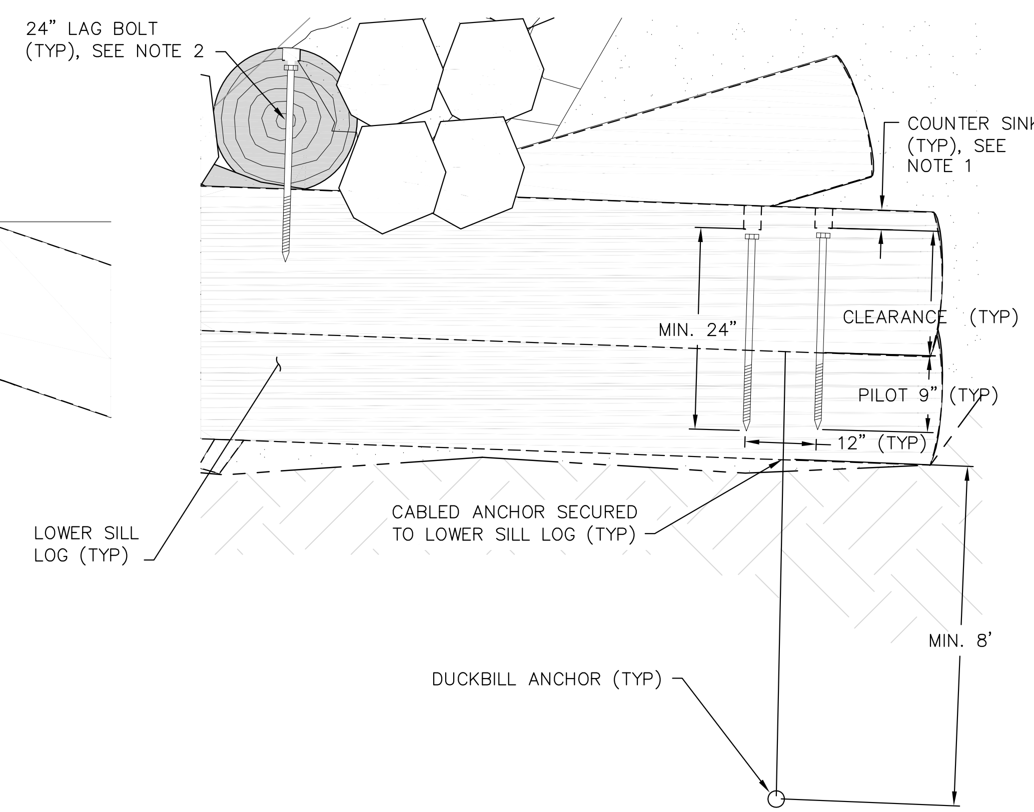
DETAIL – FLOOD CONTROL BERM NEAR BUILDING (B / VAR.)

SCALE: 1"=1'



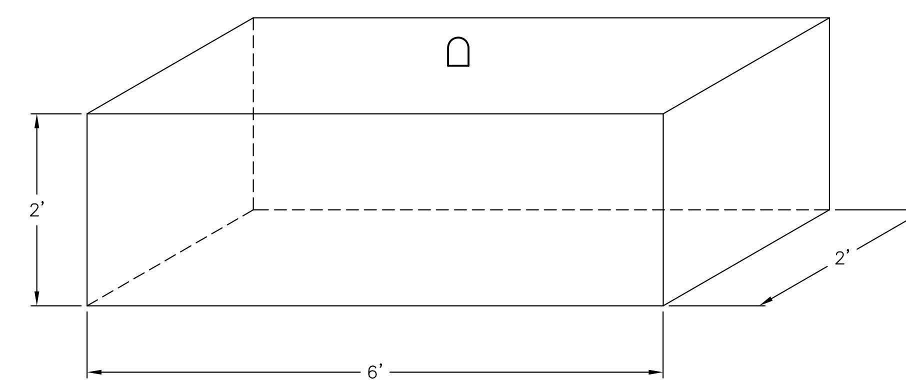
SECTION–DOWNSTREAM GRADE CONTROL LAG/PIN DETAIL (C / C-7)

SCALE: 1"=1'



DETAIL–TYPICAL LAG BOLT INSTALLATION DETAIL (D / –)

SCALE: 1"=1'



DETAIL – ECOLOGY BLOCK (1 / –)

SCALE: NTS

NAVD 88/NAD 83

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PROJECT MANAGER DATE

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DESIGNED BY	DATE
T. PRESCOTT	07/2010
DRAWN BY	DATE
M. EWBANK	07/2010
CHECKED BY	DATE

City of Bellevue UTILITIES

DETAILS

DRAWING C-9

SHT 12 OF 19

Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\C-9.dwg Cad User: Laura Turnidge
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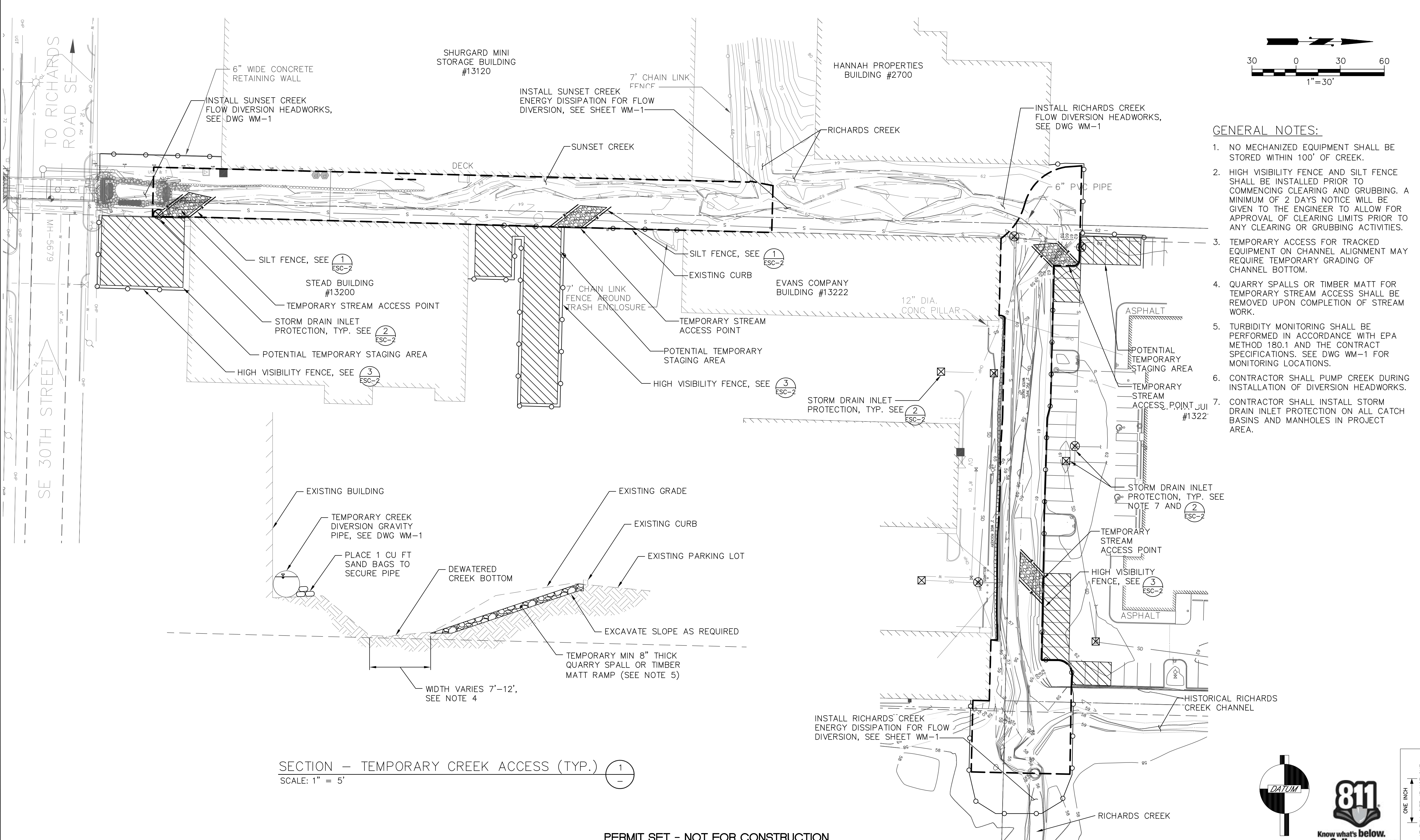

GENERAL NOTES:

1. NO MECHANIZED EQUIPMENT SHALL BE STORED WITHIN 100' OF CREEK.
2. HIGH VISIBILITY FENCE AND SILT FENCE SHALL BE INSTALLED PRIOR TO COMMENCING CLEARING AND GRUBBING. A MINIMUM OF 2 DAYS NOTICE WILL BE GIVEN TO THE ENGINEER TO ALLOW FOR APPROVAL OF CLEARING LIMITS PRIOR TO ANY CLEARING OR GRUBBING ACTIVITIES.
3. TEMPORARY ACCESS FOR TRACKED EQUIPMENT ON CHANNEL ALIGNMENT MAY REQUIRE TEMPORARY GRADING OF CHANNEL BOTTOM.
4. QUARRY SPALLS OR TIMBER MATT FOR TEMPORARY STREAM ACCESS SHALL BE REMOVED UPON COMPLETION OF STREAM WORK.
5. TURBIDITY MONITORING SHALL BE PERFORMED IN ACCORDANCE WITH EPA METHOD 180.1 AND THE CONTRACT SPECIFICATIONS. SEE DWG WM-1 FOR MONITORING LOCATIONS.
6. CONTRACTOR SHALL PUMP CREEK DURING INSTALLATION OF DIVERSION HEADWORKS.
7. CONTRACTOR SHALL INSTALL STORM DRAIN INLET PROTECTION ON ALL CATCH BASINS AND MANHOLES IN PROJECT AREA.

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Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\ESC-1.dwg Cad User: Laura Turnidge
Plot Date: 7/13/2010 5:51 PM

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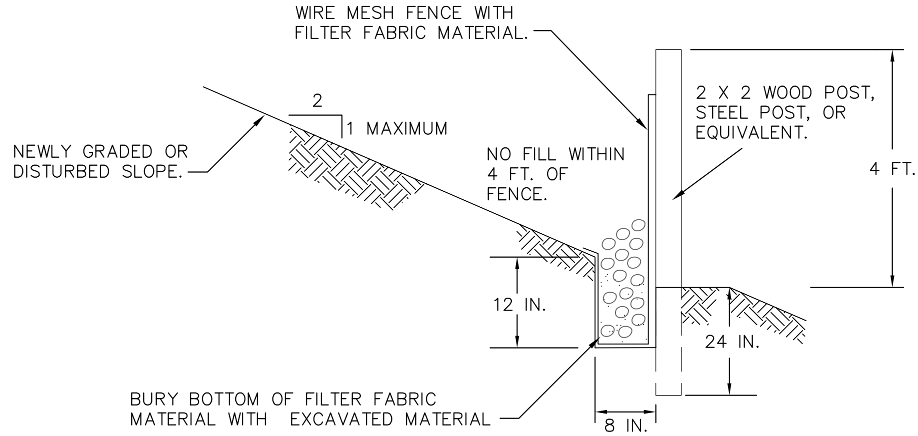
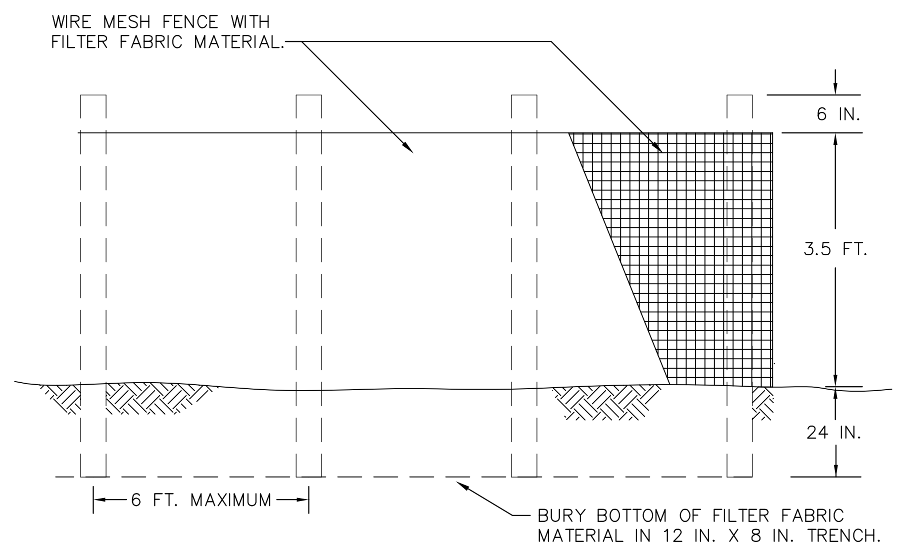
CITY OF BELLEVUE WASHINGTON
City of Bellevue
UTILITIES

TEMPORARY EROSION AND SEDIMENT CONTROL PLAN

DRAWING ESC-1 SHT 13 OF 19



TYPICAL CROSS SECTION

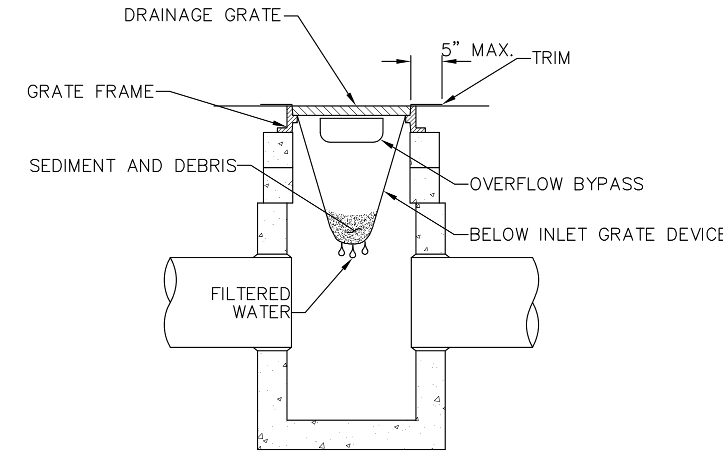


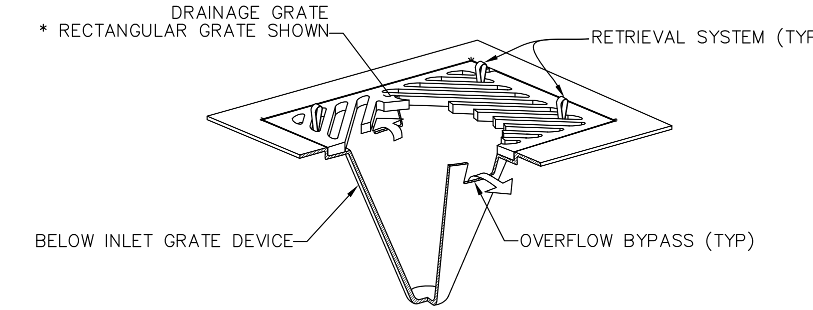
ELEVATION

NOTES:

1. FENCE SHALL NOT BE INSTALLED ON SLOPES STEEPER THAN 2:1.
2. JOINTS IN FILTER FABRIC SHALL BE OVERLAPPED 6 INCHES AT POST.
3. USE STAPLES, WIRE RINGS, OR EQUIVALENT TO ATTACH FABRIC TO WIRE FENCE.
4. REMOVE SEDIMENT WHEN IT REACHES 1/3 FENCE HEIGHT.

SILT FENCE DETAIL 1 / ESC-1
SCALE: NTS



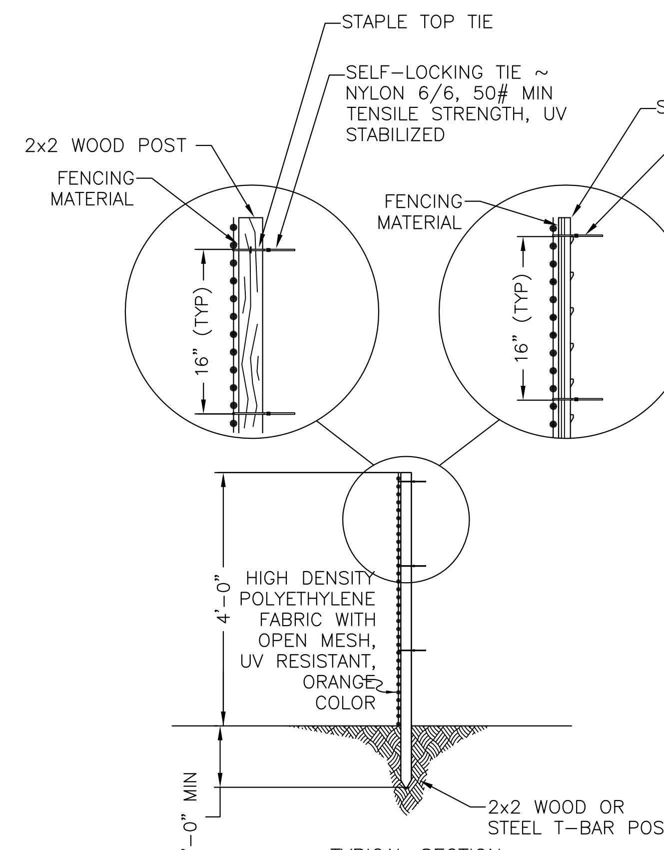


ISOMETRIC VIEW

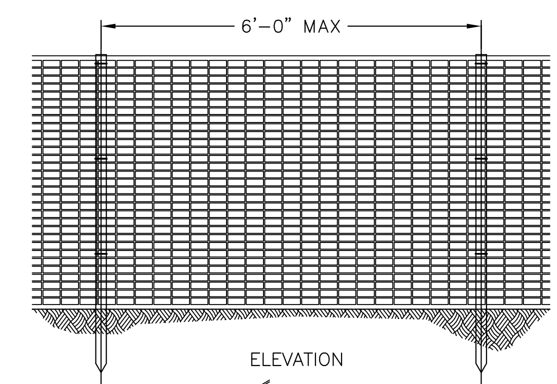
NOTES:

1. SIZE THE BELOW INLET GRATE DEVICE (BIGD) FOR THE STORM WATER STRUCTURE IT WILL SERVICE.
2. THE BIGD SHALL HAVE A BUILT-IN HIGH-FLOW RELIEF SYSTEM (OVERFLOW BYPASS).
3. THE RETRIEVAL SYSTEM MUST ALLOW REMOVAL OF THE BIGD WITHOUT SPILLING THE COLLECTED MATERIAL.
4. PERFORM MAINTENANCE IN ACCORDANCE WITH STANDARD SPECIFICATION 8-01.3(15).

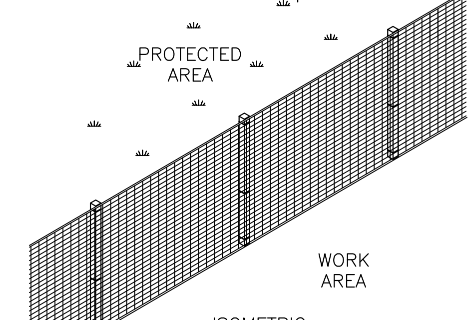
STORM DRAIN INLET PROTECTION 2 / ESC-1
SCALE: NTS



TYPICAL SECTION



ELEVATION



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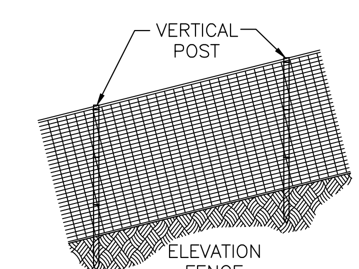

ELEVATION FENCE ON SLOPE

HIGH VISIBILITY FENCE DETAIL 1 / ESC-1
SCALE: NTS

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DATUM
NAVD 88/NAD 83

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M. EWBANK 07/2010 — CHECKED BY — DATE

City of Bellevue
UTILITIES

TESC DETAILS

DRAWING ESC-2 | SHT 14 OF 19

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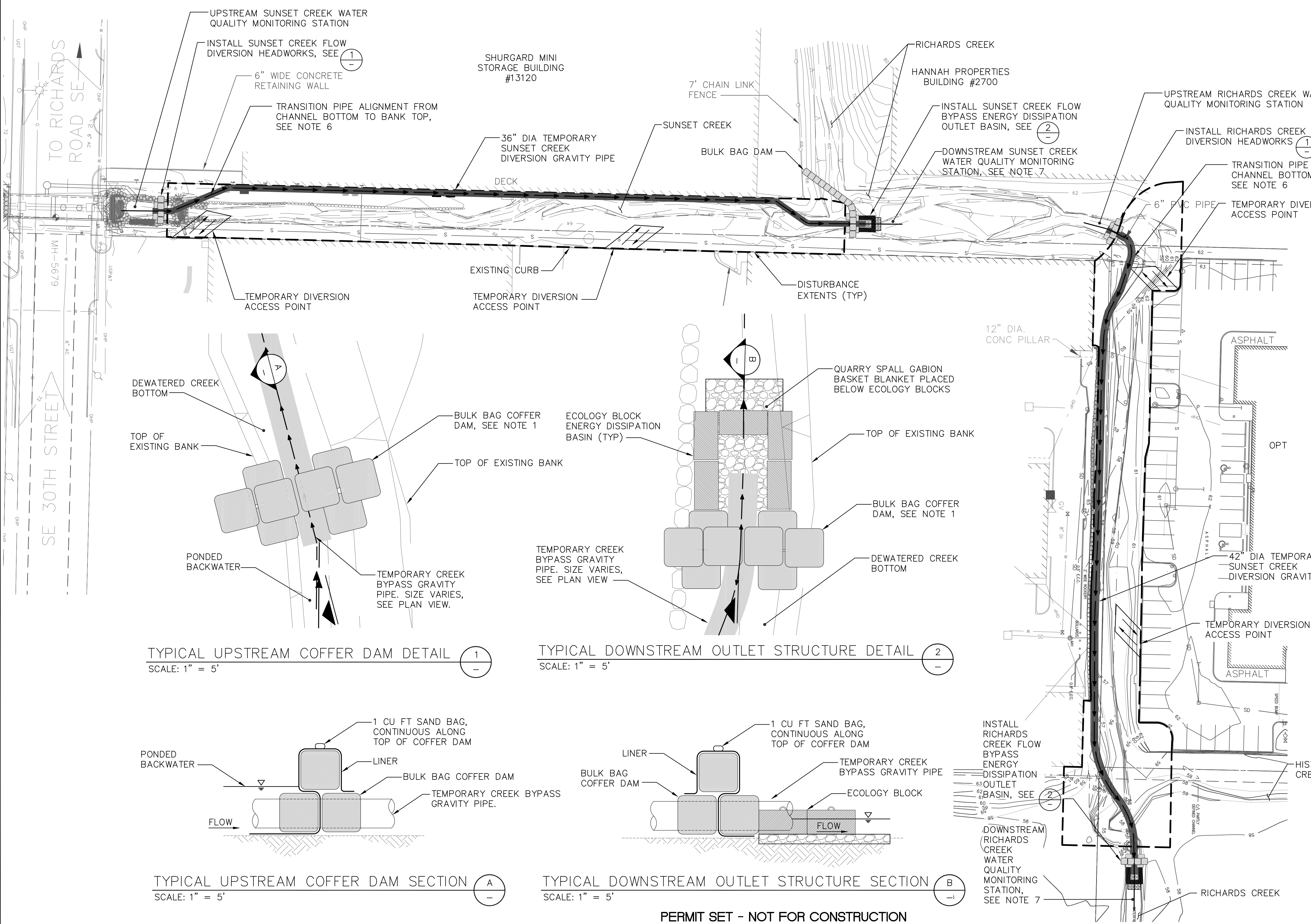

GENERAL NOTES:

1. BULK BAGS SHALL BE FILLED WITH CLEAN WASHED ROUNDED GRAVEL.
2. TEMPORARY PUMPING OF CREEK DURING GRAVITY PIPE, UPSTREAM COFFERDAM, AND DOWNSTREAM OUTFALL DISSIPATION INSTALLATION AND REMOVAL WILL BE REQUIRED.
3. COORDINATE FISH EXCLUSION WITH CREEK DIVERSION PER THE WSDOT FISH EXCLUSION PROTOCOLS AND STANDARDS (AUGUST 2006) AND THE REQUIREMENTS OF THE HYDRAULIC PROJECT APPROVAL.
4. CONTRACTOR SHALL REMOVE ALL TEMPORARY BYPASS MATERIALS FOLLOWING CONSTRUCTION.
5. TRANSITION BYPASS PIPE TO BANK TOP SUFFICIENTLY DOWNSTREAM TO ENSURE PIPE DOES NOT BACKWATER INTO HEADWORKS.
6. ADDITIONAL DOWNSTREAM MONITORING STATION TO BE LOCATED 100 FEET DOWNSTREAM OF FLOW OUTLET BASIN.
7. INSTALLATION OF DIVERSION HEADWORKS MAY REQUIRE PUMPING.

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FLOW DIVERSION AND FISH EXCLUSION DETAILS

DRAWING WM-1 — SHT 15 OF 19

Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\WM-1.dwg Cad User: Laura Turnidge
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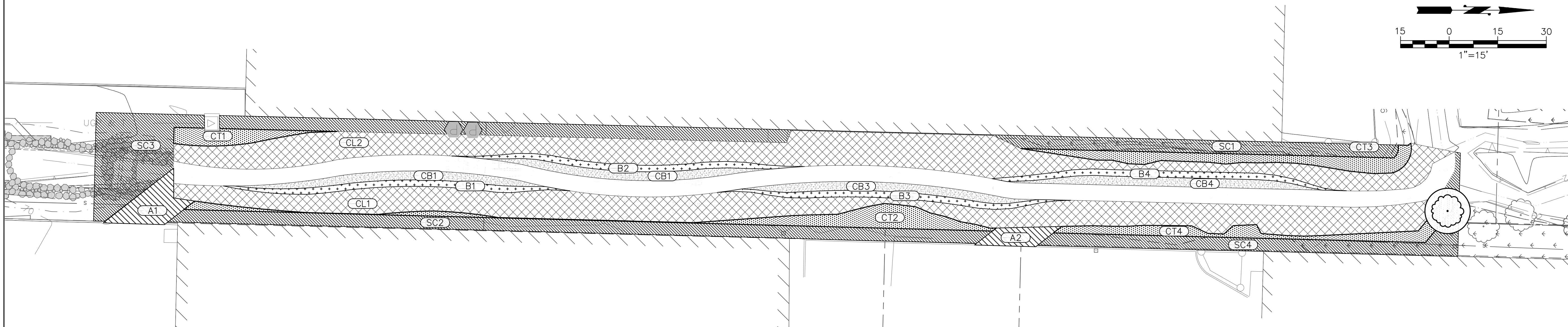

PLANT SCHEDULE

PLANTING AREA\TYPE NAME	SCIENTIFIC NAME	COMMON NAME	PLANTING QUANTITY BY PLANTING AREA TYPE										TOTAL
A: ACCESS AREA			A1	A2	A3	A4							
	HOLODISCUS DISCOLOR	OCEANSPRAY	8	5	8	5							26
	RIBES SANGUINEUM	RED FLOWERING CURRANT	8	5	8	5							26
	SYMPHORICARPOS ALBUS	SNOWBERRY	8	5	8	5							26
	THUJA PLICATA	WESTERN RED CEDAR	2	1	2	1							6
CB: CHANNEL TO BENCH			CB1	CB2	CB3	CB4	CB5	CB6	CB7				
	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW	5	4	5	5	9	7	3				38
	SALIX SITCHENSIS	SITKA WILLOW	5	4	5	5	9	7	3				38
B: BENCH			B1	B2	B3	B4	B5	B6	B7				
	CORNUS SERICEA	RED OSIER DOGWOOD	7	7	7	7	12	10	4				54
	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW	7	7	7	7	12	10	4				54
	SALIX SITCHENSIS	SITKA WILLOW	7	7	7	7	12	10	4				54
CL: COIR LIFTS			CL1	CL2	CL3	CL4							
	SALIX SCOULERIANA	SCOULER'S WILLOW	127	127	117	117							488
	SALIX SESSILIFOLIA	SOFT LEAVED WILLOW	127	127	117	117							488
	CORNUS SERICEA	RED-OSIER DOGWOOD	127	127	117	117							488
CT: TOP OF COIR BANK			CT1	CT2	CT3	CT4	CT5	CT6	CT7	CT8	CT9	CT10	
	HOLODISCUS DISCOLOR	OCEANSPRY	7	16	14	13	7	26	16	6	16	13	134
	RIBES SANGUINEUM	RED FLOWERING CURRANT	7	16	14	13	7	26	16	6	16	13	134
	SYMPHORICARPOS ALBUS	SNOWBERRY	7	16	14	13	7	26	16	6	16	13	134
	ALNUS RUBRA	RED ALDER	1	2	2	2	1	3	2	1	2	2	18
	POPULUS BALSAMIFERA	BLACK COTTONWOOD	1	2	2	2	1	3	2	1	2	2	18
	THUJA PLICATA	WESTERN RED CEDAR	1	2	2	2	1	3	2	1	2	2	18
SC: SELECTIVE PLANTING AREA			SC1	SC2	SC3	SC4	SC5	SC6	SC7				
	HOLODISCUS DISCOLOR	OCEANSPRY	2	3	3	2	10	4	5				29
	RIBES SANGUINEUM	RED FLOWERING CURRANT	2	3	3	2	10	4	5				29
	SYMPHORICARPOS ALBUS	SNOWBERRY	2	3	3	2	10	4	5				29
	ALNUS RUBRA	RED ALDER	1	2	2	1	5	2	3				16
	POPULUS BALSAMIFERA	BLACK COTTONWOOD	1	2	2	2	6	2	4				16
	THUJA PLICATA	WESTERN RED CEDAR	1	2	2	2	6	2	4				16

GENERAL NOTES:

1. TREES TO BE RETAINED DURING CONSTRUCTION SEE DRAWING C-2 FOR SPECIFICATIONS.
2. SEE PLANTING MATERIALS AND NOTES ON DRAWING P-3.
3. SEE PLANTING DETAILS ON DRAWING P-4.

DATUM
NAVD 88/NAD 83

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City of Bellevue
UTILITIES

PLANTING PLAN - SUNSET CREEK

DRAWING P-1

SHT 16 OF 19

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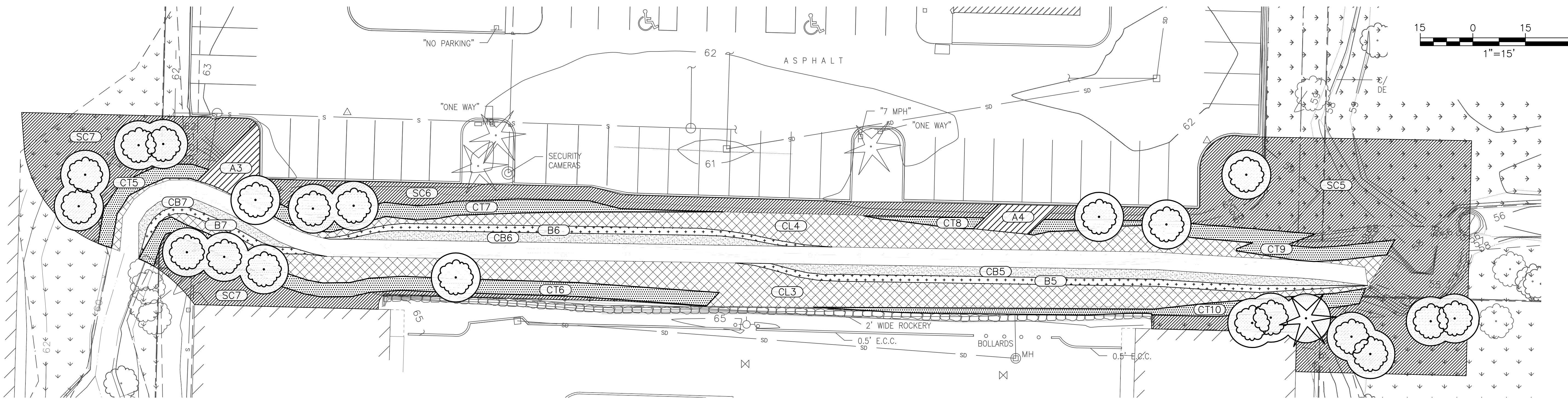

PLANT SCHEDULE

PLANTING AREA\TYPE NAME	SCIENTIFIC NAME	COMMON NAME	PLANTING QUANTITY BY PLANTING AREA TYPE										TOTAL
A: ACCESS AREA			A1	A2	A3	A4							
	HOLODISCUS DISCOLOR	OCEANSPRAY	8	5	8	5							26
	RIBES SANGUINEUM	RED FLOWERING CURRANT	8	5	8	5							26
	SYMPHORICARPOS ALBUS	SNOWBERRY	8	5	8	5							26
	THUJA PLICATA	WESTERN RED CEDAR	2	1	2	1							6
CB: CHANNEL TO BENCH			CB1	CB2	CB3	CB4	CB5	CB6	CB7				
	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW	5	4	5	5	9	7	3				38
	SALIX SITCHENSIS	SITKA WILLOW	5	4	5	5	9	7	3				38
B: BENCH			B1	B2	B3	B4	B5	B6	B7				
	CORNUS SERICEA	RED OSIER DOGWOOD	7	7	7	7	12	10	4				54
	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW	7	7	7	7	12	10	4				54
	SALIX SITCHENSIS	SITKA WILLOW	7	7	7	7	12	10	4				54
CL: COIR LIFTS			CL1	CL2	CL3	CL4							
	SALIX SCOULERIANA	SCOULER'S WILLOW	127	127	117	117							488
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CT: TOP OF COIR BANK			CT1	CT2	CT3	CT4	CT5	CT6	CT7	CT8	CT9	CT10	
	HOLODISCUS DISCOLOR	OCEANSPRY	7	16	14	13	7	26	16	6	16	13	134
	RIBES SANGUINEUM	RED FLOWERING CURRANT	7	16	14	13	7	26	16	6	16	13	134
	SYMPHORICARPOS ALBUS	SNOWBERRY	7	16	14	13	7	26	16	6	16	13	134
	ALNUS RUBRA	RED ALDER	1	2	2	2	1	3	2	1	2	2	18
	POPULUS BALSAMIFERA	BLACK COTTONWOOD	1	2	2	2	1	3	2	1	2	2	18
	THUJA PLICATA	WESTERN RED CEDAR	1	2	2	2	1	3	2	1	2	2	18
SC: SELECTIVE PLANTING AREA			SC1	SC2	SC3	SC4	SC5	SC6	SC7				
	HOLODISCUS DISCOLOR	OCEANSPRY	2	3	3	2	10	4	5				29
	RIBES SANGUINEUM	RED FLOWERING CURRANT	2	3	3	2	10	4	5				29
	SYMPHORICARPOS ALBUS	SNOWBERRY	2	3	3	2	10	4	5				29
	ALNUS RUBRA	RED ALDER	1	2	2	1	5	2	3				16
	POPULUS BALSAMIFERA	BLACK COTTONWOOD	1	2	2	2	6	2	4				16
	THUJA PLICATA	WESTERN RED CEDAR	1	2	2	2	6	2	4				16

GENERAL NOTES:

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2. SEE PLANTING MATERIALS AND NOTES ON DRAWING P-3.
3. SEE PLANTING DETAILS ON DRAWING P-4.

DATUM
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City of Bellevue UTILITIES

PLANTING PLAN - RICHARDS CREEK

DRAWING P-2

SHT 17 OF 19

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Plot Date: 7/13/2010 5:51 PM
Cad User: Laura Turnidge

PLANT MATERIAL LIST:

PLANTING AREA\ TYPE NAME	SCIENTIFIC NAME	COMMON NAME	MATERIAL TYPE AND SIZE	SPACING ON CENTER (FT)	QUANTITY
A: ACCESS AREA					
	HOLODISCUS DISCOLOR	OCEANSPRAY	1 GAL CONT. 24" HEIGHT	3	26
	RIBES SANGUINEUM	RED FLOWERING CURRANT	1 GAL CONT. 24" HEIGHT	3	26
	SYMPHORICARPOS ALBUS	SNOWBERRY	1 GAL CONT. 24" HEIGHT	3	26
	THUJA PLICATA	WESTERN RED CEDAR	2 GAL CONT. 24" HEIGHT	3	6
CB: CHANNEL TO BENCH					
	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW	BARE ROOT OR LIVE STAKE 36–48" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	38
	SALIX SITCHENSIS	SITKA WILLOW	BARE ROOT OR LIVE STAKE 36–48" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	38
B: BENCH					
	CORNUS SERICEA	RED OSIER DOGWOOD	BARE ROOT OR LIVE STAKE 36–48" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	54
	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW	BARE ROOT OR LIVE STAKE 36–48" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	54
	SALIX SITCHENSIS	SITKA WILLOW	BARE ROOT OR LIVE STAKE 36–48" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	54
CL: COIR LIFTS					
	SALIX SCOULERIANA	SCOULER'S WILLOW	LIVE STAKE 36–48" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	488
	SALIX SESSILIFOLIA	SOFT LEAVED WILLOW	LIVE STAKE 36–48" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	488
	CORNUS SERICEA	RED–OSIER DOGWOOD	LIVE STAKE 36–48" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	488
CT: TOP OF COIR BANK					
	HOLODISCUS DISCOLOR	OCEANSPRY	1 GAL CONT. 24" HEIGHT	3	134
	RIBES SANGUINEUM	RED FLOWERING CURRANT	1 GAL CONT. 24" HEIGHT	3	134
	SYMPHORICARPOS ALBUS	SNOWBERRY	1 GAL CONT. 24" HEIGHT	3	134
	ALNUS RUBRA	RED ALDER	1 GAL CONT. 24" HEIGHT	10	18
	POPULUS BALSAMIFERA	BLACK COTTONWOOD	1 GAL CONT. 24" HEIGHT	10	18
	THUJA PLICATA	WESTERN RED CEDAR	2 GAL CONT. 24" HEIGHT	10	18
SC: SELECTIVE PLANTING AREA					
	HOLODISCUS DISCOLOR	OCEANSPRY	1 GAL CONT. 24" HEIGHT	10	29
	RIBES SANGUINEUM	RED FLOWERING CURRANT	1 GAL CONT. 24" HEIGHT	10	29
	SYMPHORICARPOS ALBUS	SNOWBERRY	1 GAL CONT. 24" HEIGHT	10	29
	ALNUS RUBRA	RED ALDER	1 GAL CONT. 24" HEIGHT	30	16
	POPULUS BALSAMIFERA	BLACK COTTONWOOD	1 GAL CONT. 24" HEIGHT	30	19
	THUJA PLICATA	WESTERN RED CEDAR	1 GAL CONT. 24" HEIGHT	30	19
CT AND CS: TOP OF BANK COVER					
	NATIVE GRASS SEED MIX PER CITY		HYDROSEED IF POSSIBLE	PER CITY	

GENERAL NOTES:

1. NOXIOUS WEEDS SHALL BE REMOVED PRIOR TO COMMENCING CONSTRUCTION. WEEDS SHALL BE REMOVED BY SELECTIVE CLEARING METHODS WITHIN THE RIPARIAN ENHANCEMENT ZONES. THE WORK SITE SHALL BE MAINTAINED IN A WEED FREE CONDITION THROUGHOUT CONSTRUCTION UNTIL THE CLOSE OF THE CONTRACT. AT A MINIMUM, HIMALAYAN BLACKBERRY, REED CANARYGRASS, ENGLISH IVY SHALL BE COMPLETELY REMOVED FROM THE PROJECT SITE. JAPANESE KNOTWEED TO BE REMOVED PER CITY SPECIFICATIONS.
2. SELECTIVE CLEARING METHODS CONSIST OF LIGHTWEIGHT HAND OR HAND–HELD EQUIPMENT TO PREVENT DAMAGE TO ROOTS OF EXISTING VEGETATION, COMPACTION OF SOIL, AND DISPERSAL OF SEEDS OR POLLEN FROM INVASIVE PLANTS.
3. NATIVE SEED MIX SHALL BE APPLIED TO ALL DISTURBED AREAS TO STABILIZED SOILS & TO PROVIDE HERBACEOUS COVER. SEEDING SHALL OCCUR AFTER SOIL PREPARATION AND GRADING HAS BEEN APPROVED BY ENGINEER. NATIVE SEED MIX SHALL BE APPLIED BY HAND TO FACES OF SOIL LIFTS PRIOR TO WRAPPING WITH WOVEN GEOTEXTILE. ALL OTHER AREAS WILL BE HYDROSEEDED.
4. ALL PLANTS, EXCEPT AS NOTED, SHALL BE NURSERY CONTAINER GROWN A MINIMUM OF ONE YEAR AND CONTAINERIZED PER ANSI STANDARDS. PLANT MATERIAL IS TO BE SUPPLIED BY COMMERCIAL NURSERIES THAT SPECIALIZE IN NATIVE PLANTS. PLANT SUBSTITUTIONS ARE SUBJECT TO APPROVAL BY THE ENGINEER.
5. SPECIFICATIONS FOR SIZE AND CONDITION ON DWG P–3 ARE MINIMUM.
6. PLANT SPECIES SELECTIONS FOR EACH PLANTING AREA ARE BASED ON PREDICTED LIGHT AND WATER AVAILABILITY. PLANTS SHALL BE MIXED THROUGHOUT EACH PLANTING ZONE. VERIFICATION OF APPROPRIATE ENVIRONMENTAL CONDITIONS PER SPECIES REQUIREMENTS WILL BE NECESSARY TO ACHIEVE MAXIMUM PLANT SURVIVAL. LAYOUT OF ALL PLANT MATERIAL AND SEEDING TO BE APPROVED BY THE ENGINEER PRIOR TO INSTALLATION. PLANTING PLAN MAY REQUIRE MODIFICATION FOLLOWING ASSESSMENT OF AS–BUILT CONDITIONS: USE PLAN FOR QUANTITIES – FINAL LOCATIONS OF PLANTS SUBJECT TO CHANGE.
7. SHRUBS, TREES AND, LIVE STAKES SHALL BE INSTALLED ACCORDING TO DETAILS ON DWG P–4.
8. DISCREPANCIES BETWEEN PLANS AND SITE CONDITIONS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER PRIOR TO PROCEEDING.
9. ENGINEER TO APPROVE GRADING PRIOR TO PLANTING.
10. KEEP ALL PLANT MATERIAL WELL–WATERED AND SHADED UNTIL THE ACTUAL TIME OF PLANTING: DO NOT ALLOW PLANT MATERIAL TO BE EXPOSED TO SUNLIGHT OR OTHER DRYING CONDITIONS PRIOR TO PLANTING.
11. ALL SHRUB AND TREE PLANTING SHALL OCCUR DURING THE DORMANT SEASON (OCTOBER THROUGH FEBRUARY).
12. THOROUGHLY WATER ALL PLANTED AREAS IMMEDIATELY AFTER PLANTING AND WATER FOR OPTIMUM HEALTH DURING DRY PERIODS DURING THE PLANT ESTABLISHMENT PERIOD.
13. EXISTING AREAS DISTURBED BY CONSTRUCTION ACTIVITIES AND NOT SHOWN TO BE RE–LANDSCAPED ON THESE PLANS SHALL BE RESTORED AND SEEDED AS DIRECTED BY THE ENGINEER.
14. SEE SPECIFICATIONS FOR ADDITIONAL SEEDING, PLANTING, AND SOIL PREPARATION NOTES.
15. ALL TREE OR SHRUB PLANTINGS SHALL BE SETBACK A MINIMUM OF 5 FEET FROM ALL PAVEMENT EDGES, AND ALL TREE PLANTINGS SHALL BE SETBACK A MINIMUM OF 10 FEET FROM BUILDINGS.
16. TREES WILL BE RETAINED DURING CONSTRUCTION ACCORDING TO SPECIFICATIONS ON DRAWING C–2.

DATUM

NAVD 88/NAD 83

811 Know what's below. Call before you dig.

ONE INCH

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

PERMIT SET - NOT FOR CONSTRUCTION

NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
Suite 1100
Seattle, Washington
98121-1820
206-441-9080
206-441-9108 FAX
http://www.herrerainc.com

SUNSET CREEK/RICHARDS CREEK FLOOD CONTROL AND HABITAT IMPROVEMENT PROJECT

Approved By

DESIGN MANAGER DATE

PROJECT MANAGER DATE

C. AVOLIO/M. STRAZER 07/2010
DESIGNED BY DATE
T. PRESCOTT 07/2010
DRAWN BY DATE
M. EWBANK 07/2010
CHECKED BY DATE

City of Bellevue UTILITIES

PLANT MATERIAL LIST

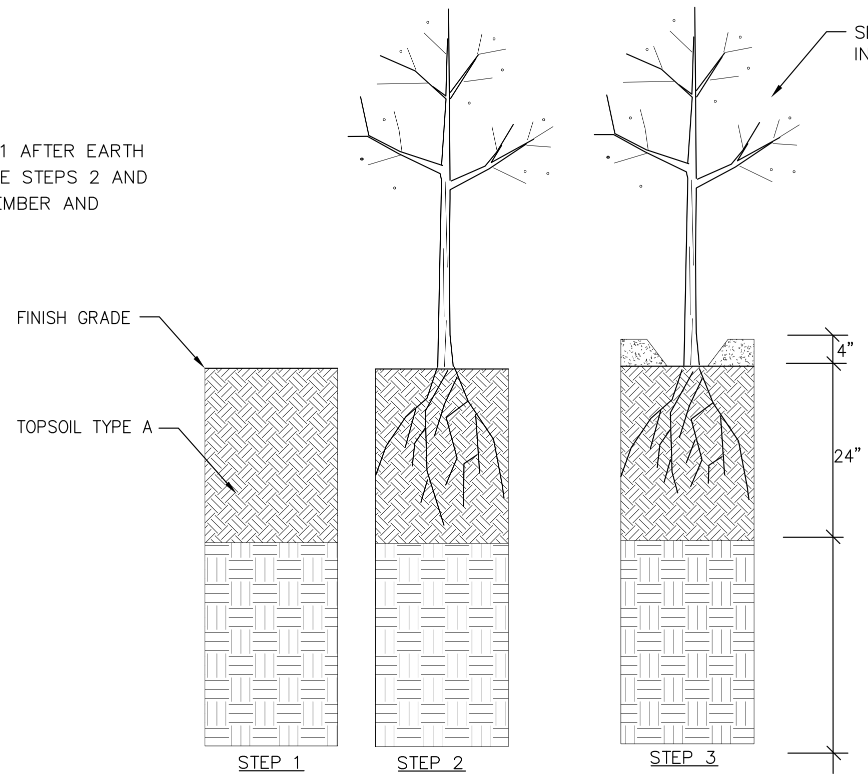
DRAWING P-3

SHT 18 OF 19

Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\P-3.dwg
Plot Date: 7/13/2010 5:51 PM Cad User: Laura Turnidge

NOTE:

1. COMPLETE STEP 1 AFTER EARTH WORK. COMPLETE STEPS 2 AND 3 BETWEEN NOVEMBER AND FEBRUARY



PLANTING AREA PREPARATION (SEE SPECIAL PROVISIONS)

STEP 1
- ADD 24" TOPSOIL TYPE A
- HYDROSEED WITH SEED MIX

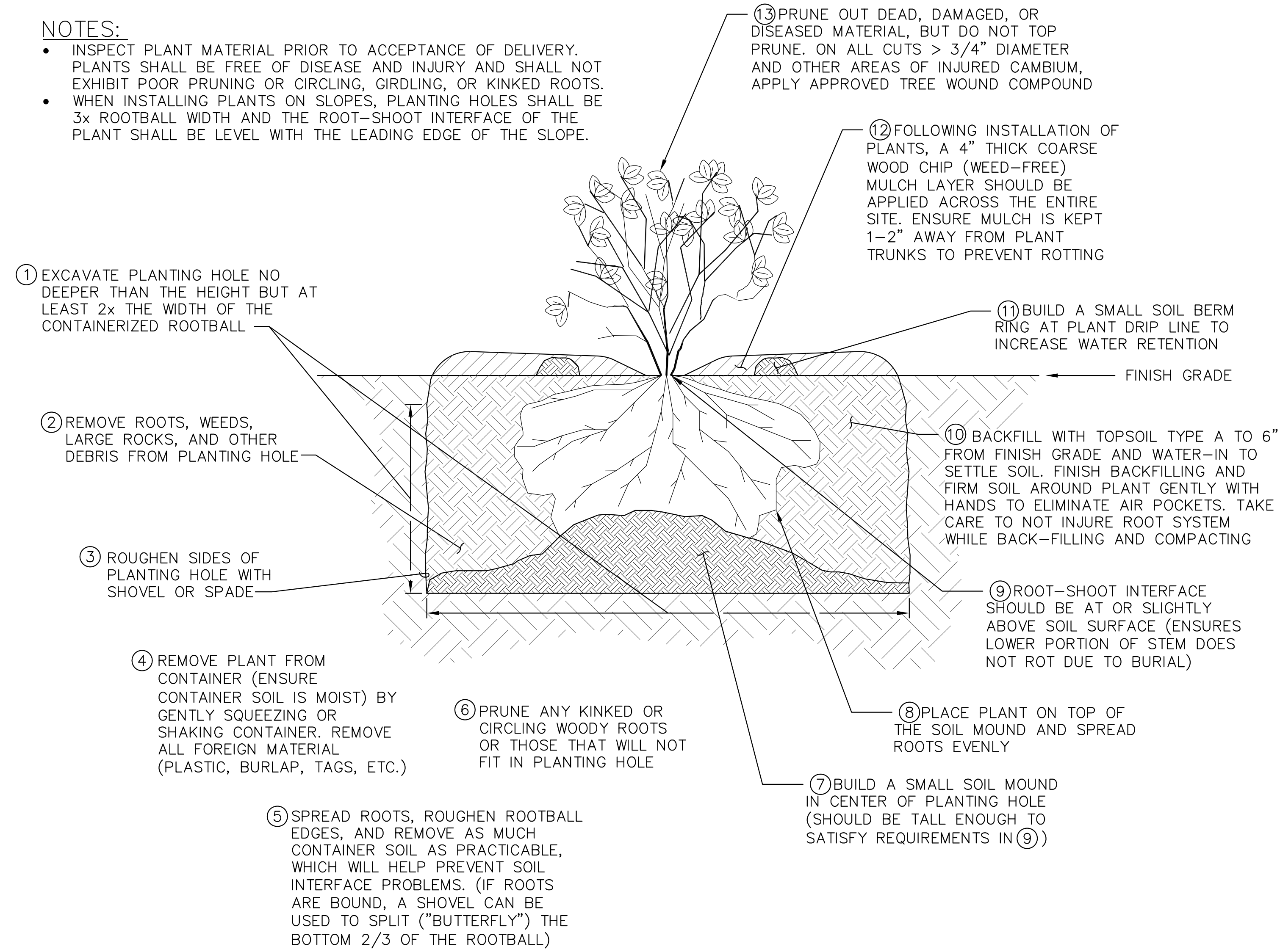
STEP 2
- INSTALL PLANT (SEE PLANTING DETAIL AND NOTE 1)

STEP 3
- INSTALL SOIL BERM RINGS AND 4" WOOD CHIP MULCH (SEE PLANTING DETAIL AND NOTE 1)

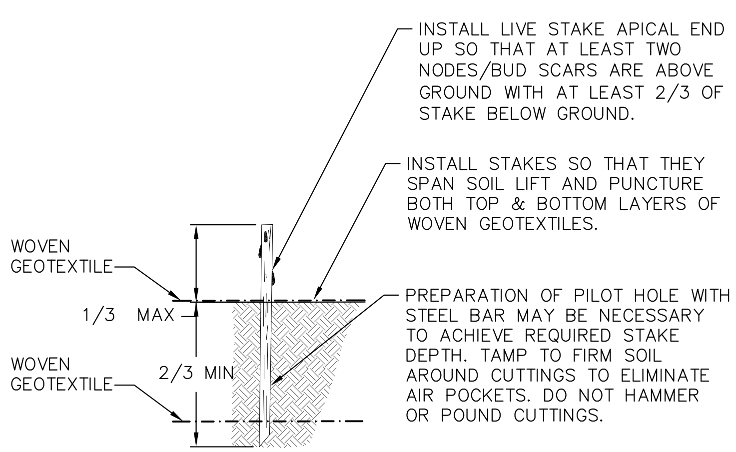
TOPSOIL TYPE A AMENDMENT AND PLANTING SEQUENCE OF WORK (1/–)
SCALE: NTS

NOTES:

- INSPECT PLANT MATERIAL PRIOR TO ACCEPTANCE OF DELIVERY. PLANTS SHALL BE FREE OF DISEASE AND INJURY AND SHALL NOT EXHIBIT POOR PRUNING OR CIRCLING, GIRDLING, OR KINKED ROOTS.
- WHEN INSTALLING PLANTS ON SLOPES, PLANTING HOLES SHALL BE 3x ROOTBALL WIDTH AND THE ROOT–SHOOT INTERFACE OF THE PLANT SHALL BE LEVEL WITH THE LEADING EDGE OF THE SLOPE.



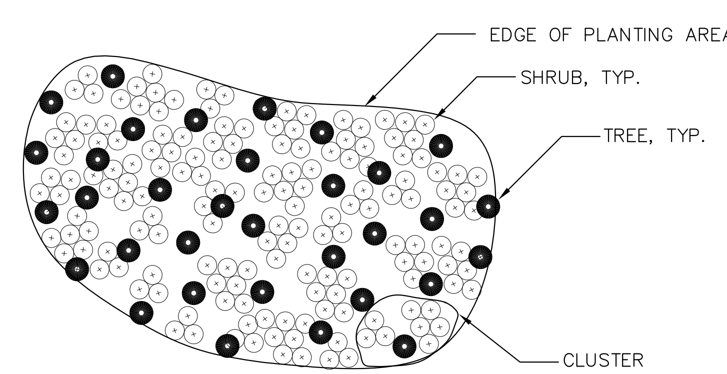
CONTAINERIZED TREE/SHRUB INSTALLATION SEQUENCE (2/–)
SCALE: NTS



NOTES:

1. SOAK WILLOW STAKES IN WATER FOR 24 HOURS PRIOR TO PLANTING.
2. BASAL END OF LIVE STAKES SHOULD BE 0.5–1.5 INCHES IN DIAMETER AND AT LEAST 36 INCHES IN LENGTH.
3. KEEP LIVE STAKES COVERED, COOL, AND MOIST AT ALL TIMES PRIOR TO PLANTING. AT NO TIME SHOULD LIVE STAKES BE EXPOSED AND ALLOWED TO DRY OUT.
4. WHEN PLANTING ON STREAM BANKS, ANGLE APICAL END OF STAKES SLIGHTLY DOWNSTREAM.

LIVE STAKE INSTALLATION (3/–)
SCALE: NTS



NOTES:

1. PLANT SHRUBS OF SAME SPECIES IN CLUSTERS OF THREE, FIVE, OR SEVEN.
2. PLACE SHRUBS 3 FEET ON CENTER WITHIN EACH CLUSTER. PLACE TREES ON CENTER PER PLANT MATERIAL LIST ON DRAWINGS P–3 BETWEEN CLUSTERS. (PLANTING DENSITIES WILL BE GREATER IN AREAS WITH HERBS.)
3. EVENLY SPACE CLUSTERS THROUGHOUT PLANTING AREA.
4. INTENT OF SHRUB PLANTING ARRANGEMENT IS TO ENCOURAGE NATURAL, IRREGULAR PATCH FORMATION.

DATUM
NAVD 88/NAD 83

Know what's below. Call before you dig.

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

PERMIT SET - NOT FOR CONSTRUCTION

Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\P-4.dwg Cad User: Laura Turnidge
Plot Date: 7/13/2010 5:51 PM

NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
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SUNSET CREEK/RICHARDS CREEK FLOOD CONTROL AND HABITAT IMPROVEMENT PROJECT

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C. AVOLIO/M. STRAZER	07/2010
DESIGNED BY	DATE
T. PRESCOTT	07/2010
DRAWN BY	DATE
M. EWBANK	07/2010
CHECKED BY	DATE

City of Bellevue UTILITIES

PLANTING DETAILS

DRAWING P-4

SHT 19 OF 19

APPENDIX B

Wetland Delineation Methods

Wetland Delineation Methods

This wetland delineation was performed in accordance with the Washington State Wetlands Identification and Delineation Manual (Ecology 1997) and the Interim Regional Supplement to the Corps of Engineers Wetlands Delineation Manual: Western Mountains, Valleys, and Coast Region (Environmental Laboratory 2008), both of which are consistent with the 1987 Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987). These methods use a three-parameter approach for identifying and delineating wetlands. This approach is based on the presence of field indicators for hydrophytic vegetation, hydric soils, and hydrology. This wetland delineation was performed according to procedures specified for the routine wetland determination method (Ecology 1997).

Hydrophytic Vegetation

Hydrophytic vegetation is characterized by the ability to grow, effectively compete, reproduce, and persist in anaerobic soil conditions that have resulted from periodic or long-term saturation. Numerous field indicators of hydrophytic vegetation may be used, although the most common indicator is defined as more than 50 percent of the dominant species in each vegetation stratum having a wetland indicator status of obligate wetland (OBL), facultative wetland (FACW), or facultative (FAC). The plant indicator status categories are explained in Table B-1.

Table B-1. Plant indicator status categories.

Indicator Status	Indicator Symbol	Definition
Obligate wetland plants	OBL	Plants that occur almost always (estimated probability >99 percent) in wetlands under natural conditions but also occur rarely (estimated probability <1 percent) in upland areas
Facultative wetland plants	FACW	Plants that usually occur (estimated probability >67 percent) in wetlands under natural conditions but also occur (estimated probability 1 percent to 33 percent) in upland areas
Facultative plants	FAC	Plants with a similar likelihood (estimated probability 33 percent to 67 percent) of occurring in both wetlands and upland areas
Facultative upland plants	FACU	Plants that sometimes occur (estimated probability 1 percent to 33 percent) in wetlands but occur more often (estimated probability >67 percent to 99 percent) in upland areas
Obligate upland plants	UPL	Plants that rarely occur (estimated probability <1 percent) in wetlands under natural conditions

WET ⟷ *DRY*

OBL → FACW → FAC → FACU → UPL

Source: Environmental Laboratory (1987).

Dominant species are those that contribute more than other species to the character of a plant community. To determine dominance, first a complete list of plant species that occur in the sampling area is compiled and divided into four strata: tree, sapling/shrub, herb, and woody vine.

Next, a vegetation sampling plot is determined by the field biologist to accurately characterize the plant community in the area to be evaluated. These sampling plots are typically circular areas that are centered on the location of the test pit (used to sample soils). The radius of the circle is determined in the field on the basis of site conditions. In large wetlands, a typical sampling radius would be 2 to 5 meters for tree and sapling/shrub species and 1 meter for herbaceous species. In a small or narrow wetland (or upland area), the radius might be reduced to accurately sample wetland (upland) areas and avoid overlapping an adjacent community with different vegetation, soils, or hydrologic conditions (Environmental Laboratory 2008). A plant is included in the tree stratum if it is a woody plant with a diameter at breast height (dbh) of at least 3 inches; in the sapling/shrub stratum if it is a woody plant less than 3 inches dbh; in the herb stratum if it is an herbaceous (nonwoody) plant; and in the woody vine stratum if it is a woody vine of any height (Environmental Laboratory 2008). To be included in the sampling, 50 percent or more of the plant base must be within the radius of the sampling plot. For a tree to be included, more than 50 percent of the trunk (diameter) must be within the sampling radius.

For each sampling plot, the plant species within each stratum are listed on the wetland determination data form, in decreasing order of their areal coverage. Starting with the plant species at the top of the stratum list (the highest percentage of coverage) and proceeding down the list (in descending order of coverage); the percentages are cumulatively totaled until the sum reaches 50 percent. The plant species that constitute this first 50 percent of areal coverage are considered the dominant species in the stratum. In addition, a plant species that constitutes 20 percent or more of the areal coverage in the stratum is also considered a dominant species (Environmental Laboratory 1987). The wetland determination data form includes this dominance test and the prevalence test for assessing whether the criteria for hydrophytic vegetation are met at each sampling plot (Environmental Laboratory 2008).

Plant species were identified using *Flora of the Pacific Northwest* (Hitchcock and Cronquist 1987) and *A Field Guide to the Common Wetland Plants of Western Washington and Northwestern Oregon* (Cooke 1997). The indicator status of each plant species is based on a list of plant species that occur in wetlands in the Pacific Northwest (USFWS 1993). Biologists referred to the national Plants Database produced by the U.S. Department of Agriculture (NRCS 2009a) to determine whether the scientific names of plants have changed since the publication of the national list of plant species that occur in wetlands (Reed 1988, 1993); any name changes were noted according to the Plants Database.

Other evidence of hydrophytic vegetation includes observation of plant species growing in areas of prolonged inundation or soil saturation, and visual evidence of physiological, morphological, or reproductive adaptations. The section in the supplement to the Corps of Engineers manual that discusses problematic hydrophytic vegetation further explains how to interpret these situations (Environmental Laboratory 2008).

Hydric Soils

A hydric soil is a soil that is saturated, flooded, or inundated long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation (SCS 1988). Hydric soils data were obtained by digging test pits at least 20 inches deep and 4 inches wide.

Hydric soil conditions were evaluated using indicators outlined in *Field Indicators of Hydric Soils in the United States* (NRCS 2006) and adopted by the *Interim Regional Supplement to the Corps of Engineers Wetlands Delineation Manual: Western Mountains, Valleys, and Coast Region* (Environmental Laboratory 2008)**.** These indicators are divided into three groups: all soils, sandy soils, and loamy and clayey soils. The “all soils” indicators can apply to any soil, regardless of texture; the “sandy soils” indicators are used in soil layers with textures of loamy fine sand or coarser; the “loamy and clayey soils” indicators are used for soil layers of loamy very fine sand and finer.

Hydric soil indicators applicable to the Western Mountains, Valleys, and Coast region include but are not limited to the presence of organic soils (i.e., histosols or histic epipedons), sulfidic material (i.e., hydrogen sulfide), depleted, gleyed, or reduced soil matrices, the presence of iron or manganese concretions, and color (Environmental Laboratory 2008). Soil color (i.e., hue, value, and chroma) was evaluated using *Munsell Soil Color Charts* (Munsell Color 2000).

Hydric soils were further confirmed by verifying their inclusion on the hydric soils list (NRCS 2009b).

Wetland Hydrology

Wetland hydrology is indicated by soils that are periodically inundated or saturated to the surface for a sufficient duration during the growing season. A sufficient duration is defined as at least 12.5 percent of the total growing season days that are consecutively inundated or saturated to the surface. The growing season is the period of consecutive frost-free days or the longest period during which the soil temperature stays above biological zero (41 degrees Fahrenheit [°F]) at 12 inches below the surface. As a general rule, the growing season for western Washington lowlands consists of 245 days, extending from March 1 to October 31 (Ecology 1997). Therefore, a sufficient duration of inundation would be a minimum of 31 days.

Two indicators of biological activity can be used to determine whether the growing season has begun and is ongoing (Environmental Laboratory 2008). The first indicator is the occurrence of aboveground growth and development of at least two nonevergreen vascular plant species within the wetland. Examples of this growth include the emergence or elongation of leaves on woody plants and the emergence or opening of flowers. The second indicator is soil temperature of at least 41°F at a depth of 12 inches, which can be measured once during a single site visit.

For this wetland delineation, hydrologic indicators were examined within the soil test pits in the field. Hydrologic indicators include the presence of surface water, standing water in the test pit at a depth of 12 inches or less, saturation in the root zone, watermarks, drift lines, sediment deposits, drainage patterns within wetlands, oxidized rhizospheres surrounding living roots, and water-stained leaves.

APPENDIX C

Wetland Delineation Data Forms

HERRERA ENVIRONMENTAL CONSULTANTS

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project Site:	Richards Creek	City/County:	King	Sampling Date:	06-21-2010
Applicant/Owner:	City of Bellevue	State:	WA	Sampling Point:	TP-1
Investigator(s):	Kris Lepine, Erik Schwartz	Section, Township, Range:	9, 24N, 5E		

Landform (hillslope, terrace, etc.): riverine | Local relief (concave, convex, none): concave | Slope (percent): 1

Subregion (LRR): A | Lat: 47°35'7.62"N | Long: 122°9'51.71"W | Datum:

Soil Map Unit Name: Urban Land | NWI classification: PFO

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation ☐, Soil ☐, Or Hydrology ☐, significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐

Are Vegetation ☐, Soil ☐, Or Hydrology ☐, naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☒ No ☐	Is the Sampled Area within a Wetland?	YES ☒ NO ☐
Hydric Soil Present?	Yes ☒ No ☐		
Wetland Hydrology Present?	Yes ☒ No ☐		

Remarks:

VEGETATION – Use scientific names of plants

Tree Stratum (Plot Size: **5 meters**)	Absolute percent Cover	Dominant Species?	Indicator Status
1. *Alnus rubra*	30	Y	FAC
2. *Salix sitchensis*	20	Y	FACW
3. *Salix lucida*	10		FACW+
4.			
	60	= Total Cover	
Sapling/Shrub Stratum (Plot Size: 5 meters)			
1. *Rubus spectabilis*	10	Y	FAC+
2. *Rubus armeniacus*	5	Y	FACU
3. *Acer circinatum**	5		FAC-
4. *Oemlaria cerasiformis*	2		FACU
5.			
	22	= Total Cover	
Herb Stratum (Plot Size: 1 meter)			
1. *Equisetum hyemale*	5	Y	FACW
2. *Glyceria borealis*	5	Y	OBL
3. *Cardamine occidentalis*	3		FACW+
4. *Rumex obtusifolius*	2		FAC
5.			
6.			
7.			
8.			
9.			
10.			
	17	= Total Cover	
Woody Vine Stratum (Plot Size:)			
1. *Hedera helix*	2	Y	NI
2. *Solanum dulcamara*	2	Y	FAC+
	4	= Total Cover	
percent Bare Ground in Herb Stratum =	**80**		

Dominance Test Worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC:	6	(A)
Total Number of Dominant Species Across All Strata:	8	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	75	(A/B)

Prevalence Index worksheet:

Total percent Cover of:	Multiply by:
OBL species	x1 =
FACW species	x2 =
FAC species	x3 =
FACU species	x4 =
UPL species	x5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- Dominance Test is >50 percent
- Prevalence Index is ≤3.0[1]
- Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- Wetland Non-Vascular Plants[1]
- Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ☒ No ☐

Remarks: ***Acer circinatum rooted outside of wetland.***

Project Site: Richards Creek

SOIL

Sampling Point: TP-1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	percent	Color (Moist)	percent	Type[1]	Loc[2]	Texture	Remarks
0-14	10YR 2/1	100					Sandy muck	
14-18+	5B 5/1	100	7.5YR 4/6	2	C	M	Sand	

[1]Type: C= Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☒ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type:

Depth (inches):

Hydric Soil Present? **Yes** ☒ **No** ☐

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☒ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stresses Plants (D1) **(LRR A)**
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) **(LRR A)**
- ☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes ☐	No ☒	Depth (inches):	
Water Table Present?	Yes ☒	No ☐	Depth (inches):	18
Saturation Present? (includes capillary fringe)	Yes ☒	No ☐	Depth (inches):	0

Wetland Hydrology Present? **Yes** ☒ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

HERRERA ENVIRONMENTAL CONSULTANTS

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project Site:	East Creek and Richards Creek Fish Passage Improvement and Stream Modification Project	City/County:	Bellevue	Sampling Date:	4-27-10
Applicant/Owner:	City of Bellevue	State:	WA	Sampling Point:	WLA –TP2
Investigator(s):	Kris Lepine, George Iftner, Katheryn Seckel	Section, Township, Range:	S 10, T 24 N, R 5 E		
Landform (hillslope, terrace, etc.):	Terrace	Local relief (concave, convex, none):	none	Slope (%):	3%
Subregion (LRR):	A	Lat: 47.585	Long: -122.162	Datum:	
Soil Map Unit Name:	Urban land	NWI classification:	PSSC		

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation ☐, Soil ☐, Or Hydrology ☐, significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐

Are Vegetation ☐, Soil ☐, Or Hydrology ☐, naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐ No ☒	**Is the Sampled Area within a Wetland? YES ☐ NO ☒**
Hydric Soil Present?	Yes ☐ No ☒	
Wetland Hydrology Present?	Yes ☐ No ☒	

Remarks: **None of the parameters were met.**

VEGETATION – Use scientific names of plants

Tree Stratum (Plot Size: **5 meters**)	Absolute % Cover	Dominant Species?	Indicator Status
1. *Alnus rubra*	30	Y	FAC
2. *Sorbus scopulina*	10	Y	FACW
3. *Pseudotsuga menziesii*	5	N	FACU
4.			
	45	= Total Cover	
Sapling/Shrub Stratum (Plot Size: **5 meters**)			
1. *Oemleria cerasiformis*	5	Y	FACU
2. *Ilex aquifolium*	5	Y	FACU
3. *Rubus armeniacus*	5	Y	FACU
4.			
5.			
	15	= Total Cover	
Herb Stratum (Plot Size: **1 meter**)			
1. *Equisetum telmateia*	5	Y	FACW
2. *Polystichum munitum*	5	Y	FACU
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
	10	= Total Cover	
Woody Vine Stratum (Plot Size:)			
1. *Hedera helix*	50	Y	NL
2.			
	50	= Total Cover	
% Bare Ground in Herb Stratum = **0**			

Dominance Test Worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC:	3	(A)
Total Number of Dominant Species Across All Strata:	8	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	37	(A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x1 =
FACW species	x2 =
FAC species	x3 =
FACU species	x4 =
UPL species	x5 =
Column Totals: (A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

Dominance Test is >50%

Prevalence Index is $\leq$3.0[1]

Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

Wetland Non-Vascular Plants[1]

Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ☐ No ☒

Remarks: **The criteria for hydrophytic vegetation indicators are not met.**

Project Site: East Creek and Richards Creek Fish Passage Improvement and Stream Modification Project

SOIL

Sampling Point: WLA – TP2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (Moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-5	10YR 3/2	100					Silty clay loam	No redox
5-16	10YR 5/2	100					Sandy clay loam	No redox

[1]Type: C= Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: N/A

Depth (inches): N/A

Hydric Soil Present? **Yes** ☐ **No** ☒

Remarks: **No hydric soil indicators were met**

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Water-Stained Leaves (B9) **(except MLRA 1, 2, 4A, and 4B)**
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stresses Plants (D1) **(LRR A)**
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water-Stained Leaves (B9) **(MLRA 1, 2, 4A, and 4B)**
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) **(LRR A)**
- ☐ Frost-Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes	☐	No	☒	Depth (inches):
Water Table Present?	Yes	☐	No	☒	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes	☐	No	☒	Depth (inches):

Wetland Hydrology Present? **Yes** ☐ **No** ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: **No wetland hydrology indicators were present.**

APPENDIX D

Wetland Rating Forms

Wetland name or number: A

WETLAND RATING FORM - WESTERN WASHINGTON

Version 2 - Updated July 2006 to increase accuracy and reproducibility among users
Updated Oct. 2008 with the new WDFW definitions for priority habitats

Name of wetland (if known): Wetland A — Date of site visit: 4/27/10

Rated by : Katheryn Seckel — Trained by Ecology? Yes ☑ No ☐ — Date: 6/18/08

SEC: 10 TWNSHP: 24 N RNGE: 5 E Is S/T/R in Appendix D? Yes ☐ No ☑

Map of wetland unit: Figure 6 **Estimated size:** >3

SUMMARY OF RATING

Category based on FUNCTIONS provided by wetland:

I ☐ **II** ☐ **III** ☑ **IV** ☐

Category I = Score >=70	
Category II = Score 51-69	
Category III = Score 30-50	
Category IV = Score <30	

Score for Water Quality Functions	16
Score for Hydrologic Functions	12
Score for Habitat Functions	20
TOTAL score for functions	**48**

Category based on SPECIAL CHARACTERISTICS of wetland

I ☐ **II** ☐ **Does not Apply** ☑

Final Category (choose the "highest" category from above) **III**

Check the appropriate type and class of wetland being rated.

Wetland Type	
Estuarine	☐
Natural Heritage Wetland	☐
Bog	☐
Mature Forest	☐
Old Growth Forest	☐
Coastal Lagoon	☐
Interdunal	☐
None of the above	☑

Wetland Class	
Depressional	☑
Riverine	☐
Lake-fringe	☐
Slope	☐
Flats	☐
Freshwater Tidal	☐
Check if unit has multiple HGM classes present	☐

Comments:

Does the wetland unit being rated meet any of the criteria below?

If you answer YES to any of the questions below, you will need to protect the wetland according to the regulations regarding the special characteristics found in the wetland.

Check List for Wetlands That May Need Special Protection (in addition to the protection recommended for its category)		YES	NO
SP1.	*Has the wetland unit been documented as a habitat for any federally listed Threatened or Endangered* ***animal or plant*** *species (T/E species)?* For the purposes of this rating system, "documented" means the wetland is on the appropriate state or federal database.	☐	☑
SP2.	*Has the wetland unit been documented as habitat for any state listed Threatened or Endangered* ***animal*** *species?* For the purposes of this rating system, "documented" means the wetland is on the appropriate state database. Note: Wetlands with State listed plant species are categorized as Category I Natural Heritage Wetlands (see p. 19 of data form).	☐	☑
SP3.	*Does the wetland unit contain individuals of Priority species listed by the WDFW for the state?*	☐	☐
SP4.	*Does the wetland unit have a local significance in addition to its functions?* For example, the wetland has been identified in the Shoreline Master Program, the Critical Areas Ordinance, or in a local management plan as having special significance.	☐	☐

To complete the next part of the data sheet, you will need to determine the Hydrogeomorphic Class of the wetland being rated.

The hydrogeomorphic classification groups wetlands into those that function in similar ways. This simplifies the questions needed to answer how well the wetland functions. The Hydrogeomorphic Class of a wetland can be determined using the key below. See p. 24 for more detailed instructions on classifying wetlands.

Classification of Vegetated Wetlands in Western Washington

If the hydrologic criteria listed in each question do not apply to the entire unit being rated, you probably have a unit with multiple HGM classes. In this case, indentify which hydrologic criteria in questions 1-7 apply and go to Question 8.

1. Are the water levels in the entire unit usually controlled by tides (i.e., except during floods)?

☑ NO - go to 2 ☐ YES - the wetland class is **Tidal Fringe**

If YES, is the salinity of the water during periods of annual low flow below 0.5 ppt (parts per thousand)?

☐ YES - **Freshwater Tidal Fringe** ☐ NO - **Saltwater Tidal Fringe (Estuarine)**

If your wetland can be classified as a Freshwater Tidal Fringe, use the forms for Riverine wetlands. If it is Saltwater Tidal Fringe, it is rated as an Estuarine wetland. Wetlands that were called estuarine in the first and second editions of the rating system are called Saltwater Tidal Fringe in the Hydrogeomorphic Classification. Estuarine wetlands were categorized separately in the earlier editions, and this separation is being kept in this revision. To maintain consistency between editions, the term "Estuarine" wetland is being kept. Please note, however, that the characteristics that define Category I and II estuarine wetlands have changed (see p. xx).

2. The entire wetland unit is flat and precipitation is only source (>90%) of water to it. Groundwater and surface water runoff are NOT sources of water to the unit.

☑ NO - go to 3 ☐ YES - the wetland class is **Flats**

If your wetland can be classified as a "Flats" wetland, use the form for **Depressional** wetlands.

3. Does the entire wetland unit **meet both** of the following criteria?

☐ The vegetated part of the wetland is on the shores of a body of permanent open water (without any vegetation on the surface) at least 20 acres (8 ha) in size;

☐ At least 30% of the open water area is deeper than 6.6 feet (2 m)?

☑ NO - go to 4 ☐ YES - the wetland class is **Lake-fringe (Lacustrine Fringe)**

4. Does the entire wetland unit **meet all** of the following criteria?

☐ The wetland is on a slope (*slope can be very gradual*).

☐ The water flows through the wetland in one direction (unidirectional) and usually comes from seeps. It may flow subsurface, as sheetflow, or in a swale without distinct banks.

☐ The water leaves the wetland **without being impounded.**

NOTE: *Surface water does not pond in these type of wetlands except occasionally in very small and shallow depressions or behind hummocks (depressions are usually <3 feet in diameter and less than 1 foot deep).*

☑ NO - go to 5 ☐ YES - the wetland class is **Slope**

5. Does the entire wetland unit **meet all** of the following criteria?

- ☐ The unit is in a valley, or stream channel, where it gets inundated by overbank flooding from that stream or river.
- ☐ The overbank flooding occurs once every two years.

☑ NO - go to 6 ☐ YES - the wetland class is **Riverine**

6. Is the entire wetland unit in a topographic depression in which water ponds, or is saturated to the surface, at some time of the year? *This means that any outlet, if present, is higher than the interior of the wetland.*

☐ NO - go to 7 ☑ YES - the wetland class is **Depressional**

7. Is the entire wetland unit located in a very flat area with no obvious depression and no overbank flooding? The unit does not pond surface water more than a few inches. The unit seems to be maintained by high ground water in the area. The wetland may be ditched, but has no obvious natural outlet.

☐ NO - go to 8 ☑ YES - the wetland class is **Depressional**

8. Your wetland unit seems to be difficult to classify and probably contains several different HGM classes. For example, seeps at the base of a slope may grade into a riverine floodplain, or a small stream within a depressional wetland has a zone of flooding along its sides. GO BACK AND IDENTIFY WHICH OF THE HYDROLOGIC REGIMES DESCRIBED IN QUESTIONS 1-7 APPLY TO DIFFERENT AREAS IN THE UNIT (make a rough sketch to help you decide). Use the following table to identify the appropriate class to use for the rating system if you have several HGM classes within your wetland. NOTE: Use this table only if the class that is recommended in the second column represents 10% or more of the total area of the wetland being rated. If the area of the second class is less than 10% of the unit, classify the wetland using the class that represent more than 90% of the total area.

HGM Classes Within a Delineated Wetland Boundary	***Class to Use in Rating***	
Slope + Riverine	Riverine	☐
Slope + Depressional	Depressional	☐
Slope + Lake-fringe	Lake-fringe	☐
Depressional + Riverine along stream within boundary	Depressional	☐
Depressional + Lake-fringe	Depressional	☐
Saltwater Tidal Fringe and any other class of freshwater wetland	Treat as ESTUARINE under wetlands with special characteristics	☐

If you are unable still to determine which of the above criteria apply to your wetland, or you have more than 2 HGM classes within a wetland boundary, classify the wetland as **Depressional** for the rating.

D Depressional and Flats Wetlands		
WATER QUALITY FUNCTIONS - Indicators that wetland functions to improve water quality.		
D 1.	**Does the wetland unit have the potential to improve water quality? *(see p. 38)***	**Points**
D 1.1	Characteristics of surface water flows out of the wetland: ☐ Unit is a depression with no surface water leaving it (no outlet) **Points = 3** ☐ Unit has an intermittently flowing, or highly constricted permanently flowing outlet. **Points = 2** ☑ Unit has an unconstricted, or slightly constricted, surface outlet (*permanently flowing*). **Points = 1** ☐ Unit is a flat depression (Q. 7 on key) or in the Flats class, with permenent surface outflow and **no obvious natural outlet** and/or outlet is a man-made ditch. (If ditch is not permanently flowing, treat unit as "intermittently flowing.") **Points = 1** Provide photo or drawing	1 **Figure __**
D 1.2	The soil 2 inches below the surface (or duff layer) is clay or organic (use NRCS definitions): ☐ YES **Points = 4** ☑ NO **Points = 0**	0
D 1.3	Characteristics of persistent vegetation (emergent, shrub, and/or forest Cowardin class): ☑ Wetland has persistent, ungrazed vegetation >=95% of area. **Points = 5** ☐ Wetland has persistent, ungrazed vegetation >=1/2 of area. **Points = 3** ☐ Wetland has persistent, ungrazed vegetation >=1/10 of area. **Points = 1** ☐ Wetland has persistent, ungrazed vegetation <1/10 of area **Points = 0** Map of Cowardin vegetation classes	5 **Figure __**
D 1.4	Characteristics of seasonal ponding or inundation. *This is the area of the wetland that is ponded for at least 2 months, but dries out sometime during the year. Do not count the area that is permanently ponded. Estimate area as the average condition 5 out of 10 years.* ☐ Area seasonally ponded is >1/2 total area of wetland. **Points = 4** ☑ Area seasonally ponded is >1/4 total area of wetland. **Points = 2** ☐ Area seasonally ponded is <1/4 total area of wetland. **Points = 0** Map of hydroperiods	2 **Figure __**
	Total for D 1 *Add the points in the boxes above*	8
D 2.	**Does the wetland unit have the opportunity to improve water quality? *(see p. 44)*** Answer YES if you know or believe there are pollutants in ground water or surface water coming into the wetland that would otherwise reduce water quality in streams, lakes, or ground water downgradient from the wetland. *Note which of the following conditions provide the sources of pollutants:* ☐ Grazing in the wetland or within 150 feet. ☑ Untreated stormwater discharges to wetland. ☐ Tilled fields or orchards within 150 feet of wetland. ☑ A stream or culvert discharges into wetland that drains developed areas, residential areas, farmed fields, roads, or clear-cut logging. ☑ Residential, urban areas, golf courses are within 150 feet of wetland. ☐ Wetland is fed by ground water high in phosphorus or nitrogen. ☐ Other: YES - multiplier is **2** NO - multiplier is **1**	Multiplier 2
TOTAL - Water Quality Functions	Multiply the score from D 1. by D 2. ***Add score to table on p. 1***	16

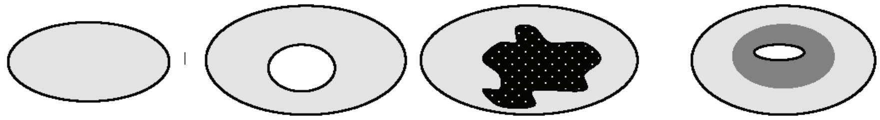
D Depressional and Flats Wetlands HYDROLOGIC FUNCTIONS - Indicators that wetland functions to reduce flooding/stream degradation.	
D 3. Does wetland unit have the <u>potential</u> to reduce flooding/erosion? ***(see p. 46)***	**Points**
D 3.1 Characteristics of surface water flows out of the wetland: ☐ Unit is a depression with no surface water leaving it (no outlet). **Points = 4** ☐ Unit has an intermittently flowing, **OR** highly constricted permanently flowing outlet. **Points = 2** ☐ Unit is a "flat" depression (Q. 7 on key), or in the Flats class, with permanent surface outflow and **no obvious natural outlet** and/or outlet is a man-made ditch. (*If ditch is not permanently flowing, treat unit at "intermittently flowing."*) **Points = 1** ☑ Unit has an unconstricted, or slightly constricted, surface outlet (*permanently flowing*). **Points = 0**	0
D 3.2 Depth of storage during wet periods. *Estimate the height of ponding above the bottom of the outlet. For units with no outlet measure from the surface of permanent water or deepest part (if dry).* ☐ Marks of ponding are 3 feet or more above the surface or bottom of outlet. **Points = 7** ☐ The wetland is a "headwater" wetland. **Points = 5** ☐ Marks of ponding between 2 feet to <3 feet from surface or bottom of outlet. **Points = 5** ☑ Marks are at least 0.5 feet to <2 feet from surface or bottom of outlet. **Points = 3** ☐ Wetland is flat (yes to Q. 2 or Q. 7 on key) but has small depressions on the surface that trap water. **Points = 1** ☐ Marks of ponding are less than 0.5 feet. **Points = 0**	3
D 3.3 Contribution of wetland to storage in the watershed. *Estimate the ratio of the area of upstream basin contributing surface water to the wetland to the area of the wetland itself.* ☐ The area of the basin is <10 times the area of the unit. **Points = 5** ☑ The area of the basin is 10 to 100 times the area of the unit. **Points = 3** ☐ The area of the basin is >100 times the area of the unit. **Points = 0** ☐ Entire unit is in the **Flats** class (basin=wetland) **Points = 5**	3
Total for D 3 *Add the points in the boxes above*	6
D 4. Does wetland unit have the opportunity to reduce flooding/erosion? ***(see p. 49)*** Answer YES if the unit is in a location in the watershed where the flood storage, or reduction in water velocity, helps protect downstream property and aquatic resources from flooding or excessive and/or erosive flows. Answer NO if the water coming into the wetland is controlled by a structure such as flood gate, tide gate, flap valve, reservoir, etc. OR you estimate that more than 90% of the water in the wetland is from groundwater in areas where damaging groundwater flooding does not occur. *Note which of the following indicators of opportunity apply:* ☐ Wetland is in a headwater of a river or stream that has flooding problems. ☑ Wetland drains to a river or stream that has flooding problems. ☐ Wetland has no outlet and impounds surface runoff water that might otherwise flow into a river or stream that has flooding problems. ☐ Other:	Multiplier
YES - multiplier is **2** NO - multiplier is **1**	2
TOTAL - Hydrologic Functions Multiply the score from D 3. by D 4. ***Add score to table on p. 1***	12

These questions apply to wetlands of all HGM classes HABITAT FUNCTIONS - Indicators that wetland functions to provide important habitat.	
H 1. Does the wetland unit have the <u>potential</u> to provide habitat for many species?	**Points**
H 1.1 <u>Vegetation structure</u> ***(see p. 72)*** *Check the types of vegetation classes present (as defined by Cowardin). Size threshold for class is 1/4 acre or more than 10% of the area if unit is smaller than 2.5 acres.* ☐ Aquatic bed ☐ Emergent plants ☐ Scrub/shrub (areas where shrubs have >30% cover) ☑ Forested (areas where trees have >30% cover) *If the unit has a forested class, check if:* ☐ The forested class has 3 out of 5 strata (canopy, sub-canopy, shrubs, herbaceous, moss/ground-cover) that each cover 20% within the forested polygon *Add the number of vegetation types that qualify. If you have:* 4 structures or more **Points = 4** 3 structures **Points = 2** 2 structures **Points = 1** 1 structure **Points = 0**	1
Map of Cowardin classes	**Figure __**
H 1.2 <u>Hydroperiods</u> ***(see p. 73)*** *Check the types of water regimes (hydroperiods) present within the wetland. The water regime has to cover more than 10% of the wetland if less than 2.5 acres in size or 1/4 acre to count (see text for descriptions of hydroperiods).* ☐ Permanently flooded or inundated — 4 or more types present **Points = 3** ☑ Seasonally flooded or inundated — 3 types present **Points = 2** ☐ Occasionally flooded or inundated — 2 types present **Points = 1** ☑ Saturated only — 1 type present **Points = 0** ☑ Permanently flowing stream or river in, or adjacent to, the wetland ☐ Seasonally flowing stream in, or adjacent to, the wetland ☐ ***Lake-fringe wetland = 2 points*** ☐ ***Freshwater tidal wetland = 2 points***	2
Map of hydroperiods	**Figure __**
H 1.3 <u>Richness of Plant Species</u> ***(see p. 75)*** *Count the number of plant species in the wetland that cover at least 10 sq. ft. (different patches of the same species can be combined to meet the size threshold). You do not have to name the species. Do not include Eurasian Milfoil, reed canarygrass, purple loosestrife, Canadian Thistle.* If you counted: $\boxed{\text{>19 species}}$ **Points = 2** 5-19 species **Points = 1** *List species below if you want to:* <5 species **Points = 0**	2

Total for page: 5

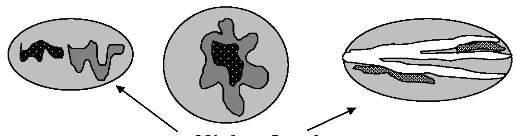
		Points
H 1.4	Interspersion of Habitats ***(see p. 76)***	

Decide from the diagrams below whether interspersion between Cowardin vegetation classes (described in H 1.1) or the classes and unvegetated areas (can include open water or mudflats) is high, medium, low, or none.



None = **0 points** Low = **1 point** Moderate = **2 points**

Points: 3



[riparian braided channels]

High = **3 points**

NOTE: If you have four or more vegetation types or three vegetation types and open water, the rating is always "high". **Use map of Cowardin vegetation classes.**

		Points
H 1.5	Special Habitat Features ***(see p. 77)***	

Check the habitat features that are present in the wetland. The number of checks is the number of points you put into the next column.

- ☑ Large, downed, woody debris within the wetland (>4 inches in diameter and 6 feet long).
- ☑ Standing snags (diameter at the bottom >4 inches) in the wetland.
- ☑ Undercut banks are present for at least 6.6 feet (2 m) and/or overhanging vegetation extends at least 3.3 feet (1 m) over a stream (or ditch) in or contiguous with the wetland, for at least 33 feet (10 m).
- ☑ Stable steep banks of fine material that might be used by beaver/muskrat for denning (>30° slope) OR signs of recent beaver activity are present (*cut shrubs or trees that have not yet turned brown/gray*).
- ☑ At least 1/4 acre of thin-stemmed presistent vegetation or woody branches are present in areas that are permanently or seasonally inundated (*structures for egg-laying by amphibians*).
- ☑ Invasive plants cover less than 25% of the wetland area in each stratum of plants.

Points: 5

Note: The 20% stated in early printings of the manual on page 78 is an error.

	Points
H 1. TOTAL Score - potential for providing habitat *Add the scores from H1.1, H1.2, H1.3, H1.4, H1.5*	13

Comments:

H 2.	Does the wetland unit have the opportunity to provide habitat for many species?	Points

H 2.1 Buffers ***(see p. 80)***

Choose the description that best represents condition of buffer of wetland unit. The highest scoring criterion that applies to the wetland is to be used in the rating. See text for definition of "undisturbed."

- ☐ 100 m (330 feet) of relatively undisturbed vegetated areas, rocky areas, or open water >95% of circumference. No structures are within undisturbed part of buffer (*relatively undisturbed also means no grazing, no landscaping, no daily human use*). **Points = 5**
- ☐ 100 m (330 feet) of relatively undisturbed vegetated areas, rocky areas, or open water >50% of circumference. **Points = 4**
- ☐ 50 m (170 feet) of relatively undisturbed vegetated areas, rocky areas, or open water >95% circumference. **Points = 4**
- ☐ 100 m (330 feet) of relatively undisturbed vegetated areas, rocky areas, or open water for >25% circumference. **Points = 3**
- ☐ 50 m (170 feet) of relatively undisturbed vegetated areas, rocky areas, or open water for >50% circumference. **Points = 3**

If buffer does not meet any of the criteria above:

- ☐ No paved areas (except paved trails) or buildings within 25 m (80 feet) of wetland >95% circumference. Light to moderate grazing, or lawns are OK. **Points = 2**
- ☐ No paved areas or buildings within 50 m of wetland for >50% circumference. Light to moderate grazing, or lawns are OK. **Points = 2**
- ☐ Heavy grazing in buffer. **Points = 1**
- ☑ Vegetated buffers are <2 m wide (6.6 feet) for more than 95% of the circumference (e.g., tilled fields, paving, basalt bedrock extend to edge of wetland). **Points = 0**
- ☐ Buffer does not meet any of the criteria above. **Points = 1**

Points: 0

Aerial photo showing buffers | **Figure __**

H 2.2 Corridors and Connections ***(see p. 81)***

H 2.2.1 Is the wetland part of a relatively undisturbed/unbroken vegetated corridor (riparian or upland) at least 150 feet wide, has at least 30% cover of shrubs, forest, or native undisturbed prairie, that connects to estuaries, other wetlands, or undisturbed uplands that are at least 250 acres in size? (*Dams in riparian corridors, heavily used gravel roads, and paved roads are considered breaks in the corridor.*)

YES = **4 points** (*go to H 2.3*) | NO = *go to H 2.2.2*

H 2.2.2 Is the wetland part of a relatively undisturbed/unbroken vegetated corridor (either riparian or upland) at least 50 feet wide, has at least 30% cover of shrubs or forest, and connects to estuaries, other wetlands, or undisturbed uplands that are at least 25 acres in size **OR** a **Lake-fringe** wetland, if it does not have an undisturbed corridor as in the question above?

YES = **2 points** (*go to H 2.3*) | NO = *go to H 2.2.3*

H 2.2.3 Is the wetland:

- ☐ within 5 miles (8 km) of a brackish or salt water estuary **OR**
- ☐ within 3 miles of a large field or pasture > 40 acres in size **OR**
- ☐ within 1 mile of a lake greater than 20 acres in size?

YES = **1 point** | NO = **0 points**

Points: 0

Total for page: 0

H 2.3 Near or Adjacent to Other Priority Habitats Listed by WDFW ***(see p. 82)***

Points

Which of the following priority habitats are within 330 feet (100 m) of the wetland unit?
NOTE: the connections do not have to be relatively undisturbed. These are DFW definitions. Check with your local DFW biologist if there are any questions

- [ ] **Aspen stands:** Pure or mixed stands of aspen >0.4 ha (1 acre).
- [x] **Biodiversity Areas and Corridors**: Areas of habitat that are relatively important to various species of native fish and wildlife (*full descriptions in WDFW PHS report p. 152*).
- [ ] **Herbaceous Balds**: Variable size patches of grass and forbs on shallow soils over bedrock.
- [ ] **Old-growth/Mature forests**: (Old growth west of Cascade crest) Stands of at least 2 tree species, forming a multi-layered canopy with occasional small openings; with at least 20 trees/ha (8/acre) >81 cm (32 in) dbh or > 200 years of age. (Mature forests) Stands with average diameters exceeding 53 cm (21 in) dbh; crown cover may be less than 100%; decay, decadance, numbers of snags, and quantity of large downed material is generally less than that found in old-growth; 80 - 200 years old west of the Cascade crest.
- [ ] **Oregon white Oak:** Woodland stands of pure oak or oak/conifer associations where canopy coverage of the oak component is 25% (*full descrptions in WDFW PHS report p. 158*).
- [x] **Riparian**: The area adjacent to aquatic systems with flowing water that contains elements of both aquatic and terrestrial ecosystems which mutually influence each other.
- [ ] **Westside Prairies**: Herbaceous, non-forested plant communities that can either take the form of a dry prairie or a wet prairie (*full descriptions in WDFW PHS report p. 161*).
- [x] **Instream**: The combination of physical, biological, and chemical processes and conditions that interact to provide functional life hsitory requirements for instream fish and wildlife resources.
- [ ] **Nearshore**: Relatively undisturbed nearshore habitats. These include Coastal Nearshore, Open Coastal Nearshore, and Puget Sound Nearshore. (*full descriptions of habitats and the definition of relatively undisturbed are in WDFW report pp. 167-169 and glossary in Appendix A).*
- [ ] **Caves**: Naturally occurring cavity, recess, void, or system of interconnected passages under the earth in soils, rock, ice, or other geological formations and is large enough to contain a human.
- [ ] **Cliffs**: Greater than 7.6 m (25 ft) high and occuring below 5,000 ft.
- [ ] **Talus**: Homogenous areas of rock rubble ranging in average size 0.15 - 2.0 m (0.5 - 6.5 ft), composed of basalt, andesite, and/or sedimentary rock, including riprap slides and mine tailings. May be associated with cliffs.
- [x] **Snags and Logs**: Trees are considered snags if they are dead or dying and exhibit sufficient decay characteristics to enable cavity excavation/use by wildlife. Priority snags have a diameter at breast height of > 51 cm (20 in) in western Washington and are > 2 m (6.5 ft) in height. Priority logs are > 30 cm (12 in) in diameter at the largest end, and > 6 m (20 ft) long.

4

If wetland has:		
	3+ priority habitats = **4 points**	**1** priority habitat = **1 point**
	2 priority habitats = **3 points**	No habitats = **0 points**

Note: all vegetated wetlands are by definition a priority habitat but are not included in this list. Nearby wetlands are addressed in question H 2.4

H 2.4	Wetland Landscape ***(see p. 84)*** *Choose the* ***one*** *description of the landscape around the wetland that best fits.*		Points
	☐ There are at least 3 other wetlands within 1/2 mile, and the connections between them are relatively undisturbed (light grazing between wetlands OK, as is lake shore with some boating, but connections should NOT be bisected by paved roads, fill, fields, or other development).	**Points = 5**	3
	☐ The wetland is Lake-fringe on a lake with little disturbance and there are 3 other Lake-fringe wetlands within 1/2 mile.	**Points = 5**	
	☑ There are at least 3 other wetlands within 1/2 mile, BUT the connections between them are disturbed.	**Points = 3**	
	☐ The wetland is Lake-fringe on a lake **with** disturbance, and there are 3 other Lake-fringe wetlands within 1/2 mile.	**Points = 3**	
	☐ There is at least 1 wetland within 1/2 mile.	**Points = 2**	
	☐ There are no wetlands within 1/2 mile.	**Points = 0**	
	H 2. TOTAL Score - opportunity for providing habitat *Add the scores from H2.1, H2.2, H2.3, H2.4*		7
Total Score for Habitat Functions - add the points for H1 and H2, and record the result on p. 1			20

CATEGORIZATION BASED ON SPECIAL CHARACTERISTICS

Please determine if the wetland meets the attributes described below and choose the appropriate answers and Category.

Wetland Type *Check off any criteria that apply to the wetland. Check the appropriate Category when the appropriate criteria are met.*	**Category**
SC 1.0 **<u>Estuarine Wetlands</u>** ***(see p. 86)*** Does the wetland unit meet the following criteria for Estuarine wetlands? ☐ The dominant water regime is tidal, ☐ Vegetated, and ☐ With a salinity greater than 0.5 ppt. ☐ YES = *Go to SC 1.1* ☐ NO - not an estuarine wetland	
SC 1.1 Is the wetland unit within a National Wildlife Refuge, National Park, National Estuary Reserve, Natural Area Preserve, State Park, or Educational, Environmental, or Scientific Reserve designated under WAC 332-30-151? ☐ YES = **Category I** ☐ NO = *Go to SC 1.2*	
SC 1.2 Is the wetland unit at least 1 acre in size and meeting at least two of the following three conditions? ☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing, and has <10% cover of non-native plant species. If the non-native *Spartina* spp. are the only species that cover >10% of the wetland, then the wetland should be given a dual rating (I/II). The area of *Spartina* would be rated a Category II while the relatively undisturbed upper marsh with native species would be a Category I. Do not, however, exclude the area of *Spartina* in determining the size threshold of 1 acre. ☐ At least 3/4 of the landward edge of the wetland has a 100 foot buffer of shrub, forest, or ungrazed or unmowed grassland. ☐ The wetland has at least two of the following features: tidal channels, depressions with open water, or continguous freshwater wetlands. ☐ YES = **Category I** ☑ NO = **Category II**	

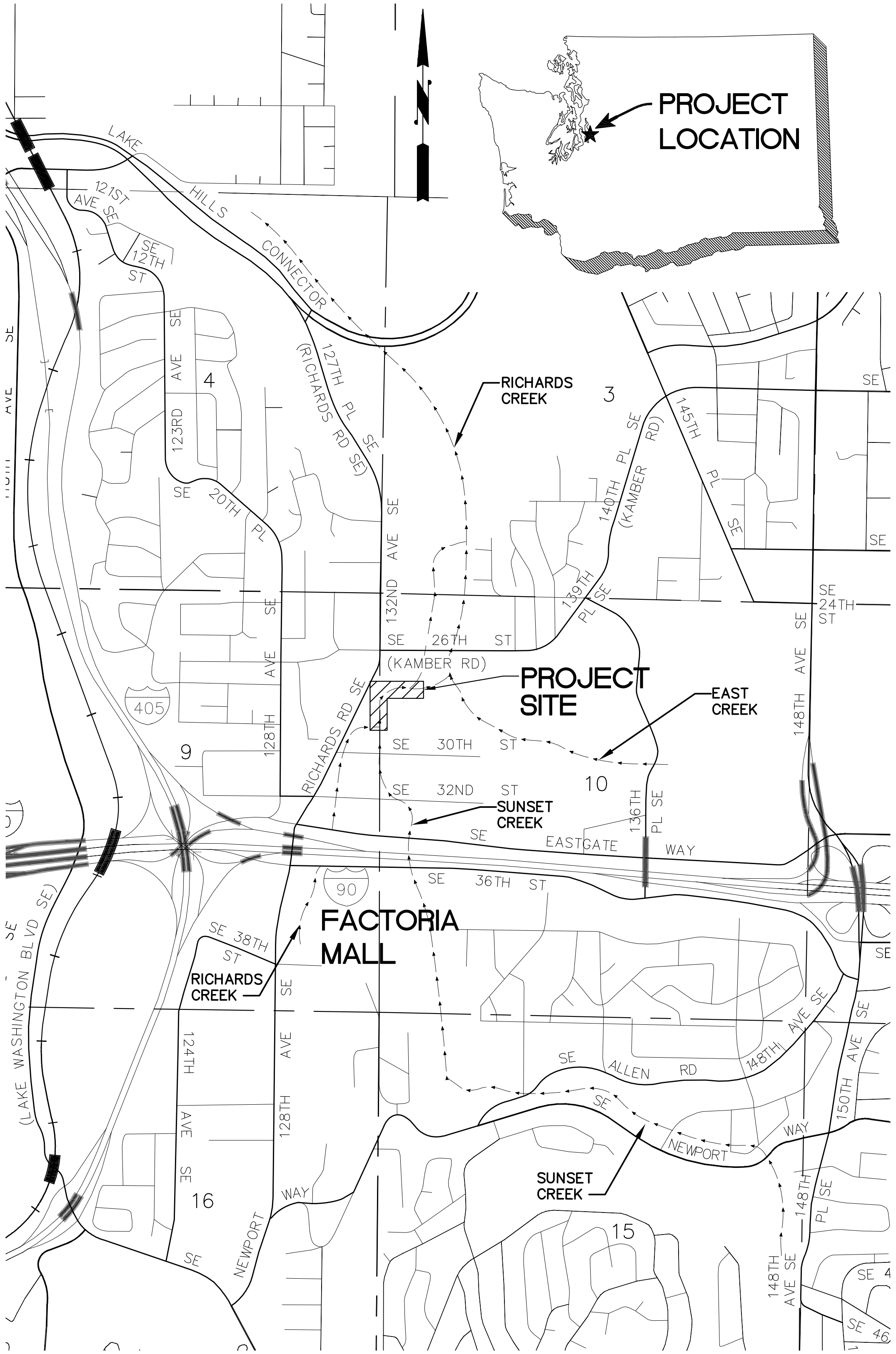
		Category
SC 2.0	**<u>Natural Heritage Wetlands</u>** ***(see p. 87)*** Natural Heritage wetlands have been identified by the Washington Natural Heritage Program/DNR as either high quality undisturbed wetlands or wetlands that support state Threatened, Endangered, or Sensitive plant species.	
SC 2.1	Is the wetland unit being rated in a Section/Township/Range that contains a Natural Heritage wetland? (This question is used to screen out most sites before you need to contact WNHP/DNR.) S/T/R information from Appendix D ☐ or accessed from WNHP/DNR web site ☐ ☐ YES - contact WNHP/DNR *(see p. 79)* and *go to SC 3.2* ☑ NO	
SC 2.2	Has DNR identified the wetland as a high quality undisturbed wetland or as a site with state Threatened or Endangered plant species? ☐ YES = **Category I** ☑ NO - not a Heritage wetland	
SC 3.0	**<u>Bogs</u>** ***(see p. 87)*** Does the wetland unit (or any part of the unit) meet both the criteria for soils and vegetation in bogs? *Use the key below to identify if the wetland is a bog.* ***If you answer Yes, you will still need to rate the wetland based on its function.*** 1. Does the unit have organic soil horizons (i.e., layers of organic soil), either peats or mucks, that compose 16 inches or more of the first 32 inches of the soil profile? (See Appendix B for a field key to identify organic oils.) ☐ YES - *go to Q. 3* ☑ NO - *go to Q. 2* 2. Does the unit have organic soils, either peats or mucks, that are <16 inches deep over bedrock, or an impermeable hardpan such as clay or volcanic ash, or that are floating on a lake or pond? ☐ YES - *go to Q. 3* ☑ NO - not a bog for purpose of rating 3. Does the unit have more than 70% cover of mosses at ground level, AND other plants, if present, consist of the "bog" species listed in Table 3 as a significant component of the vegetation (>30% of total shrub and herbaceous cover consists of species in Table 3)? ☐ YES - is a bog for purpose of rating ☑ NO - *go to Q. 4* NOTE: If you are uncertain about the extent of mosses in the understory you may substitute that criterion by measuring the pH of the water that seeps into a hole dug at least 16" deep. If the pH is less than 5.0 and the "bog" plant species in Table 3 are present, the wetland is a bog. 4. Is the unit forested (>30% cover) with sitka spruce, subalpine fir, western redcedar, western hemlock, lodgepole pine, quaking aspen, Englemann's spruce, or western white pine, WITH any of the species (or combination of species) on bog species plant list in Table 3 as a significant component of the ground cover (*>30% coverage of total shrub/herbaceous cover*)? ☐ YES - **Category I** ☑ NO - not a bog for purpose of rating	

SC 4.0	**Forested Wetlands** *(see p. 90)*	Category
	Does the wetland unit have at least 1 acre of forest that meets one of these criteria for the Department of Fish and Wildlife's forests as priority habitat? *If you answer Yes, you will still need to rate the wetland based on its functions.*	
	☐ **Old-growth forests**: (west of Cascade Crest) Stands of at least 2 tree species, forming a multi-layered canopy with occasional small openings; with at least 8 trees/acre (20/hectare) that are at least 200 years of age OR have a diameter at breast height (dbh) of 32 inches (81 cm) or more.	
	NOTE: The criterion for dbh is based on measurements for upland forests. 200-year-old trees in wetlands will often have a smaller dbh because their growth rates are often smaller. The DFW criterion is an "OR" so old-growth forests do not necessarily have to have trees of this diameter.	
	☐ **Mature forests**: (west of the Cascade Crest) Stands where the largest trees are 80 - 200 years old OR have average diameters (dbh) exceeding 21 inches (53 cm); crown cover may be less than 100%; decay, decadence, numbers of snags, and quantity of large downed material is generally less than that found in old-growth.	
	☐ YES = **Category I** ☑ NO - not a forested wetland w/ special characteristics	
SC 5.0	**Wetlands in Coastal Lagoons** *(see p. 91)*	
	Does the wetland meet all of the following criteria of a wtland in a coastal lagoon?	
	☐ The wetland lies in a depression adjacent to marine waters that is wholly or partially separated from marine waters by sandbanks, gravel banks, shingle, or, less frequently, rocks.	
	☐ The lagoon in which the wetland is located contains surface water that is saline or brackish (>.5 ppt) during most of the year in at leat a portion of the lagoon (*needs to be measured near the bottom*).	
	☐ YES = *go to SC 5.1* ☑ NO - not a wetland in a coastal lagoon	
SC 5.1	Does the wetland meet all of the following 3 conditions?	
	☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing), and has less than 20% cover of invasive plant species (see list of invasive species on p. 74).	
	☐ At least 3/4 of the landward edge of the wetland has a 100 foot buffer of shrub, forest, or ungrazed or unmowed grassland.	
	☑ The wetland is larger than 1/10 acre (4,350 square feet).	
	☐ YES = **Category I** ☐ NO = **Category II**	

SC 6.0	**Interdunal Wetlands** ***(see p. 93)***	**Category**
	Is the wetland unit west of the 1889 line (also called the Western Boundary of Upland Ownership or WBUO)? ☐ YES - *go to SC 6.1* ☑ NO - not an interdunal wetland for rating ***If you answer YES, you will still need to rate the wetland based on its functions.*** In practical terms, that means the following geographic areas: • Long Beach Peninsula - lands west of SR 103 • Grayland-Westport - lands west of SR 105 • Ocean Shores-Copalis - lands west of SR 1115 and SR 109.	
SC 6.1	Is wetland 1 acre or larger, or is it in a mosaic of wetlands that is 1 acre or larger? ☐ YES = **Category II** ☐ NO - *go to SC 6.2*	
SC 6.2	Is the wetland unit between 0.1 and 1 acre, or is it in a mosaic of wetlands that is between 0.1 and 1 acre? ☐ YES = **Category III**	
Category of wetland based on Special Characteristics Choose the "highest" rating if wetland falls into several categories, and record on p. 1. If you answered NO for all types, enter "Not Applicable" on p. 1.		N/A

CITY OF BELLEVUE
SUNSET CREEK PHASE II/RICHARDS CREEK
FLOOD CONTROL AND HABITAT IMPROVEMENT PROJECT

BELLEVUE, WASHINGTON



VICINITY MAP
SCALE: 1"=1000'

SHEET INDEX		
SHEET NO.	DRAWING NO.	SHEET DESCRIPTION
1	G-1	TITLE SHEET, INDEX, AND VICINITY MAP
2	G-2	GENERAL NOTES
3	G-3	ABBREVIATIONS AND LEGEND
4	C-1	SITE PLAN AND KEY MAP
5	C-2	SITE PREPARATION PLAN
6	C-3	UPSTREAM SUNSET CREEK PLAN AND PROFILE
7	C-4	DOWNSTREAM SUNSET CREEK PLAN AND PROFILE
8	C-5	UPSTREAM RICHARDS CREEK PLAN AND PROFILE
9	C-6	DOWNSTREAM RICHARDS CREEK PLAN AND PROFILE
10	C-7	SECTIONS
11	C-8	REVETMENT STRUCTURE DETAILS
12	C-9	DETAILS
13	ESC-1	TEMPORARY EROSION AND SEDIMENT CONTROL PLAN
14	ESC-2	TESC DETAILS
15	WM-1	FLOW DIVERSION AND FISH EXCLUSION DETAILS
16	P-1	PLANTING PLAN – SUNSET CREEK
17	P-2	PLANTING PLAN – RICHARDS CREEK
18	P-3	PLANT MATERIAL LIST
19	P-4	PLANTING DETAILS

1 / C-3 — DETAIL REFERENCE NUMBER; DRAWING ON WHICH DETAIL IS SHOWN

DETAIL
SCALE: NTS

1 / C-1 — DETAIL REFERENCE NUMBER; DRAWING FROM WHICH DETAIL WAS TAKEN

A / C-4 — SECTION REFERENCE LETTER; DRAWING ON WHICH SECTION IS SHOWN

SECTION
SCALE: NTS

A / C-2 — SECTION REFERENCE LETTER; DRAWING FROM WHICH SECTION WAS TAKEN

"–" INDICATES THAT THE DETAIL/SECTION IS SHOWN ON THE SAME SHEET

"TYP" INDICATES THAT THE DETAIL/SECTION IS UNIFORMLY TYPICAL THROUGHOUT PROJECT EXCEPT WHERE OTHERWISE NOTED

"VAR" SPECIFIES THAT DETAIL/SECTION WAS TAKEN FROM SEVERAL DRAWINGS

NOTE AND DETAIL/SECTION REFERENCING

DATUM
NAVD 88/NAD 83

811 Know what's below. Call before you dig.

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

PERMIT SET - NOT FOR CONSTRUCTION

NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
Suite 1100
Seattle, Washington
98121-1820
206-441-9080
206-441-9108 FAX
http://www.herrerainc.com

SUNSET CREEK/RICHARDS CREEK FLOOD CONTROL AND HABITAT IMPROVEMENT PROJECT

Approved By
DESIGN MANAGER — DATE
PROJECT MANAGER — DATE

C. AVOLIO/M. STRAZER 07/2010 — DESIGNED BY — DATE
T. PRESCOTT 07/2010 — DRAWN BY — DATE
M. EWBANK 07/2010 — CHECKED BY — DATE

City of Bellevue
UTILITIES

TITLE SHEET, INDEX, AND VICINITY MAP

DRAWING G-1 | SHT 1 OF 19

Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\G-1.dwg
Plot Date: 7/13/2010 5:47 PM   Cad User: Laura Turnidge

GENERAL NOTES:

1. MATERIAL SHALL NOT BE STORED OUTSIDE OF IDENTIFIED STAGING AREAS, UNLESS APPROVED BY OWNER OR ENGINEER.
2. ALL EQUIPMENT SHALL USE ONLY BIODEGRADABLE HYDRAULIC FLUIDS.
3. CONTRACTOR SHALL LIMIT MACHINERY MOVEMENT TO PROJECT LIMITS DEFINED ON SITE PLAN OR IDENTIFIED AS ACCEPTABLE BY ENGINEER.
4. CLEARING LIMITS FOR TEMPORARY ACCESS ROAD AND PROPOSED STRUCTURES SHALL BE LIMITED TO THE AREA REQUIRED FOR SAFE EQUIPMENT OPERATION. CLEARING LIMITS SHALL BE STAKED BY CONTRACTOR AND APPROVED BY ENGINEER AT LEAST 3 DAYS PRIOR TO CLEARING ACTIVITIES. CLEARING LIMITS SHALL BE STAKED TO MINIMIZE THE AREA OF DISTURBANCE.
5. CONTRACTOR SHALL PROVIDE 24 HOURS ADVANCE NOTICE TO THE ENGINEER PRIOR TO ANY REQUIRED INSPECTION.
6. CONTRACTOR SHALL SUBMIT A CONSTRUCTION SEQUENCE PLAN FOR APPROVAL AT LEAST 5 DAYS PRIOR TO SITE WORK.
7. APPROVED CONSTRUCTION SEQUENCE PLAN SHALL NOT BE ALTERED UNLESS APPROVED BY ENGINEER.
8. EQUIPMENT USED FOR THIS PROJECT SHALL BE FREE OF EXTERNAL PETROLEUM-BASED PRODUCTS WHILE WORKING AROUND THE STREAM. ACCUMULATION OF SOILS OR DEBRIS SHALL BE REMOVED FROM THE DRIVE MECHANISMS (WHEELS, TRACKS, TIRES, ETC.) AND UNDERCARRIAGE OF EQUIPMENT PRIOR TO ITS WORKING WITHIN THE CHANNEL.
9. EQUIPMENT SHALL BE CHECKED DAILY FOR LEAKS, AND ANY NECESSARY REPAIRS SHALL BE COMPLETED PRIOR TO COMMENCING WORK ACTIVITIES.
10. THE CONTRACTOR IS RESPONSIBLE TO ENSURE THAT NO PETROLEUM PRODUCTS, HYDRAULIC FLUID, SEDIMENTS, SEDIMENT-LADEN WATER, CHEMICALS, OR ANY OTHER TOXIC OR DELETERIOUS MATERIALS ARE ALLOWED TO ENTER OR LEACH INTO THE STREAM.
11. IF AT ANY TIME, AS A RESULT OF PROJECT ACTIVITIES, FISH ARE OBSERVED IN DISTRESS, A FISH KILL OCCURS, OR WATER QUALITY PROBLEMS DEVELOP (INCLUDING EQUIPMENT LEAKS OR SPILLS), OPERATIONS SHALL CEASE AND THE ENGINEER SHALL BE NOTIFIED IMMEDIATELY. WASHINGTON DEPARTMENT OF FISH AND WILDLIFE AND WASHINGTON DEPARTMENT OF ECOLOGY SHALL BE CONTACTED IMMEDIATELY BY THE ENGINEER OR BY HIS/HER DESIGNEE. WORK SHALL NOT RESUME UNTIL FURTHER APPROVAL BY OWNER'S REPRESENTATIVE.
12. EROSION CONTROL METHODS SHALL BE USED TO PREVENT SILT-LADEN WATER FROM ENTERING THE CREEK. INITIAL EROSION CONTROL MEASURES ARE SHOWN ON DRAWINGS ESC-1 AND ESC-2. THE CONTRACTOR SHALL SUBMIT A TEMPORARY EROSION AND SEDIMENT CONTROL PLAN SHOWING ADDITIONAL SITE SPECIFIC EROSION AND SEDIMENT CONTROL TECHNIQUES AND METHODS.
13. IF HIGH FLOW CONDITIONS THAT MAY CAUSE SILTATION OR EROSION OCCUR DURING CONSTRUCTION, WORK SHALL STOP UNTIL THE FLOW SUBSIDES.
14. CONTRACTOR IS RESPONSIBLE FOR CALLING "ONE CALL" FOR UTILITY LOCATES 72 HOURS PRIOR TO CONSTRUCTION. 1 (800) 424-5555 OR 811.
15. THE EXISTING FEATURES AS SHOWN ON THE EXISTING CONDITIONS PLAN WERE PROVIDED BY THE CITY OF BELLEVUE AND FROM SUPPLEMENTAL FIELD WORK PERFORMED BY APS.
16. ALL DIMENSIONS SHOWN SHALL BE FIELD VERIFIED FOR FIT-UP.
17. LOCAL PROJECT BENCHMARK LOCATIONS:
    - CHISELED "X" ON WEST FLANGE BOLT OF FIRE HYDRANT LOCATED ON NORTH SIDE OF SE 30TH ST., APPROX. 370' EAST OF MAIN STREAM CHANNEL. ELEV.=73.66'
    - CITY OF BELLEVUE CHANNEL MONITORING PK #520400 LOCATED IN PARKING LOT APPROX. 60' NORTH OF STEAD BUILDING AND APPROX. 18' EAST OF CURB. ELEV.=64.91', N: 216125.72, E: 1311976.03
    - CITY OF BELLEVUE CHANNEL MONITORING PK #5538 LOCATED ON ASPHALT APPROX. 44' WEST AND 10' SOUTH OF SE CORNER OF OPTIVA BUILDING. ELEV.=62.83, N: 216504.21, E: 1312174.30

LOG NOTES:

1. DECKED LOGS SHALL BE ACCESSIBLE FOR INSPECTION.
2. LOG TYPE IDENTIFICATION SHALL BE PAINTED ON ALL LOGS IN A PLACE VISIBLE FOR INSPECTION PRIOR TO PLACEMENT WITH LEAD-FREE, BLAZE-ORANGE SURVEY MARKING PAINT.
3. SEE SPECIFICATIONS FOR LOG TYPE (SPECIES), DIAMETER AND LENGTH. EXCAVATIONS SHALL BE INSPECTED BY ENGINEER PRIOR TO PLACEMENT OF ANY WOOD.
4. LOG PLACEMENTS SHALL BE INSPECTED BY ENGINEER PRIOR TO BACKFILLING.

UTILITIES AND AGENCIES

CITY OF BELLEVUE

ABE SANTOS – PROJECT MANAGER

450 110TH AVENUE NE
BELLEVUE, WA 98004
(425) 452-6456

EMAIL: ASANTOS@BELLEVUEWA.GOV

KING COUNTY DEPARTMENT OF NATURAL RESOURCES, WASTEWATER TREATMENT DIVISION

ERIC DAVISON

201 S. JACKSON ST, MAIL STOP KSC-NR-0508
SEATTLE, WA 98104-3855

(206) 684-1707
FAX: (206) 684-1710
ERIC.DAVISON@KINGCOUNTY.GOV

BELLEVUE WATER DISTRICT #1

KIPP FOCKLER – OPERATING & WATER MAINTENANCE
(425) 452-2923

GREG KNIGHT
(425) 452-4493

BELLEVUE FIRE DEPARTMENT

NON-EMERGENCY GENERAL
(425) 452-6892

FIRE PREVENTION PLAN REVIEW DESK
(425) 452-4122

BELLEVUE POLICE DEPARTMENT

(425) 452-6917

CITY OF BELLEVUE – TRANSPORTATION DEPARTMENT

JON REGALIA

450 110TH AVENUE NE
BELLEVUE, WA 98004
(425) 452-4599

EMAIL: JREGALIA@BELLEVUEWA.GOV

CITY OF BELLEVUE – PERMIT CENTER

TRAVIS RIPLEY
(425) 452-6042

PUGET SOUND ENERGY (PSE CONSTRUCTION)

JEANNE COLEMAN – MUNICIPAL CONSTRUCTION PLANNER

P.O. BOX 97034
MAIL STOP: EST-11W
BELLEVUE, WA 98009-9734

(425) 462-3488
EMAIL: JEANNE.COLEMAN@PSE.COM

COMCAST (FORMERLY AT&T BROADBAND)

JILL LOOK

1525 75TH ST. SW, SUITE 200
EVERETT, WA 98203

(425) 263-5346
FAX: (425) 263-5352
MOBILE: (206) 396-6032
EMAIL: JILL_LOOK@CABLE.COMCAST.COM

QWEST (US WEST COMMUNICATIONS)

VERN SAXTON

1550 NEWPORT WAY NW, ROOM #2
ISSAQUAH, WA 98027

(206) 345-1177
EMAIL: VERN.SAXTON@QWEST.COM

ONE CALL

UTILITY LOCATION
(800) 424-5555 OR 811

DATUM
NAVD 88/NAD 83

811 Know what's below. Call before you dig.

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

PERMIT SET - NOT FOR CONSTRUCTION

NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
Suite 1100
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98121-1820
206-441-9080
206-441-9108 FAX
http://www.herrerainc.com

SUNSET CREEK/RICHARDS CREEK FLOOD CONTROL AND HABITAT IMPROVEMENT PROJECT

Approved By
DESIGN MANAGER DATE
PROJECT MANAGER DATE

C. AVOLIO/M. STRAZER 07/2010
DESIGNED BY DATE
T. PRESCOTT 07/2010
DRAWN BY DATE
M. EWBANK 07/2010
CHECKED BY DATE

City of Bellevue
UTILITIES

GENERAL NOTES

DRAWING G-2 SHT 2 OF 19

Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\G-2.dwg Cad User: Laura Turnidge
Plot Date: 7/13/2010 5:49 PM

ABBREVIATIONS:

AC	ASPHALT CONCRETE
APPROX	APPROXIMATE(LY)
CB	CATCH BASIN
CDF	CONTROLLED DENSITY FILL
CIP	CAST IN PLACE
COB	CITY OF BELLEVUE
CONC	CONCRETE
CMP	CORRUGATED METAL PIPE
DBH	DIAMETER AT BREAST HEIGHT
DI	DUCTILE IRON
DIA, ø	DIAMETER
DWG	DRAWING
ESC	EROSION AND SEDIMENT CONTROL
EX	EXISTING
FAC	FACULTATIVE
FACU	FACULTATIVE UPLAND
FACW	FACULTATIVE WETLAND
FDC	FIRE DEPARTMENT CONNECTION
FH	FIRE HYDRANT
FT	FEET
HMA	HOT MIX ASPHALT
IN	INCHES
KC	KING COUNTY
LWD	LARGE WOODY DEBRIS
MH	MANHOLE
MIN	MINIMUM
NI	NO INDICATOR
OHP	OVERHEAD POWER LINE
OHWL	ORDINARY HIGH WATER LINE
PC	PRECAST CONCRETE
PSE	PUGET SOUND ENERGY
SDMH	STORM DRAIN MANHOLE
SP	STANDARD PLAN
SS	STAINLESS STEEL
TEL	TELEPHONE
TESC	TEMPORARY EROSION AND SEDIMENT CONTROL
TYP	TYPICAL
UGP	UNDERGROUND POWER LINE
UGT	UNDERGROUND TELEPHONE LINE
UPL	OBLIGATE UPLAND

LEGEND:

- EXISTING BUILDING
- EXISTING CURB
- EXISTING CONTOURS (72)
- EXISTING R.O.W.
- EXISTING BANK SLOPE
- EXISTING OVERHEAD POWER LINE (OHP)
- EXISTING UNDERGROUND POWER LINE (UGP)
- EXISTING WATER LINE (W)
- EXISTING GAS LINE (G)
- EXISTING STORM DRAINAGE (SD)
- EXISTING SANITARY SEWER (S)
- EXISTING SANITARY SEWER MANHOLE
- EXISTING CATCH BASIN
- EXISTING STORM DRAIN MANHOLE
- EXISTING TELEPHONE J–BOX (T)
- EXISTING POWER VAULT (P)
- EXISTING GAS METER
- EXISTING FIRE DEPT CONNECTION
- EXISTING POWER POLE
- EXISTING POWER TRANSFORMER
- EXISTING TREES
- EXISTING BOULDERS
- EXISTING WETLANDS

- CREEK FLOW LINE
- HIGH VISIBILITY FENCE
- SILT FENCE
- EXCAVATION LIMITS
- COIR WRAP
- EXISTING GRADE
- EXISTING ORDINARY HIGH WATER LINE
- DIVERTED FLOW LINE
- PROPOSED AVERAGE GRADE
- SELECTIVE CLEARING AREA
- CLEAR AND GRUB AREA
- STREAMBED SEDIMENT
- STREAMBED COBBLE
- EXISTING GROUND
- TEMPORARY STREAM ACCESS
- EXCAVATED ALLUVIUM
- STAGING AREA
- STORM DRAIN INLET PROTECTION
- CHANNEL THALWEG STATIONING (FT) (1+00)
- PROPOSED DEMOLITION
- ECOLOGY BLOCKS
- FLOOD CONTROL BERM
- TREES TO BE REMOVED
- TREES TO BE PROTECTED

- BULK BAGS
- STREAMBED BOULDERS
- LOGS WITH ROOTWAD
- LOGS WITHOUT ROOTWAD
- LOGS WITH ROOTWAD BURIED
- LOGS WITHOUT ROOTWAD BURIED
- LOG SECTION
- VEGETATION
- LOG IDENTIFICATION # (#)
- LOG CONTROL POINT
- DUCK BILL ANCHOR
- SOLDIER PILE (H)
- GRADE CONTROL STRUCTURE (PLAN)
- HABITAT STRUCTURE (PLAN)
- REVETMENT STRUCTURE (PLAN)
- GRADE CONTROL STRUCTURE (PROFILE)
- HABITAT STRUCTURE (PROFILE)
- REVETMENT STRUCTURE (PROFILE)

DATUM

NAVD 88/NAD 83

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ONE INCH

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PERMIT SET - NOT FOR CONSTRUCTION

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206-441-9108 FAX
http://www.herrerainc.com

SUNSET CREEK/RICHARDS CREEK FLOOD CONTROL AND HABITAT IMPROVEMENT PROJECT

Approved By

DESIGN MANAGER DATE

PROJECT MANAGER DATE

C. AVOLIO/M. STRAZER 07/2010
DESIGNED BY DATE
T. PRESCOTT 07/2010
DRAWN BY DATE
M. EWBANK 07/2010
CHECKED BY DATE

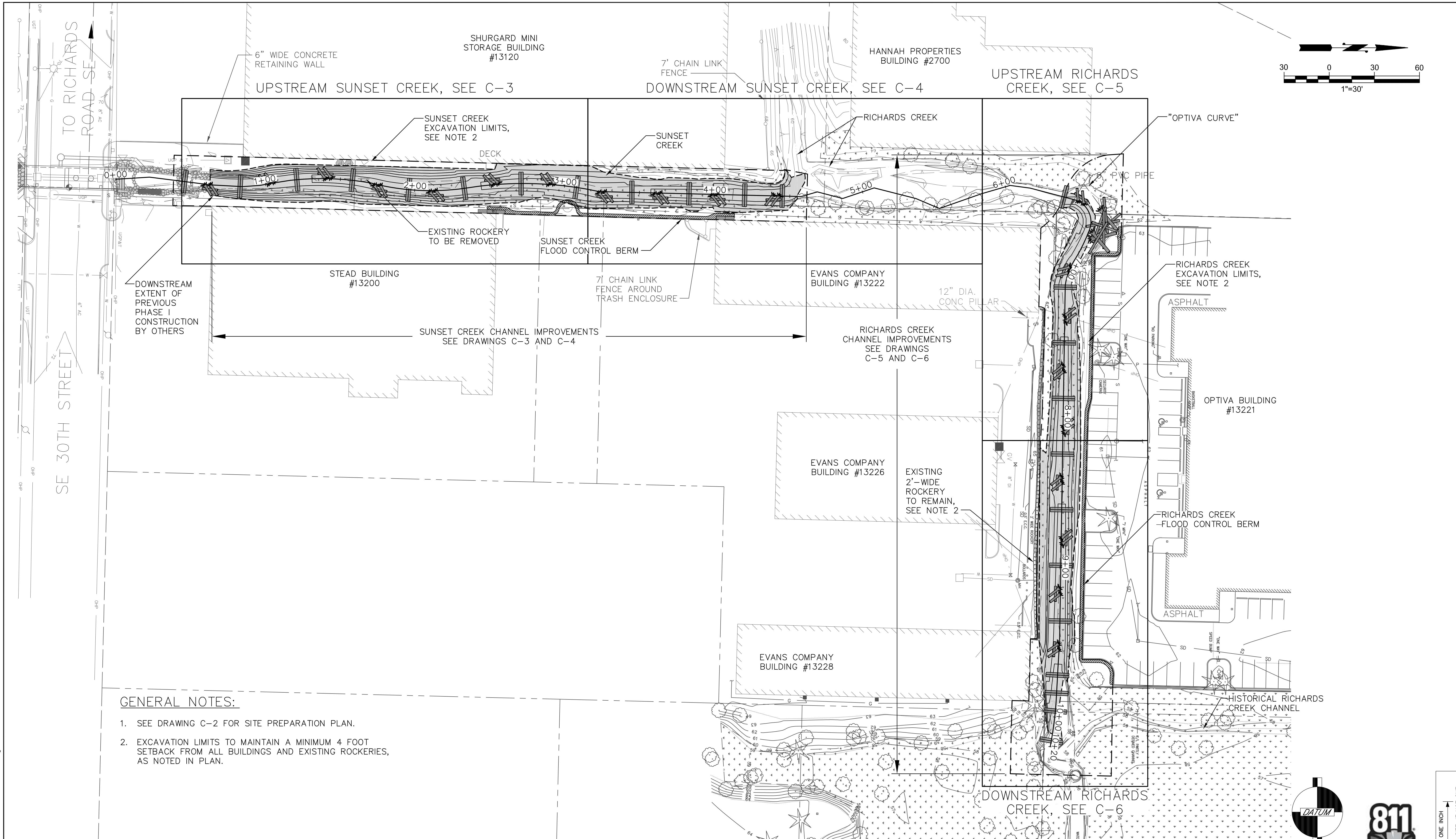
City of Bellevue UTILITIES

ABBREVIATIONS AND LEGEND

DRAWING G-3

SHT 3 OF 19

Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\G-3.dwg
Plot Date: 7/13/2010 5:49 PM
Cad User: Laura Turnidge



GENERAL NOTES:

1. SEE DRAWING C-2 FOR SITE PREPARATION PLAN.
2. EXCAVATION LIMITS TO MAINTAIN A MINIMUM 4 FOOT SETBACK FROM ALL BUILDINGS AND EXISTING ROCKERIES, AS NOTED IN PLAN.

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SITE PLAN AND KEY MAP

DRAWING C-1

SHT 4 OF 19

Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\C-1.dwg Cad User: Laura Turnidge
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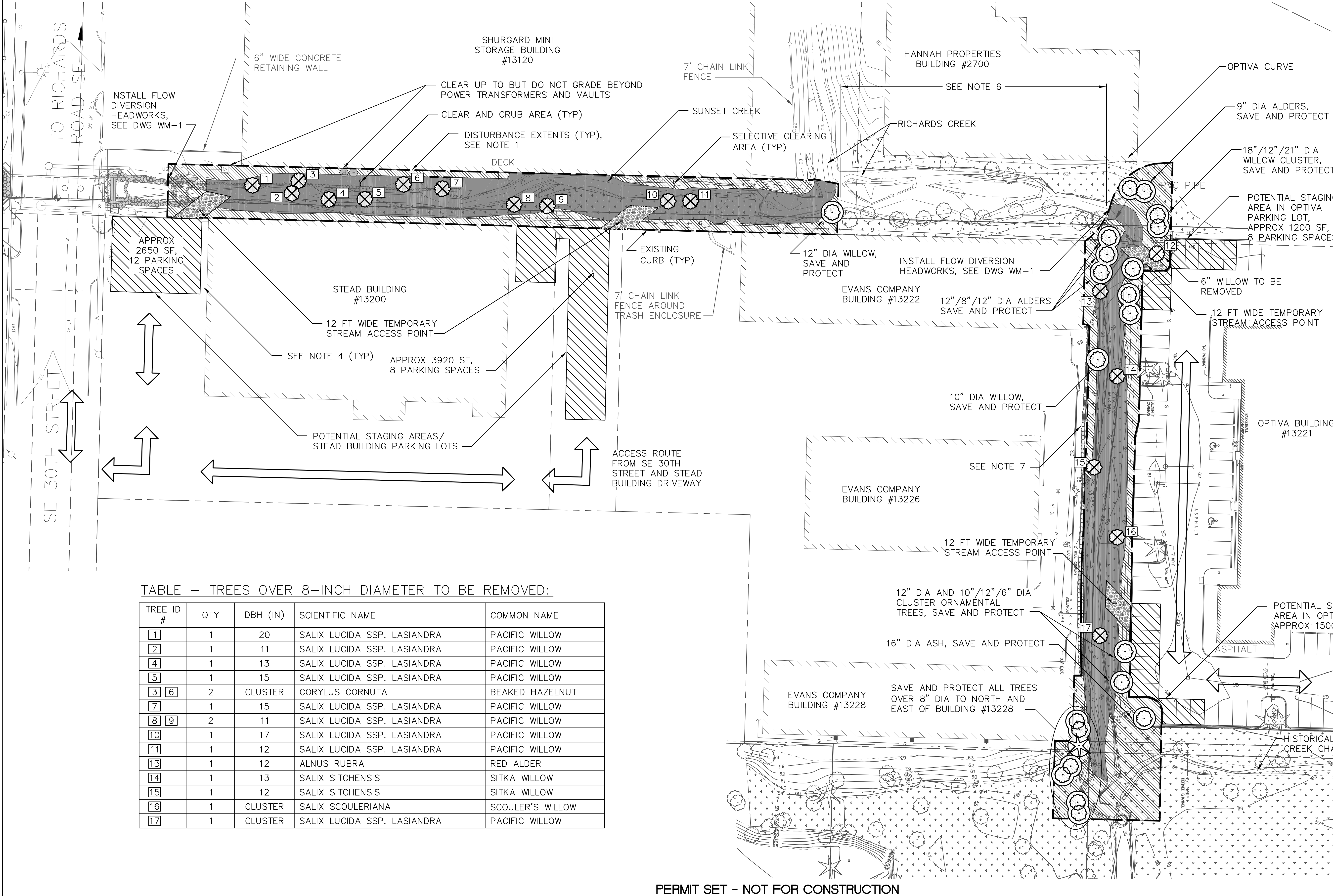

GENERAL NOTES:

1. CONTRACTOR SHALL FENCE THE PERIMETER OF THE CONSTRUCTION ZONE WITH A MINIMUM OF 6' TALL CHAINLINK FENCING PRIOR TO COMMENCEMENT OF ANY CONSTRUCTION ACTIVITIES.
2. PRIOR TO ANY CLEARING OR GRUBBING THE CONTRACTOR SHALL INSTALL TREE PROTECTION FOR ALL TREES DESIGNATED/FLAGGED BY THE CITY OF BELLEVUE TO REMAIN. TREE PROTECTION SHALL CONSIST OF ¾" 4'X'4 PLYWOOD BOXES CENTERED ON THE TRUNK OF THE TREE OR APPROVED EQUAL.
3. EXISTING PARKING LOT CURBS AND PAVEMENT USED FOR ACCESS SHALL BE PROTECTED FROM DAMAGE BY THE CONTRACTOR. THE CONTRACTOR SHALL RESTORE ANY AREAS DISTURBED DURING CONSTRUCTION TO THEIR ORIGINAL APPROXIMATE CONDITION.
4. CONTRACTOR SHALL NOT BLOCK BUILDING EGRESS.
5. LOCATE AND PROTECT ALL DRAINAGE OUTFALLS TO CHANNEL, BUILDING FOOTINGS, AND UTILITIES PRIOR TO COMMENCEMENT OF AND DURING CONSTRUCTION ACTIVITIES, UNLESS OTHERWISE INDICATED IN DRAWINGS.
6. CONTRACTOR SHALL NOT DISTURB EXISTING WOODY DEBRIS, VEGETATION, OR CHANNEL HABITAT BETWEEN RICHARDS CREEK CONFLUENCE AND OPTIVA CURVE.
7. CONTRACTOR SHALL NOT DISTURB RETAINING WALL ROCKERY LOCATED TO THE NORTH OF THE EVANS COMPANY BUILDINGS.

TABLE – TREES OVER 8-INCH DIAMETER TO BE REMOVED:

TREE ID #	QTY	DBH (IN)	SCIENTIFIC NAME	COMMON NAME
1	1	20	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW
2	1	11	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW
4	1	13	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW
5	1	15	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW
3 6	2	CLUSTER	CORYLUS CORNUTA	BEAKED HAZELNUT
7	1	15	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW
8 9	2	11	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW
10	1	17	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW
11	1	12	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW
13	1	12	ALNUS RUBRA	RED ALDER
14	1	13	SALIX SITCHENSIS	SITKA WILLOW
15	1	12	SALIX SITCHENSIS	SITKA WILLOW
16	1	CLUSTER	SALIX SCOULERIANA	SCOULER'S WILLOW
17	1	CLUSTER	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW

DATUM
NAVD 88/NAD 83

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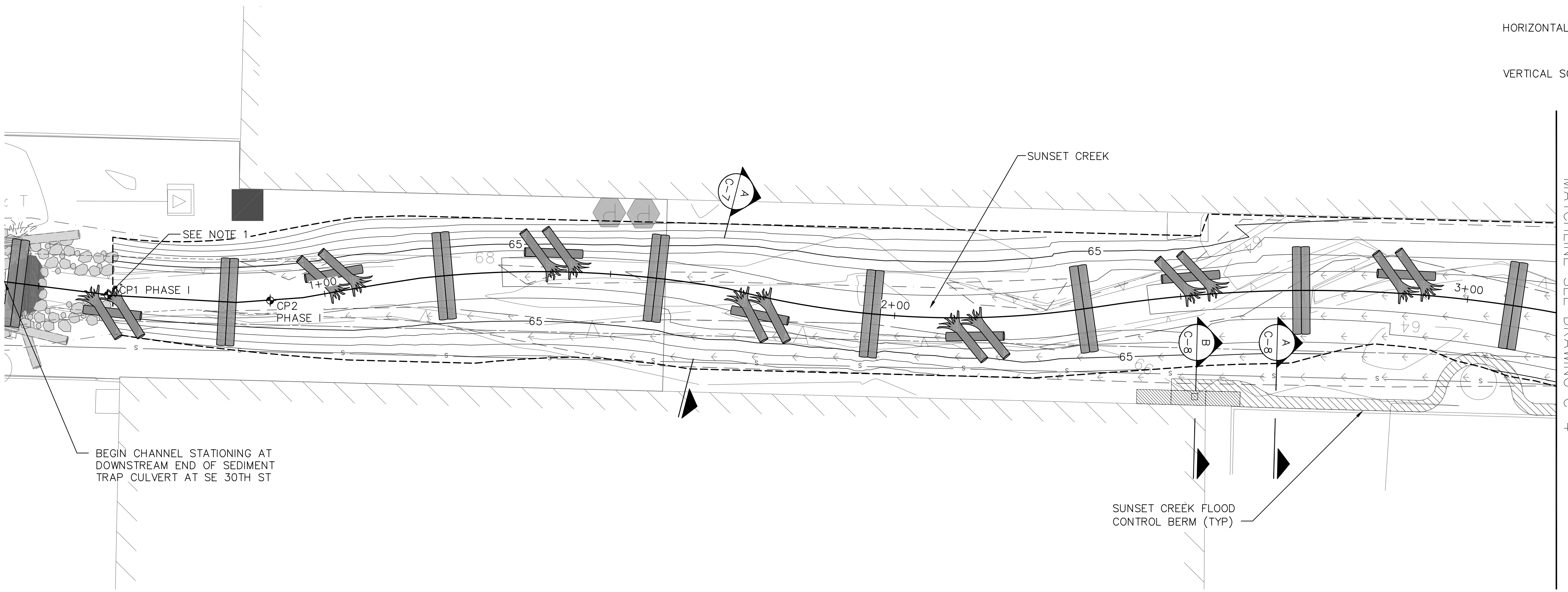
SITE PREPARATION PLAN

DRAWING C-2 | SHT 5 OF 19

Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\C-2.dwg
Plot Date: 7/13/2010 5:50 PM Cad User: Laura Turnidge

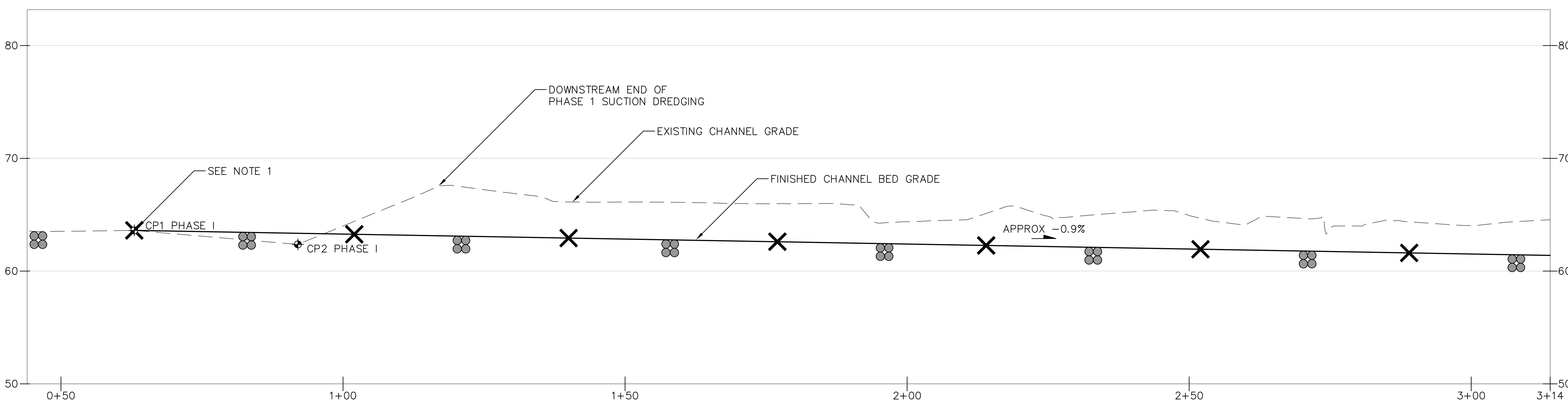
HORIZONTAL SCALE 1"=10'

VERTICAL SCALE 1"=5'



NOTES:

1. PROPOSED GRADING PHASE I LOG/BOULDER WEIR AND CHANNEL PROFILE TO TIE INTO PHASE I CP1 AT APPROX CONSTRUCTION STATIONING 0+63 AND ELEVATION 63.6 FT.



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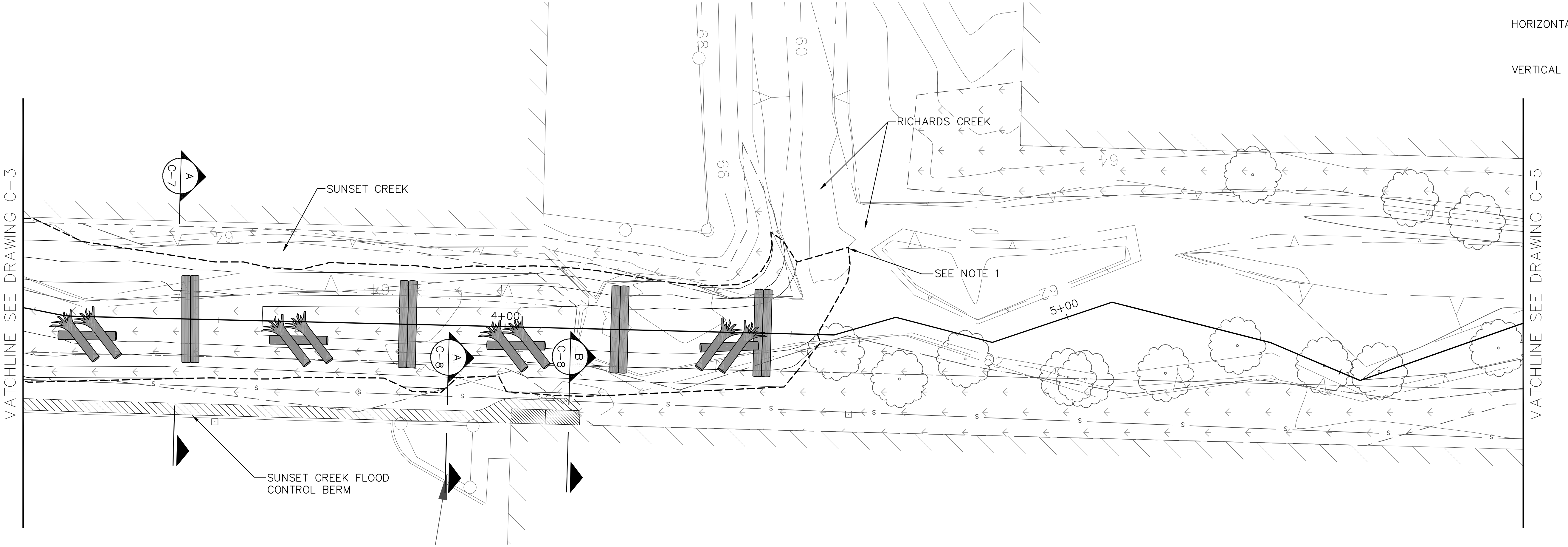
UPSTREAM SUNSET CREEK PLAN AND PROFILE

DRAWING C-3 SHT 6 OF 19

Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\C-3.dwg Cad User: Laura Turnidge
Plot Date: 7/13/2010 5:50 PM

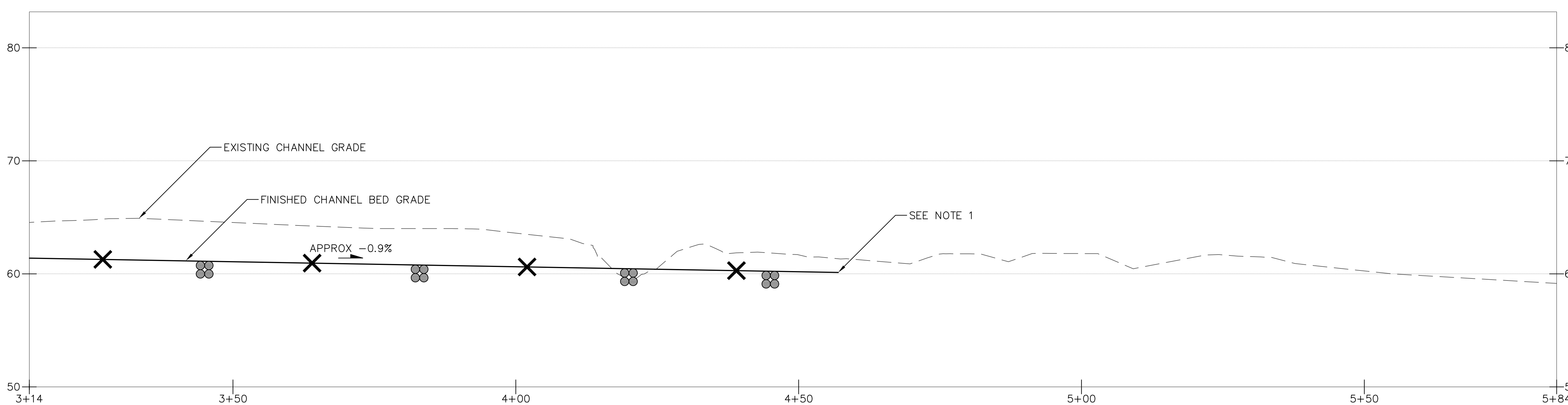
HORIZONTAL SCALE 10 0 10 20 1"=10'

VERTICAL SCALE 5 0 5 10 1"=5'



NOTES:

1. END SUNSET CREEK CHANNEL GRADING AT THE CONFLUENCE WITH RICHARDS CREEK AT STA 4+56 AND ELEVATION 60.1.



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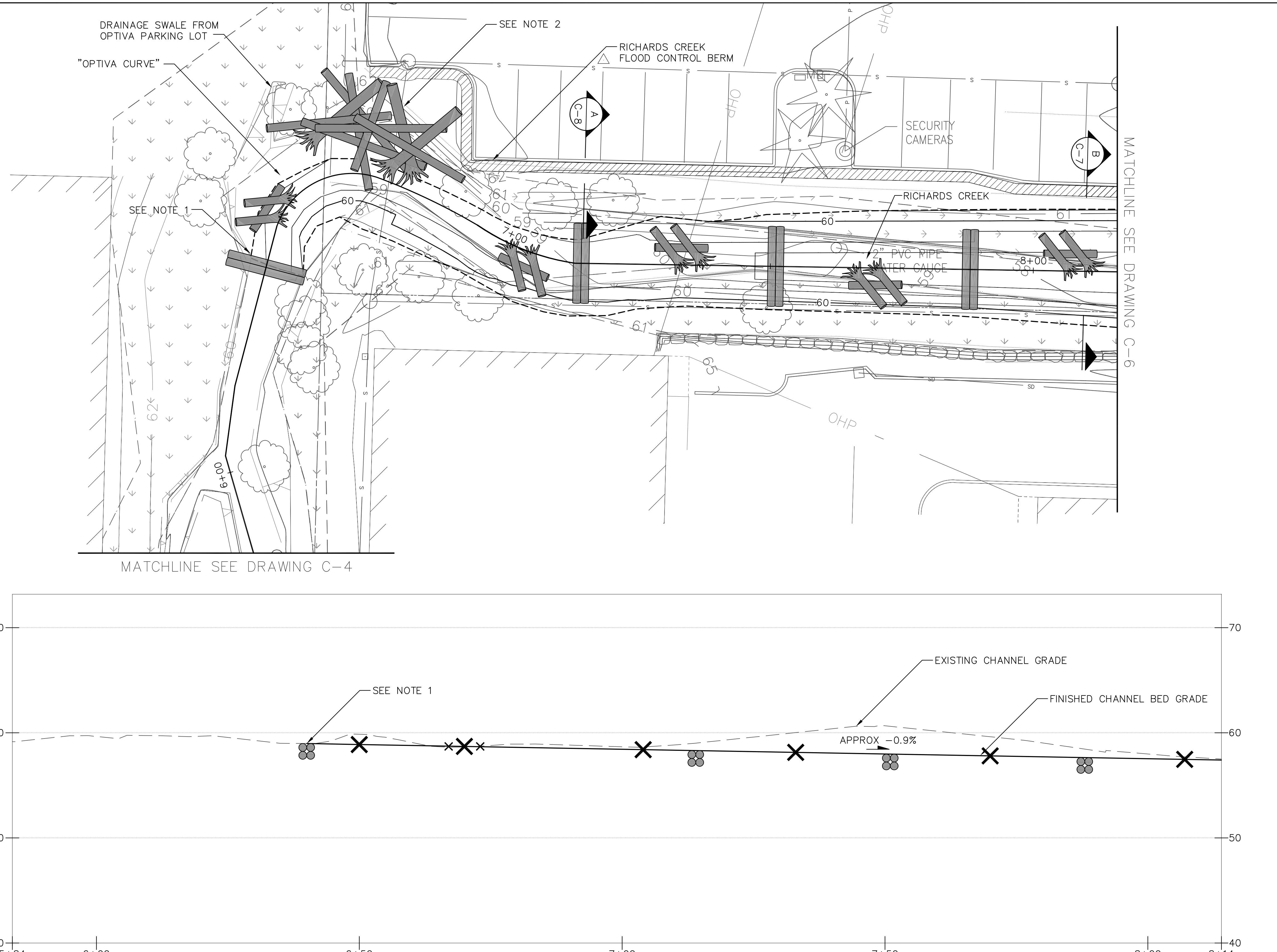
DOWNSTREAM SUNSET CREEK PLAN AND PROFILE

DRAWING C-4 SHT 7 OF 19



NOTES:

1. COMMENCE RICHARDS CREEK CHANNEL GRADING AT OPTIVA CURVE AT STA 6+40 AND ELEVATION 59.
2. OVEREXCAVATION FOR INSTALLATION OF REVETMENT STRUCTURE NOT TO PENETRATE BELOW ELEVATION 55.0' TO AVOID DAMAGE TO SANITARY SEWER PIPE.

NAVD 88/NAD 83

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UPSTREAM RICHARDS CREEK PLAN AND PROFILE

DRAWING C-5 SHT 8 OF 19

Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\C-5.dwg Cad User: Laura Turnidge
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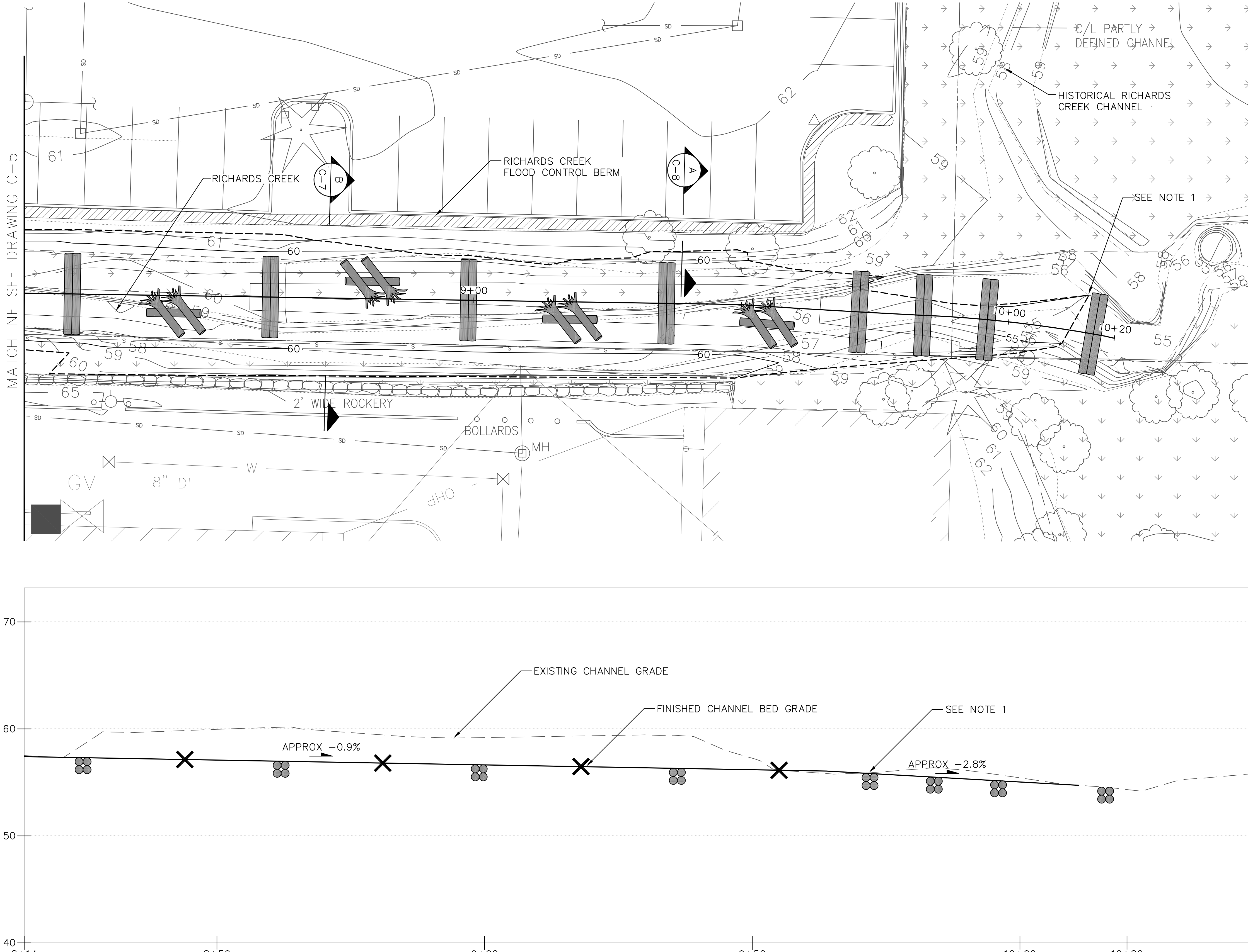

HORIZONTAL SCALE 1"=10'

VERTICAL SCALE 1"=5'

NOTES:

1. TAPER PROPOSED RICHARDS CREEK CHANNEL GRADING INTO EXISTING GRADES JUST UPSTREAM OF HISTORICAL RICHARDS CREEK CHANNEL LOCATION FROM APPROX STA 9+72 TO 10+16 AND ELEVATION 54.8'.

DATUM NAVD 88/NAD 83

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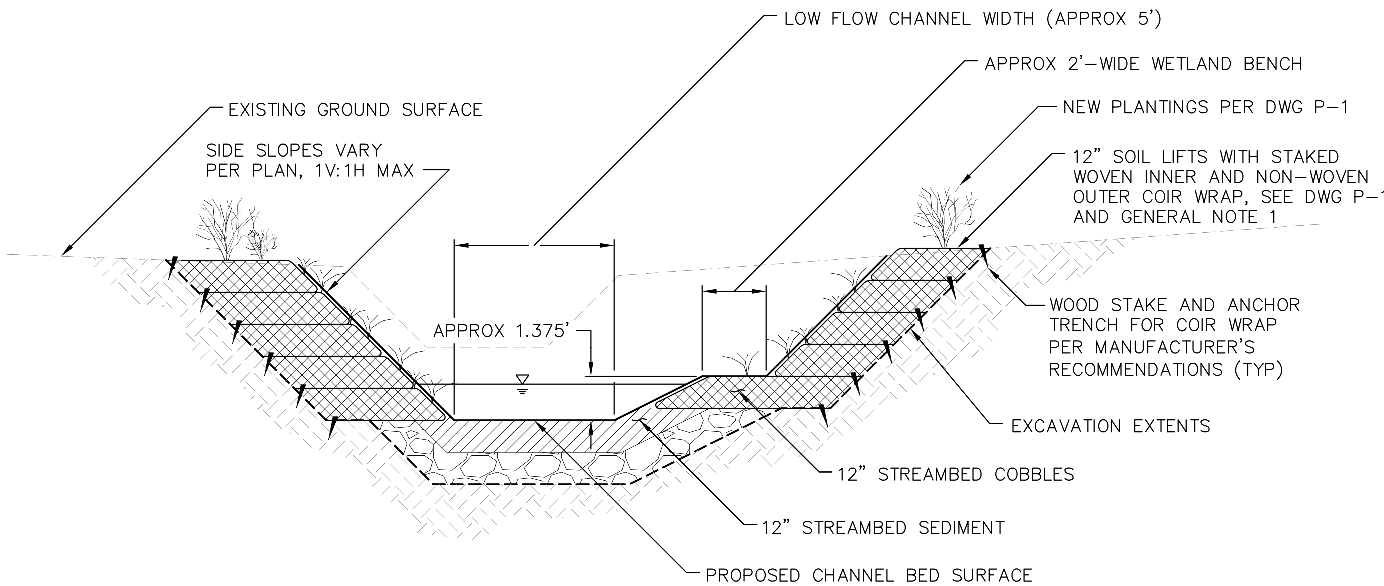
DOWNSTREAM RICHARDS CREEK PLAN AND PROFILE

DRAWING C-6 SHT 9 OF 19

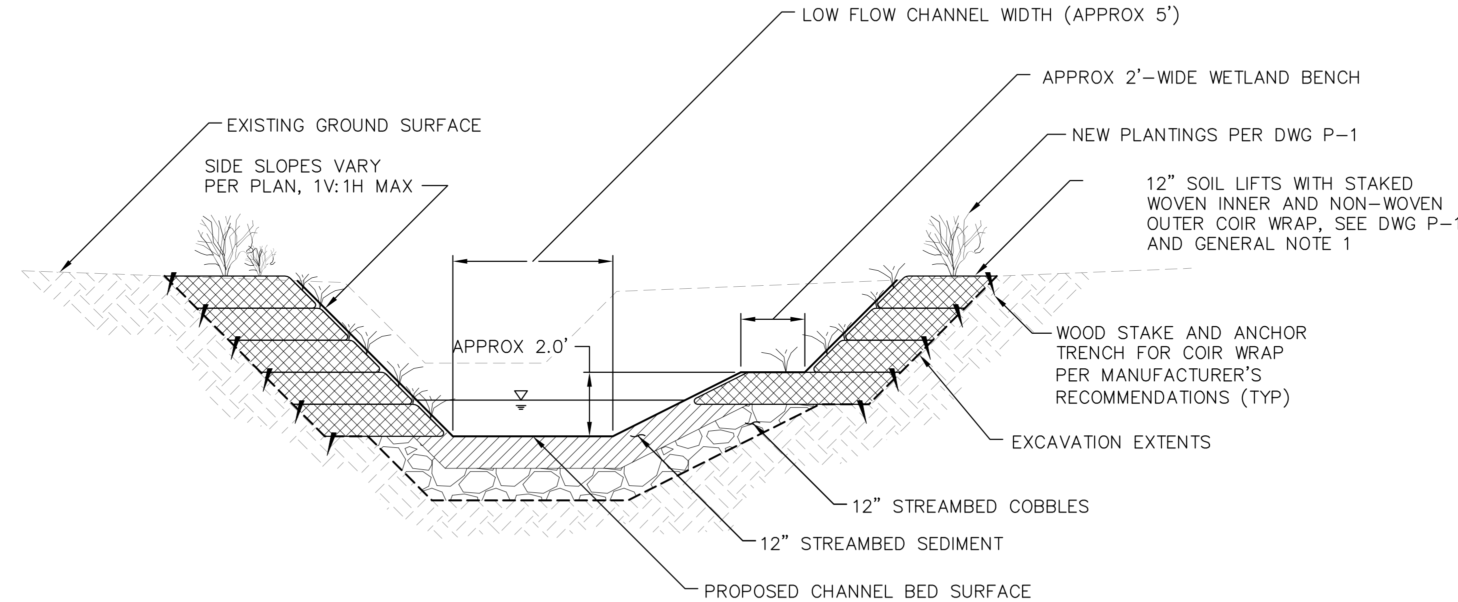
GENERAL NOTES:

1. WHERE TOP TWO COIR WRAP LIFTS COME WITHIN 4 FEET OF BUILDINGS, CURB, OR PERMANENT ROCKERIES, INSTALLATION AND STAKING REQUIREMENTS TO BE PROVIDED BY THE ENGINEER.



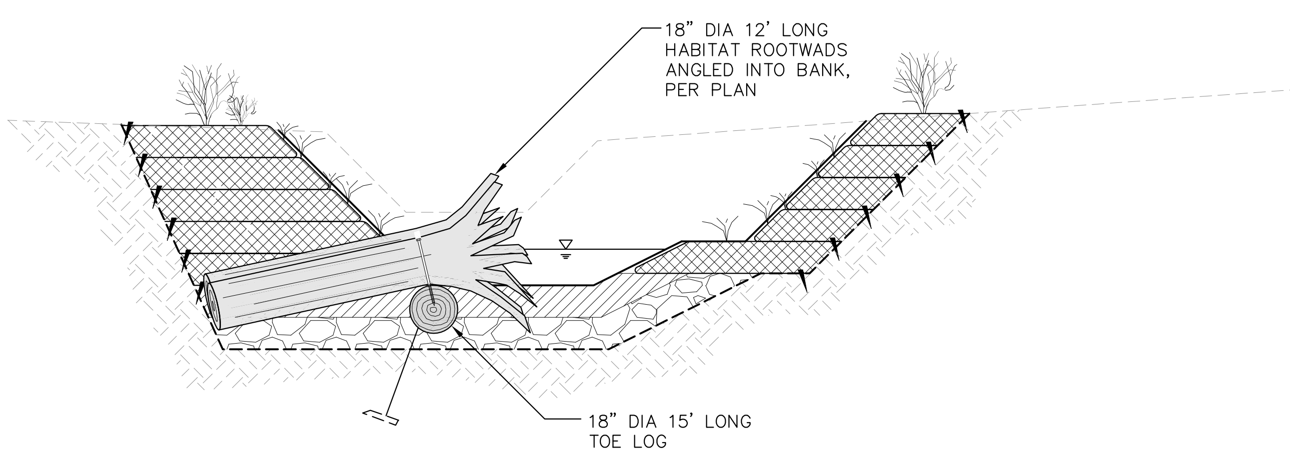
SECTION – TYPICAL SUNSET CREEK CHANNEL (A, C-3,C-4)

SCALE: 1"=3'



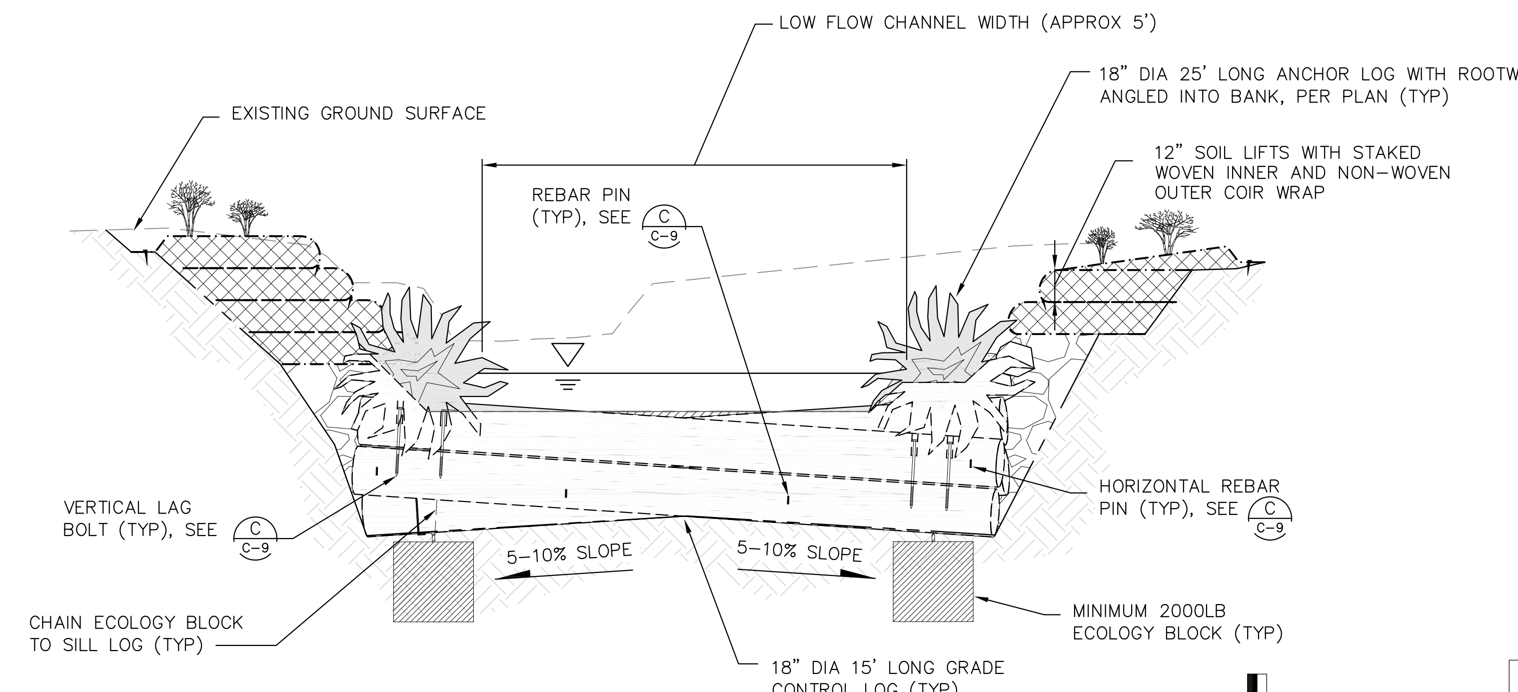
SECTION – TYPICAL RICHARDS CREEK CHANNEL (B, C-5,C-6)

SCALE: 1"=3'



SECTION – TYPICAL HABITAT STRUCTURE (C, C-3,C-4,C-5,C-6)

SCALE: 1"=3'



SECTION – TYPICAL GRADE CONTROL STRUCTURE (D, C-3,C-4,C-5,C-6)

SCALE: 1"=3'

DATUM

NAVD 88/NAD 83

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SECTIONS

DRAWING C-7 | SHT 10 OF 19

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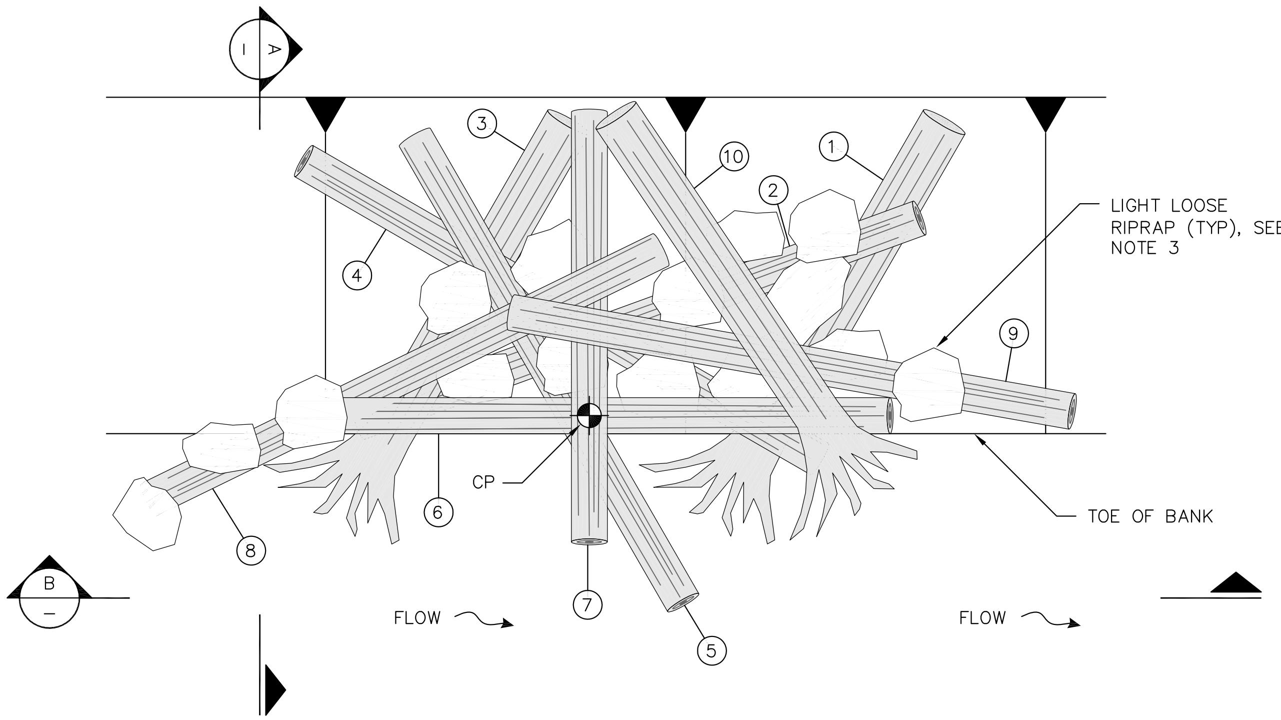
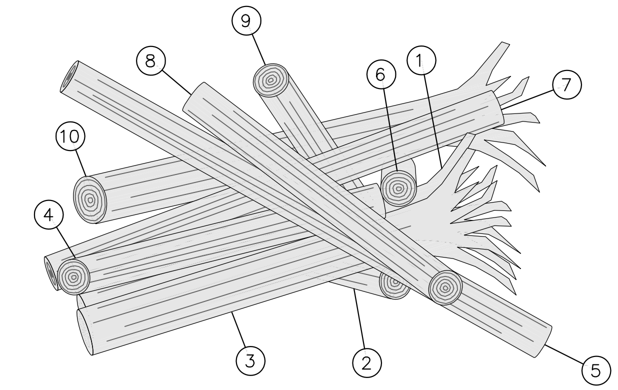


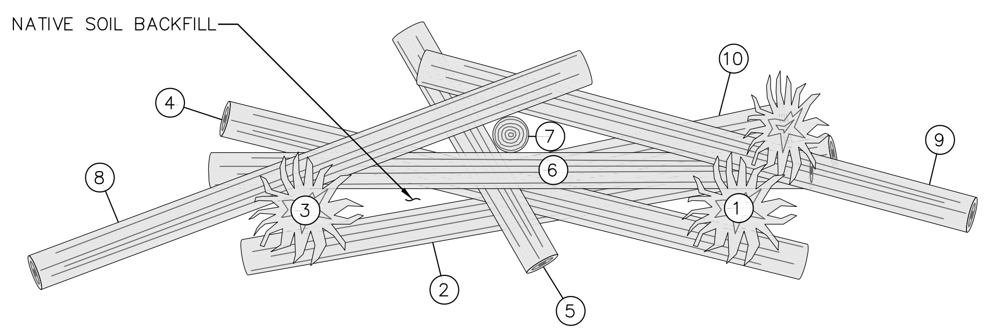
PLAN – REVETMENT STRUCTURE (1 / C-5)

SCALE:1"=4'



SECTION – REVETMENT STRUCTURE (A / –)

SCALE:1"=4'



SECTION – REVETMENT STRUCTURE (B / –)

SCALE:1"=4'

TABLE – LOG SCHEDULE:

LOG #	DIAMETER (IN)	LENGTH (FT)	ROOTWAD
1	24	20	YES
2	18	25	NO
3	24	20	YES
4	18	25	NO
5	18	25	NO
6	18	25	NO
7	18	20	NO
8	18	25	NO
9	18	25	NO
10	24	20	YES

NOTES:

1. CONTRACTOR SHALL MINIMIZE EXCAVATION INTO EXISTING BANK. MATERIAL EXCAVATED TO PLACE LOGS CAN BE REUSED ON REGRADED BANKS. CONTRACTOR SHALL PUSH LOGS INTO BANK USING EXCAVATOR WHEREVER POSSIBLE TO MINIMIZE EXCAVATION.
2. LOG IDENTIFICATION NUMBERS REPRESENT AN ORDER OF PLACEMENT/INSTALLATION. CORRESPONDING LOG DIMENSIONS SHOWN IN THE LOG SCHEDULE TABLE.
3. LIGHT LOOSE RIPRAP SHALL BE PLACED AND BURIED AMIDST THE INTERLOCKED LOGS AS DIRECTED BY THE ENGINEER.

DATUM
NAVD 88/NAD 83

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REVETMENT STRUCTURE DETAILS

DRAWING C-8 | SHT 11 OF 19

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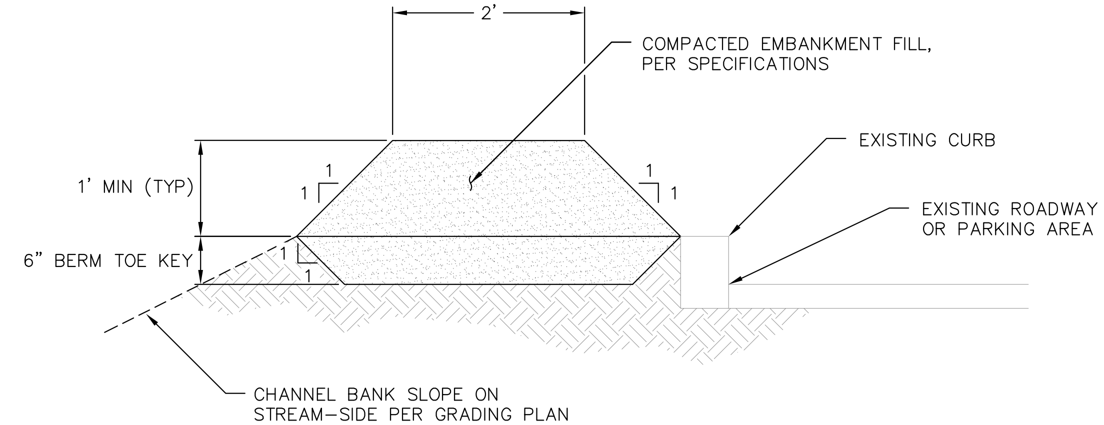
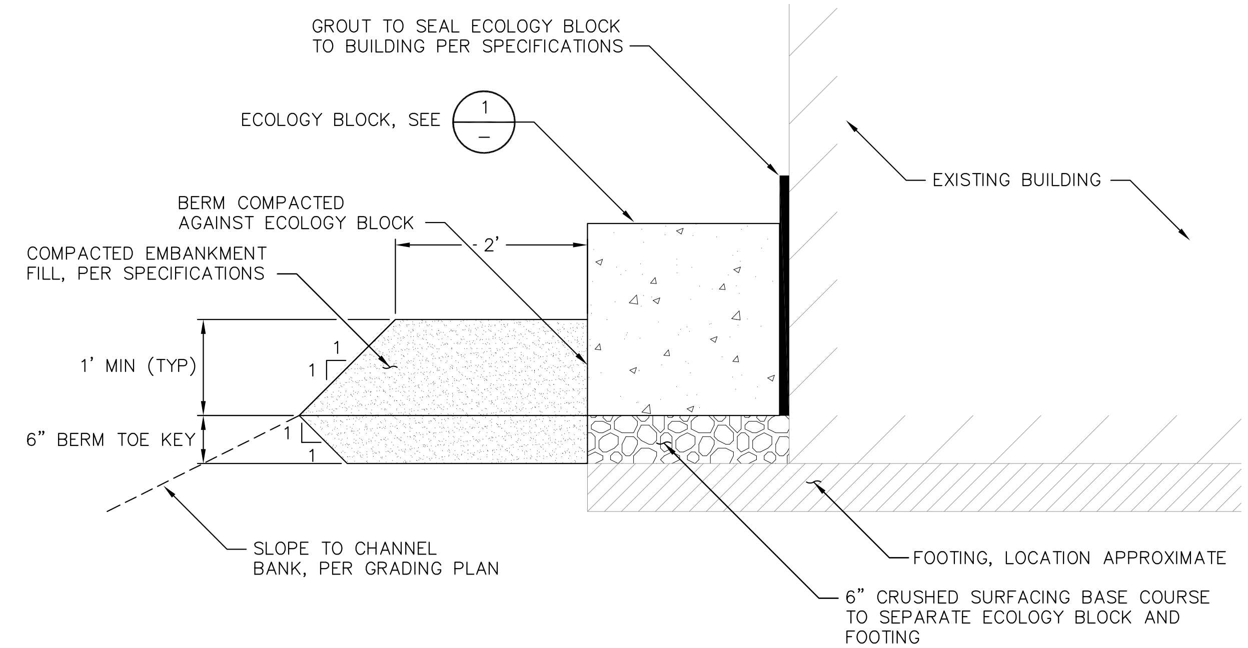


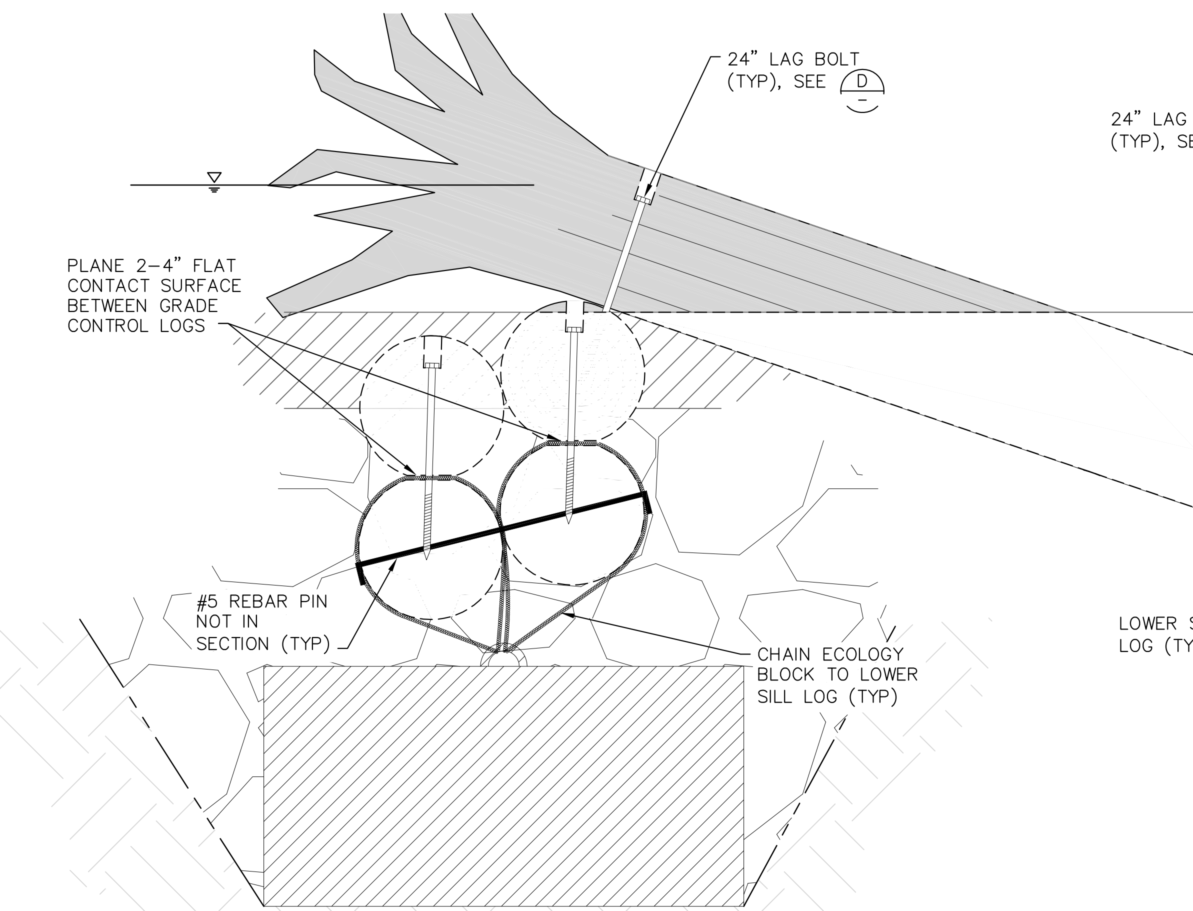
DETAIL - FLOOD CONTROL BERM NEAR CURB (A / VAR.)

SCALE: 1"=1'



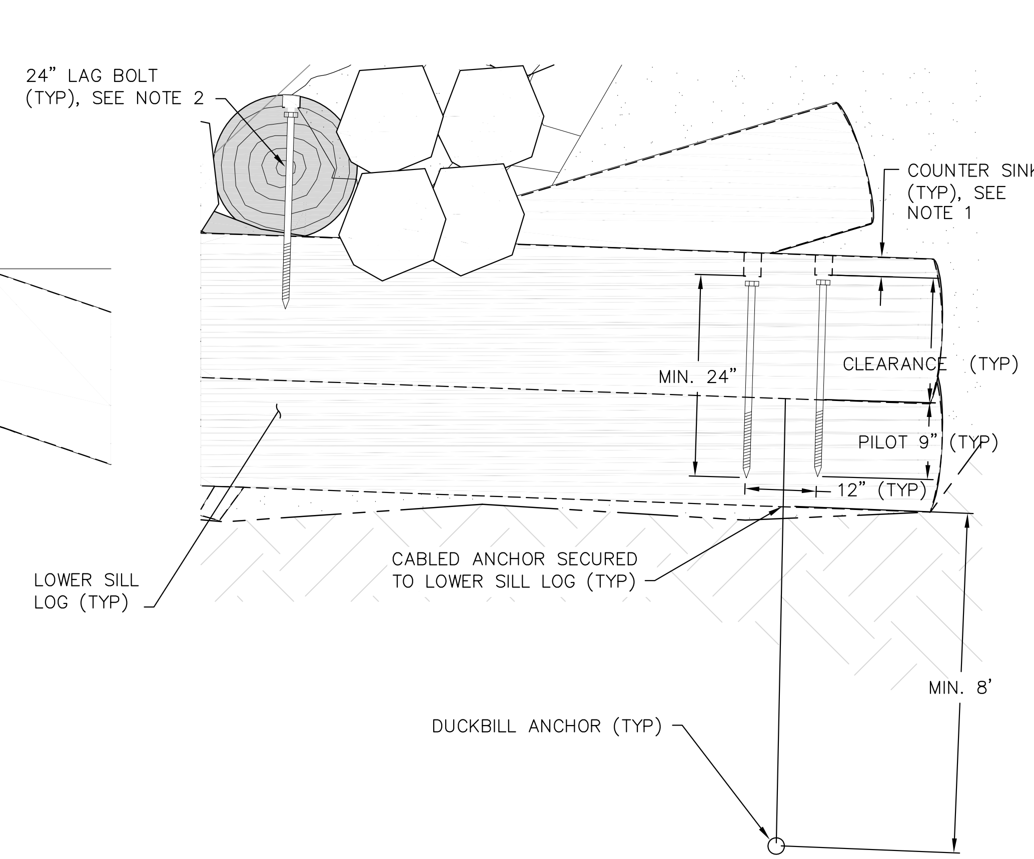
DETAIL - FLOOD CONTROL BERM NEAR BUILDING (B / VAR.)

SCALE: 1"=1'



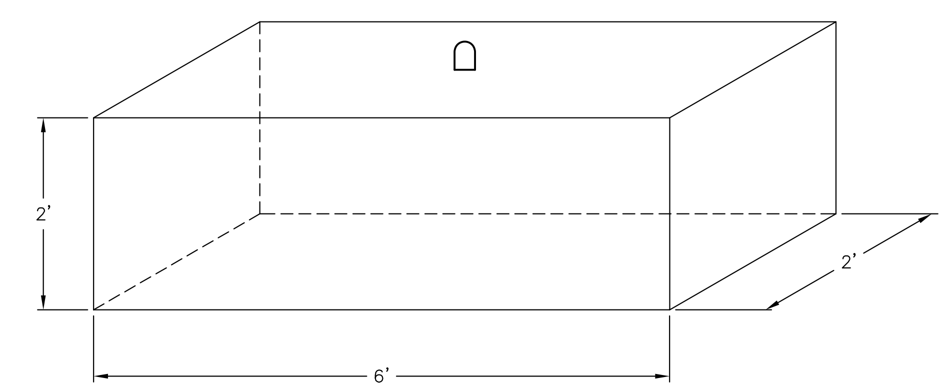
SECTION-DOWNSTREAM GRADE CONTROL LAG/PIN DETAIL (C / C-7)

SCALE: 1"=1'



DETAIL-TYPICAL LAG BOLT INSTALLATION DETAIL (D / –)

SCALE: 1"=1'



DETAIL - ECOLOGY BLOCK (1 / –)

SCALE: NTS

DATUM

NAVD 88/NAD 83

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DETAILS

DRAWING C-9 | SHT 12 OF 19

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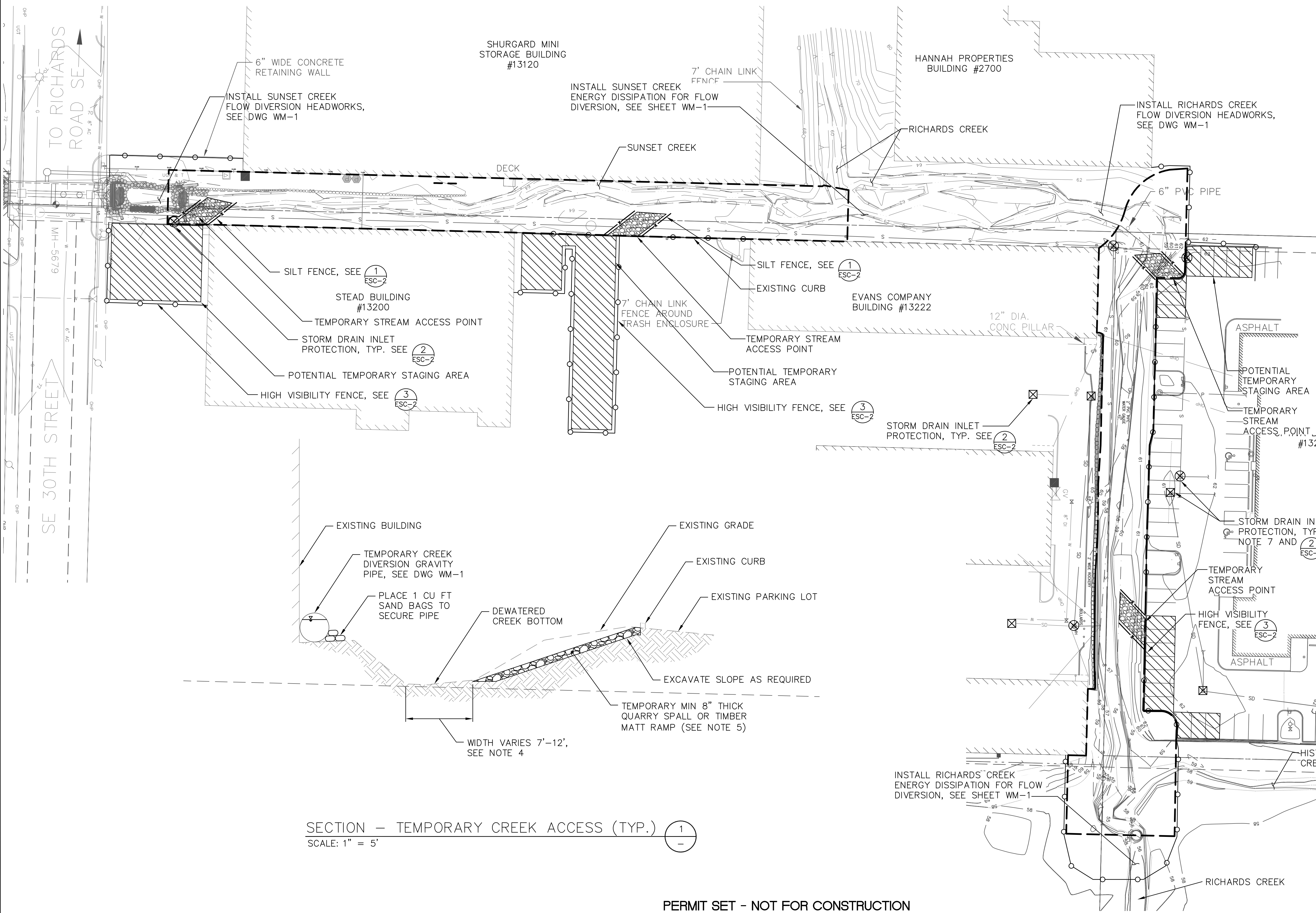

SECTION – TEMPORARY CREEK ACCESS (TYP.) 1/–

SCALE: 1" = 5'

30 0 30 60

1"=30'

GENERAL NOTES:

1. NO MECHANIZED EQUIPMENT SHALL BE STORED WITHIN 100' OF CREEK.
2. HIGH VISIBILITY FENCE AND SILT FENCE SHALL BE INSTALLED PRIOR TO COMMENCING CLEARING AND GRUBBING. A MINIMUM OF 2 DAYS NOTICE WILL BE GIVEN TO THE ENGINEER TO ALLOW FOR APPROVAL OF CLEARING LIMITS PRIOR TO ANY CLEARING OR GRUBBING ACTIVITIES.
3. TEMPORARY ACCESS FOR TRACKED EQUIPMENT ON CHANNEL ALIGNMENT MAY REQUIRE TEMPORARY GRADING OF CHANNEL BOTTOM.
4. QUARRY SPALLS OR TIMBER MATT FOR TEMPORARY STREAM ACCESS SHALL BE REMOVED UPON COMPLETION OF STREAM WORK.
5. TURBIDITY MONITORING SHALL BE PERFORMED IN ACCORDANCE WITH EPA METHOD 180.1 AND THE CONTRACT SPECIFICATIONS. SEE DWG WM-1 FOR MONITORING LOCATIONS.
6. CONTRACTOR SHALL PUMP CREEK DURING INSTALLATION OF DIVERSION HEADWORKS.
7. CONTRACTOR SHALL INSTALL STORM DRAIN INLET PROTECTION ON ALL CATCH BASINS AND MANHOLES IN PROJECT AREA.

DATUM

NAVD 88/NAD 83

811 Know what's below. Call before you dig.

ONE INCH

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

PERMIT SET - NOT FOR CONSTRUCTION

Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\ESC-1.dwg Cad User: Laura Turnidge
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NO	DATE	BY	APPR	REVISIONS

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2200 Sixth Avenue
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98121-1820
206-441-9080
206-441-9108 FAX
http://www.herrerainc.com

SUNSET CREEK/RICHARDS CREEK FLOOD CONTROL AND HABITAT IMPROVEMENT PROJECT

Approved By

DESIGN MANAGER DATE

PROJECT MANAGER DATE

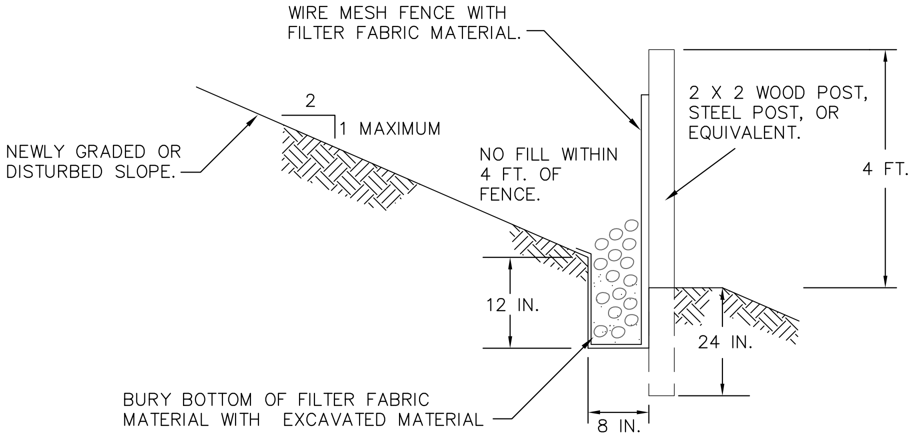
C. AVOLIO/M. STRAZER 07/2010	
DESIGNED BY	DATE
T. PRESCOTT	07/2010
DRAWN BY	DATE
M. EWBANK	07/2010
CHECKED BY	DATE

CITY OF BELLEVUE WASHINGTON

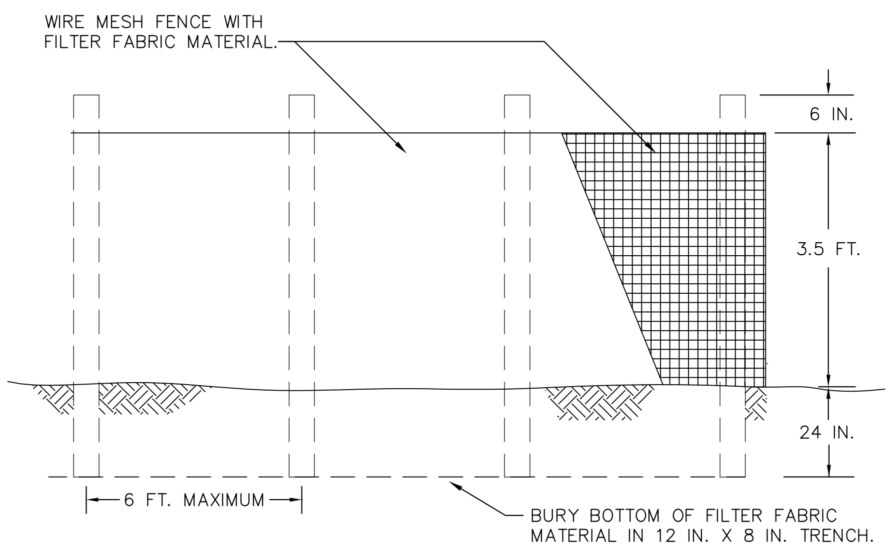
City of Bellevue UTILITIES

TEMPORARY EROSION AND SEDIMENT CONTROL PLAN

DRAWING ESC-1 SHT 13 OF 19



TYPICAL CROSS SECTION

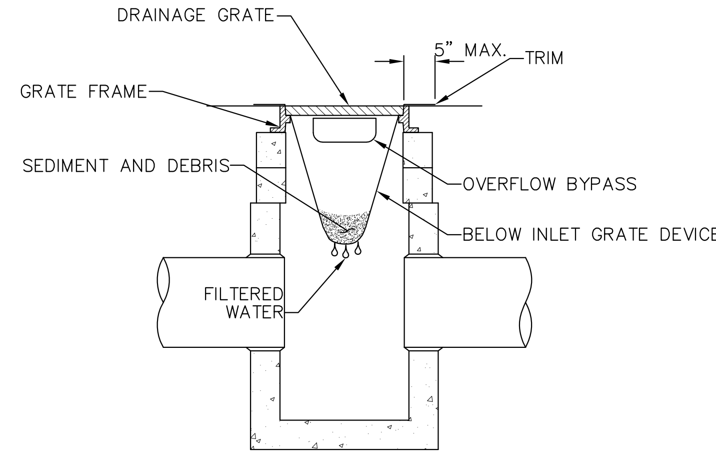


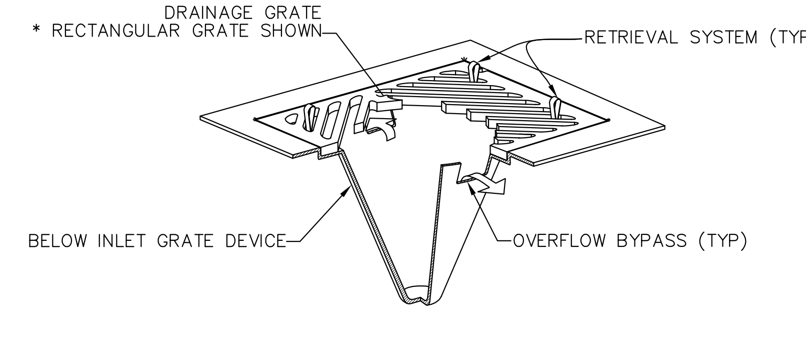
ELEVATION

NOTES:

1. FENCE SHALL NOT BE INSTALLED ON SLOPES STEEPER THAN 2:1.
2. JOINTS IN FILTER FABRIC SHALL BE OVERLAPPED 6 INCHES AT POST.
3. USE STAPLES, WIRE RINGS, OR EQUIVALENT TO ATTACH FABRIC TO WIRE FENCE.
4. REMOVE SEDIMENT WHEN IT REACHES 1/3 FENCE HEIGHT.

SILT FENCE DETAIL (1 / ESC-1)
SCALE: NTS



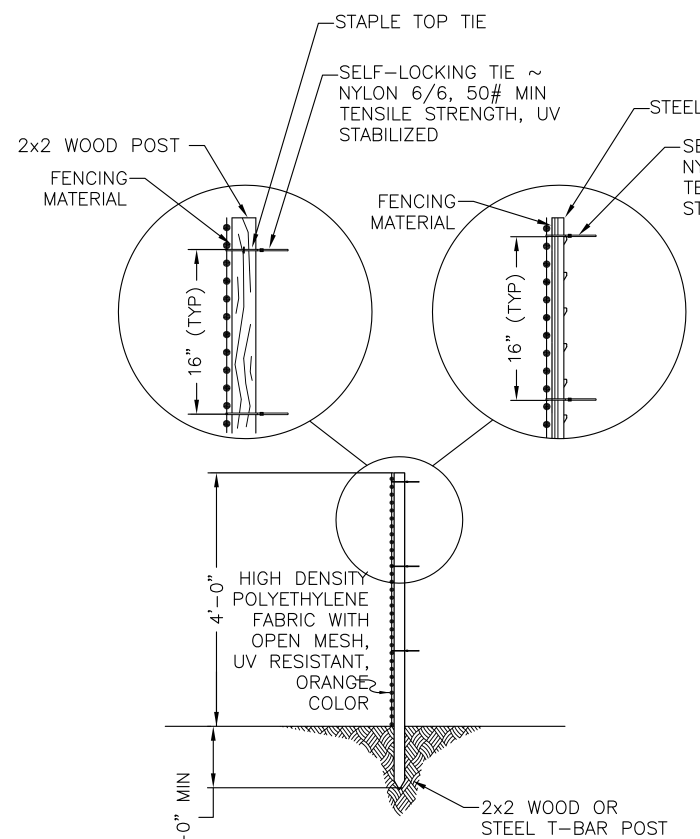


ISOMETRIC VIEW

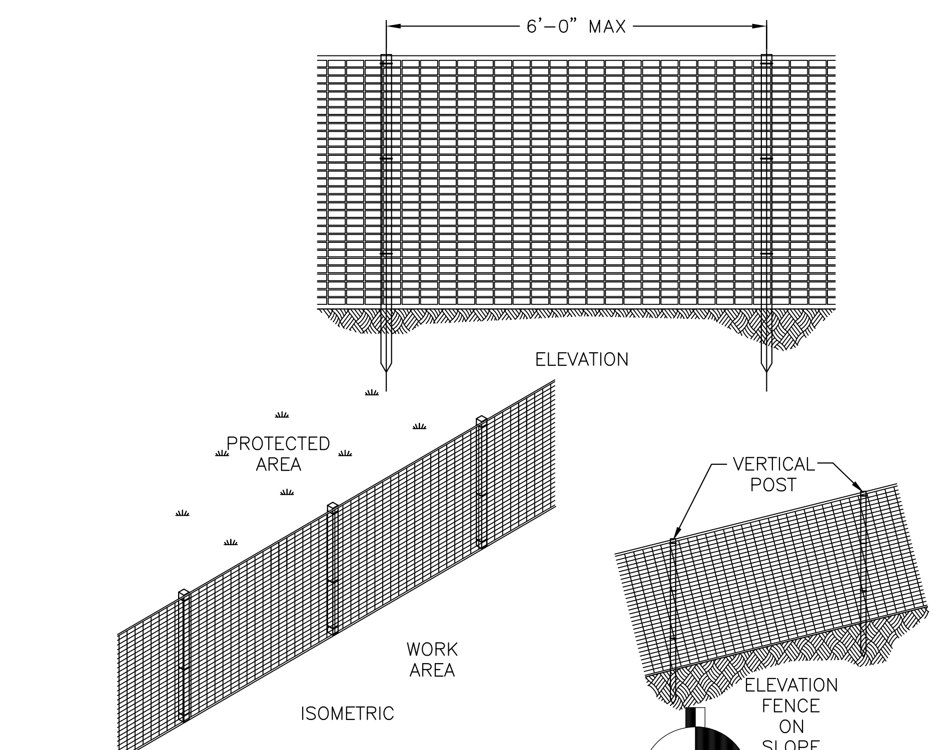
NOTES:

1. SIZE THE BELOW INLET GRATE DEVICE (BIGD) FOR THE STORM WATER STRUCTURE IT WILL SERVICE.
2. THE BIGD SHALL HAVE A BUILT-IN HIGH-FLOW RELIEF SYSTEM (OVERFLOW BYPASS).
3. THE RETRIEVAL SYSTEM MUST ALLOW REMOVAL OF THE BIGD WITHOUT SPILLING THE COLLECTED MATERIAL.
4. PERFORM MAINTENANCE IN ACCORDANCE WITH STANDARD SPECIFICATION 8-01.3(15).

STORM DRAIN INLET PROTECTION (2 / ESC-1)
SCALE: NTS



TYPICAL SECTION



HIGH VISIBILITY FENCE DETAIL (1 / ESC-1)
SCALE: NTS

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DATUM
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SUNSET CREEK/RICHARDS CREEK FLOOD CONTROL AND HABITAT IMPROVEMENT PROJECT

Approved By

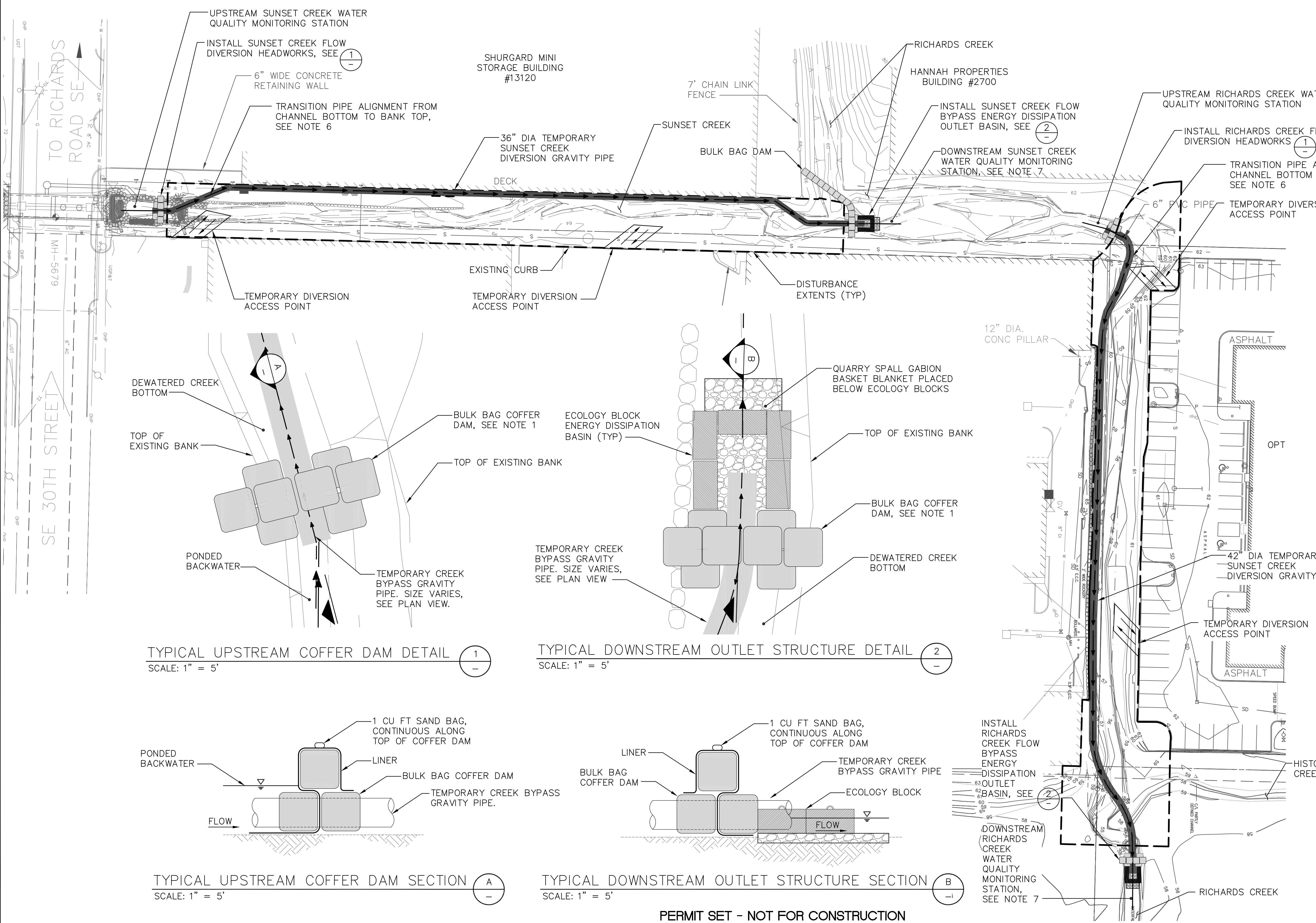
DESIGN MANAGER DATE
PROJECT MANAGER DATE

C. RABIDOY/M. STRAZER	07/2010	
DESIGNED BY	DATE	
E. PRESCOTT	07/2010	
DRAWN BY	DATE	
M. EWBANK	07/2010	
CHECKED BY	DATE	

CITY OF BELLEVUE WASHINGTON
City of Bellevue
UTILITIES

TESC DETAILS

DRAWING ESC-2 SHT 14 OF 19



GENERAL NOTES:

1. BULK BAGS SHALL BE FILLED WITH CLEAN WASHED ROUNDED GRAVEL.
2. TEMPORARY PUMPING OF CREEK DURING GRAVITY PIPE, UPSTREAM COFFERDAM, AND DOWNSTREAM OUTFALL DISSIPATION INSTALLATION AND REMOVAL WILL BE REQUIRED.
3. COORDINATE FISH EXCLUSION WITH CREEK DIVERSION PER THE WSDOT FISH EXCLUSION PROTOCOLS AND STANDARDS (AUGUST 2006) AND THE REQUIREMENTS OF THE HYDRAULIC PROJECT APPROVAL.
4. CONTRACTOR SHALL REMOVE ALL TEMPORARY BYPASS MATERIALS FOLLOWING CONSTRUCTION.
5. TRANSITION BYPASS PIPE TO BANK TOP SUFFICIENTLY DOWNSTREAM TO ENSURE PIPE DOES NOT BACKWATER INTO HEADWORKS.
6. ADDITIONAL DOWNSTREAM MONITORING STATION TO BE LOCATED 100 FEET DOWNSTREAM OF FLOW OUTLET BASIN.
7. INSTALLATION OF DIVERSION HEADWORKS MAY REQUIRE PUMPING.

DATUM
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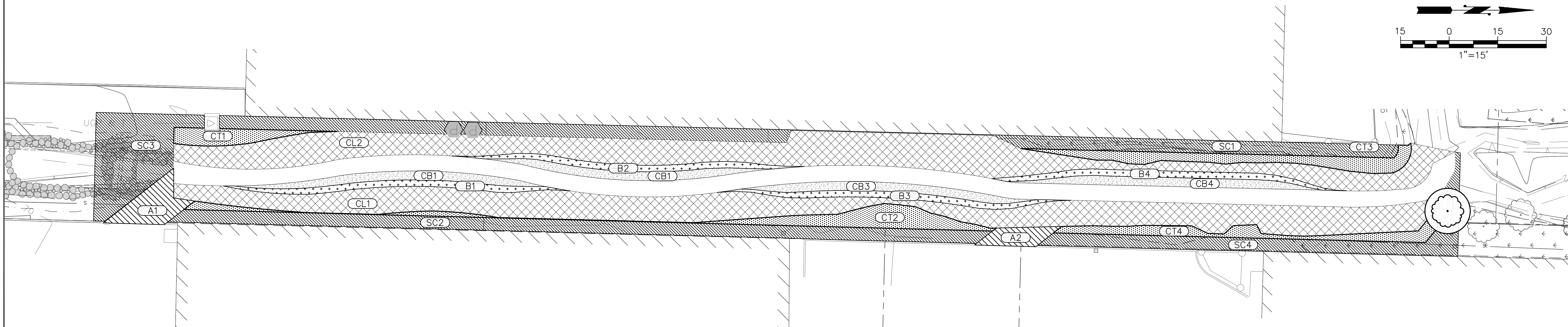
City of Bellevue
UTILITIES

FLOW DIVERSION AND FISH EXCLUSION DETAILS

DRAWING WM-1 SHT 15 OF 19



PLANT SCHEDULE

PLANTING AREA\TYPE NAME	SCIENTIFIC NAME	COMMON NAME	PLANTING QUANTITY BY PLANTING AREA TYPE										TOTAL
A: ACCESS AREA			A1	A2	A3	A4							
	HOLODISCUS DISCOLOR	OCEANSPRAY	8	5	8	5							26
	RIBES SANGUINEUM	RED FLOWERING CURRANT	8	5	8	5							26
	SYMPHORICARPOS ALBUS	SNOWBERRY	8	5	8	5							26
	THUJA PLICATA	WESTERN RED CEDAR	2	1	2	1							6
CB: CHANNEL TO BENCH			CB1	CB2	CB3	CB4	CB5	CB6	CB7				
	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW	5	4	5	5	9	7	3				38
	SALIX SITCHENSIS	SITKA WILLOW	5	4	5	5	9	7	3				38
B: BENCH			B1	B2	B3	B4	B5	B6	B7				
	CORNUS SERICEA	RED OSIER DOGWOOD	7	7	7	7	12	10	4				54
	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW	7	7	7	7	12	10	4				54
	SALIX SITCHENSIS	SITKA WILLOW	7	7	7	7	12	10	4				54
CL: COIR LIFTS			CL1	CL2	CL3	CL4							
	SALIX SCOULERIANA	SCOULER'S WILLOW	127	127	117	117							488
	SALIX SESSILIFOLIA	SOFT LEAVED WILLOW	127	127	117	117							488
	CORNUS SERICEA	RED-OSIER DOGWOOD	127	127	117	117							488
CT: TOP OF COIR BANK			CT1	CT2	CT3	CT4	CT5	CT6	CT7	CT8	CT9	CT10	
	HOLODISCUS DISCOLOR	OCEANSPRY	7	16	14	13	7	26	16	6	16	13	134
	RIBES SANGUINEUM	RED FLOWERING CURRANT	7	16	14	13	7	26	16	6	16	13	134
	SYMPHORICARPOS ALBUS	SNOWBERRY	7	16	14	13	7	26	16	6	16	13	134
	ALNUS RUBRA	RED ALDER	1	2	2	2	1	3	2	1	2	2	18
	POPULUS BALSAMIFERA	BLACK COTTONWOOD	1	2	2	2	1	3	2	1	2	2	18
	THUJA PLICATA	WESTERN RED CEDAR	1	2	2	2	1	3	2	1	2	2	18
SC: SELECTIVE PLANTING AREA			SC1	SC2	SC3	SC4	SC5	SC6	SC7				
	HOLODISCUS DISCOLOR	OCEANSPRY	2	3	3	2	10	4	5				29
	RIBES SANGUINEUM	RED FLOWERING CURRANT	2	3	3	2	10	4	5				29
	SYMPHORICARPOS ALBUS	SNOWBERRY	2	3	3	2	10	4	5				29
	ALNUS RUBRA	RED ALDER	1	2	2	1	5	2	3				16
	POPULUS BALSAMIFERA	BLACK COTTONWOOD	1	2	2	2	6	2	4				16
	THUJA PLICATA	WESTERN RED CEDAR	1	2	2	2	6	2	4				16

GENERAL NOTES:

1. TREES TO BE RETAINED DURING CONSTRUCTION SEE DRAWING C-2 FOR SPECIFICATIONS.
2. SEE PLANTING MATERIALS AND NOTES ON DRAWING P-3.
3. SEE PLANTING DETAILS ON DRAWING P-4.

DATUM
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CITY OF BELLEVUE WASHINGTON

City of Bellevue
UTILITIES

PLANTING PLAN - SUNSET CREEK

DRAWING P-1

SHT 16 OF 19

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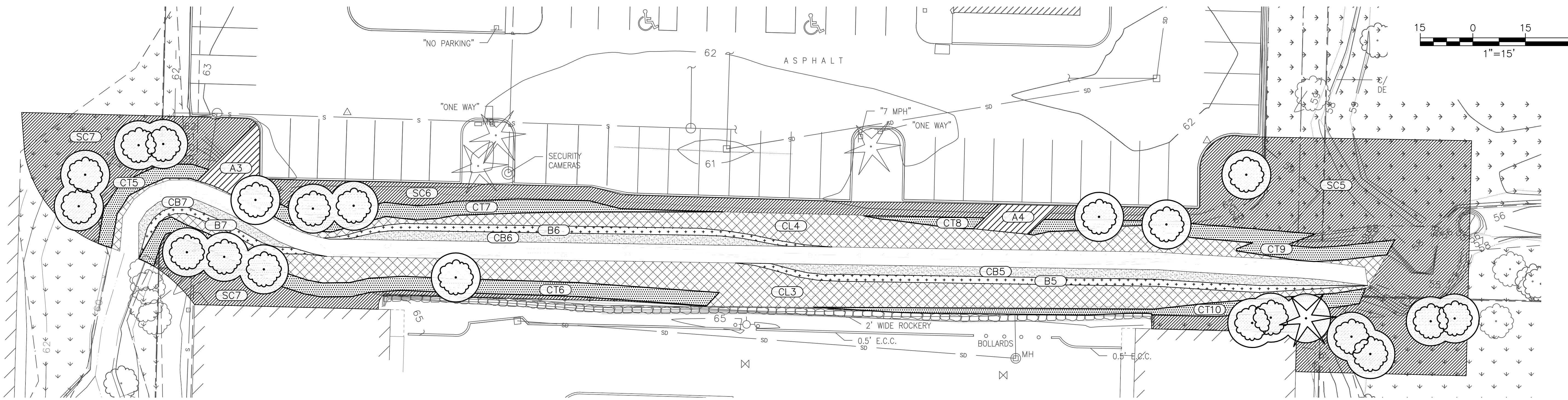

PLANT SCHEDULE

PLANTING AREA\TYPE NAME	SCIENTIFIC NAME	COMMON NAME	PLANTING QUANTITY BY PLANTING AREA TYPE										TOTAL
A: ACCESS AREA			A1	A2	A3	A4							
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	RIBES SANGUINEUM	RED FLOWERING CURRANT	8	5	8	5							26
	SYMPHORICARPOS ALBUS	SNOWBERRY	8	5	8	5							26
	THUJA PLICATA	WESTERN RED CEDAR	2	1	2	1							6
CB: CHANNEL TO BENCH			CB1	CB2	CB3	CB4	CB5	CB6	CB7				
	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW	5	4	5	5	9	7	3				38
	SALIX SITCHENSIS	SITKA WILLOW	5	4	5	5	9	7	3				38
B: BENCH			B1	B2	B3	B4	B5	B6	B7				
	CORNUS SERICEA	RED OSIER DOGWOOD	7	7	7	7	12	10	4				54
	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW	7	7	7	7	12	10	4				54
	SALIX SITCHENSIS	SITKA WILLOW	7	7	7	7	12	10	4				54
CL: COIR LIFTS			CL1	CL2	CL3	CL4							
	SALIX SCOULERIANA	SCOULER'S WILLOW	127	127	117	117							488
	SALIX SESSILIFOLIA	SOFT LEAVED WILLOW	127	127	117	117							488
	CORNUS SERICEA	RED-OSIER DOGWOOD	127	127	117	117							488
CT: TOP OF COIR BANK			CT1	CT2	CT3	CT4	CT5	CT6	CT7	CT8	CT9	CT10	
	HOLODISCUS DISCOLOR	OCEANSPRY	7	16	14	13	7	26	16	6	16	13	134
	RIBES SANGUINEUM	RED FLOWERING CURRANT	7	16	14	13	7	26	16	6	16	13	134
	SYMPHORICARPOS ALBUS	SNOWBERRY	7	16	14	13	7	26	16	6	16	13	134
	ALNUS RUBRA	RED ALDER	1	2	2	2	1	3	2	1	2	2	18
	POPULUS BALSAMIFERA	BLACK COTTONWOOD	1	2	2	2	1	3	2	1	2	2	18
	THUJA PLICATA	WESTERN RED CEDAR	1	2	2	2	1	3	2	1	2	2	18
SC: SELECTIVE PLANTING AREA			SC1	SC2	SC3	SC4	SC5	SC6	SC7				
	HOLODISCUS DISCOLOR	OCEANSPRY	2	3	3	2	10	4	5				29
	RIBES SANGUINEUM	RED FLOWERING CURRANT	2	3	3	2	10	4	5				29
	SYMPHORICARPOS ALBUS	SNOWBERRY	2	3	3	2	10	4	5				29
	ALNUS RUBRA	RED ALDER	1	2	2	1	5	2	3				16
	POPULUS BALSAMIFERA	BLACK COTTONWOOD	1	2	2	2	6	2	4				16
	THUJA PLICATA	WESTERN RED CEDAR	1	2	2	2	6	2	4				16

GENERAL NOTES:

1. TREES TO BE RETAINED DURING CONSTRUCTION SEE DRAWING C-2 FOR SPECIFICATIONS.
2. SEE PLANTING MATERIALS AND NOTES ON DRAWING P-3.
3. SEE PLANTING DETAILS ON DRAWING P-4.

DATUM
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CITY OF BELLEVUE WASHINGTON
City of Bellevue
UTILITIES

PLANTING PLAN - RICHARDS CREEK

DRAWING P-2

SHT 17 OF 19

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PLANT MATERIAL LIST:

PLANTING AREA\ TYPE NAME	SCIENTIFIC NAME	COMMON NAME	MATERIAL TYPE AND SIZE	SPACING ON CENTER (FT)	QUANTITY
A: ACCESS AREA					
	HOLODISCUS DISCOLOR	OCEANSPRAY	1 GAL CONT. 24" HEIGHT	3	26
	RIBES SANGUINEUM	RED FLOWERING CURRANT	1 GAL CONT. 24" HEIGHT	3	26
	SYMPHORICARPOS ALBUS	SNOWBERRY	1 GAL CONT. 24" HEIGHT	3	26
	THUJA PLICATA	WESTERN RED CEDAR	2 GAL CONT. 24" HEIGHT	3	6
CB: CHANNEL TO BENCH					
	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW	BARE ROOT OR LIVE STAKE 36–48" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	38
	SALIX SITCHENSIS	SITKA WILLOW	BARE ROOT OR LIVE STAKE 36–48" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	38
B: BENCH					
	CORNUS SERICEA	RED OSIER DOGWOOD	BARE ROOT OR LIVE STAKE 36–48" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	54
	SALIX LUCIDA SSP. LASIANDRA	PACIFIC WILLOW	BARE ROOT OR LIVE STAKE 36–48" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	54
	SALIX SITCHENSIS	SITKA WILLOW	BARE ROOT OR LIVE STAKE 36–48" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	54
CL: COIR LIFTS					
	SALIX SCOULERIANA	SCOULER'S WILLOW	LIVE STAKE 36–48" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	488
	SALIX SESSILIFOLIA	SOFT LEAVED WILLOW	LIVE STAKE 36–48" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	488
	CORNUS SERICEA	RED–OSIER DOGWOOD	LIVE STAKE 36–48" LENGTH; 0.5–1" DIAMETER BASE; ANGLE CUT ON BASAL END	3	488
CT: TOP OF COIR BANK					
	HOLODISCUS DISCOLOR	OCEANSPRY	1 GAL CONT. 24" HEIGHT	3	134
	RIBES SANGUINEUM	RED FLOWERING CURRANT	1 GAL CONT. 24" HEIGHT	3	134
	SYMPHORICARPOS ALBUS	SNOWBERRY	1 GAL CONT. 24" HEIGHT	3	134
	ALNUS RUBRA	RED ALDER	1 GAL CONT. 24" HEIGHT	10	18
	POPULUS BALSAMIFERA	BLACK COTTONWOOD	1 GAL CONT. 24" HEIGHT	10	18
	THUJA PLICATA	WESTERN RED CEDAR	2 GAL CONT. 24" HEIGHT	10	18
SC: SELECTIVE PLANTING AREA					
	HOLODISCUS DISCOLOR	OCEANSPRY	1 GAL CONT. 24" HEIGHT	10	29
	RIBES SANGUINEUM	RED FLOWERING CURRANT	1 GAL CONT. 24" HEIGHT	10	29
	SYMPHORICARPOS ALBUS	SNOWBERRY	1 GAL CONT. 24" HEIGHT	10	29
	ALNUS RUBRA	RED ALDER	1 GAL CONT. 24" HEIGHT	30	16
	POPULUS BALSAMIFERA	BLACK COTTONWOOD	1 GAL CONT. 24" HEIGHT	30	19
	THUJA PLICATA	WESTERN RED CEDAR	1 GAL CONT. 24" HEIGHT	30	19
CT AND CS: TOP OF BANK COVER					
	NATIVE GRASS SEED MIX PER CITY		HYDROSEED IF POSSIBLE	PER CITY	

GENERAL NOTES:

1. NOXIOUS WEEDS SHALL BE REMOVED PRIOR TO COMMENCING CONSTRUCTION. WEEDS SHALL BE REMOVED BY SELECTIVE CLEARING METHODS WITHIN THE RIPARIAN ENHANCEMENT ZONES. THE WORK SITE SHALL BE MAINTAINED IN A WEED FREE CONDITION THROUGHOUT CONSTRUCTION UNTIL THE CLOSE OF THE CONTRACT. AT A MINIMUM, HIMALAYAN BLACKBERRY, REED CANARYGRASS, ENGLISH IVY SHALL BE COMPLETELY REMOVED FROM THE PROJECT SITE. JAPANESE KNOTWEED TO BE REMOVED PER CITY SPECIFICATIONS.
2. SELECTIVE CLEARING METHODS CONSIST OF LIGHTWEIGHT HAND OR HAND–HELD EQUIPMENT TO PREVENT DAMAGE TO ROOTS OF EXISTING VEGETATION, COMPACTION OF SOIL, AND DISPERSAL OF SEEDS OR POLLEN FROM INVASIVE PLANTS.
3. NATIVE SEED MIX SHALL BE APPLIED TO ALL DISTURBED AREAS TO STABILIZED SOILS & TO PROVIDE HERBACEOUS COVER. SEEDING SHALL OCCUR AFTER SOIL PREPARATION AND GRADING HAS BEEN APPROVED BY ENGINEER. NATIVE SEED MIX SHALL BE APPLIED BY HAND TO FACES OF SOIL LIFTS PRIOR TO WRAPPING WITH WOVEN GEOTEXTILE. ALL OTHER AREAS WILL BE HYDROSEEDED.
4. ALL PLANTS, EXCEPT AS NOTED, SHALL BE NURSERY CONTAINER GROWN A MINIMUM OF ONE YEAR AND CONTAINERIZED PER ANSI STANDARDS. PLANT MATERIAL IS TO BE SUPPLIED BY COMMERCIAL NURSERIES THAT SPECIALIZE IN NATIVE PLANTS. PLANT SUBSTITUTIONS ARE SUBJECT TO APPROVAL BY THE ENGINEER.
5. SPECIFICATIONS FOR SIZE AND CONDITION ON DWG P–3 ARE MINIMUM.
6. PLANT SPECIES SELECTIONS FOR EACH PLANTING AREA ARE BASED ON PREDICTED LIGHT AND WATER AVAILABILITY. PLANTS SHALL BE MIXED THROUGHOUT EACH PLANTING ZONE. VERIFICATION OF APPROPRIATE ENVIRONMENTAL CONDITIONS PER SPECIES REQUIREMENTS WILL BE NECESSARY TO ACHIEVE MAXIMUM PLANT SURVIVAL. LAYOUT OF ALL PLANT MATERIAL AND SEEDING TO BE APPROVED BY THE ENGINEER PRIOR TO INSTALLATION. PLANTING PLAN MAY REQUIRE MODIFICATION FOLLOWING ASSESSMENT OF AS–BUILT CONDITIONS: USE PLAN FOR QUANTITIES – FINAL LOCATIONS OF PLANTS SUBJECT TO CHANGE.
7. SHRUBS, TREES AND, LIVE STAKES SHALL BE INSTALLED ACCORDING TO DETAILS ON DWG P–4.
8. DISCREPANCIES BETWEEN PLANS AND SITE CONDITIONS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER PRIOR TO PROCEEDING.
9. ENGINEER TO APPROVE GRADING PRIOR TO PLANTING.
10. KEEP ALL PLANT MATERIAL WELL–WATERED AND SHADED UNTIL THE ACTUAL TIME OF PLANTING: DO NOT ALLOW PLANT MATERIAL TO BE EXPOSED TO SUNLIGHT OR OTHER DRYING CONDITIONS PRIOR TO PLANTING.
11. ALL SHRUB AND TREE PLANTING SHALL OCCUR DURING THE DORMANT SEASON (OCTOBER THROUGH FEBRUARY).
12. THOROUGHLY WATER ALL PLANTED AREAS IMMEDIATELY AFTER PLANTING AND WATER FOR OPTIMUM HEALTH DURING DRY PERIODS DURING THE PLANT ESTABLISHMENT PERIOD.
13. EXISTING AREAS DISTURBED BY CONSTRUCTION ACTIVITIES AND NOT SHOWN TO BE RE–LANDSCAPED ON THESE PLANS SHALL BE RESTORED AND SEEDED AS DIRECTED BY THE ENGINEER.
14. SEE SPECIFICATIONS FOR ADDITIONAL SEEDING, PLANTING, AND SOIL PREPARATION NOTES.
15. ALL TREE OR SHRUB PLANTINGS SHALL BE SETBACK A MINIMUM OF 5 FEET FROM ALL PAVEMENT EDGES, AND ALL TREE PLANTINGS SHALL BE SETBACK A MINIMUM OF 10 FEET FROM BUILDINGS.
16. TREES WILL BE RETAINED DURING CONSTRUCTION ACCORDING TO SPECIFICATIONS ON DRAWING C–2.

DATUM
NAVD 88/NAD 83

811 Know what's below. Call before you dig.

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

PERMIT SET - NOT FOR CONSTRUCTION

NO	DATE	BY	APPR	REVISIONS

HERRERA ENVIRONMENTAL CONSULTANTS
2200 Sixth Avenue
Suite 1100
Seattle, Washington
98121-1820
206-441-9080
206-441-9108 FAX
http://www.herrerainc.com

SUNSET CREEK/RICHARDS CREEK FLOOD CONTROL AND HABITAT IMPROVEMENT PROJECT

Approved By

DESIGN MANAGER DATE
PROJECT MANAGER DATE

C. AVOLIO/M. STRAZER 07/2010
DESIGNED BY DATE
T. PRESCOTT 07/2010
DRAWN BY DATE
M. EWBANK 07/2010
CHECKED BY DATE

City of Bellevue
UTILITIES

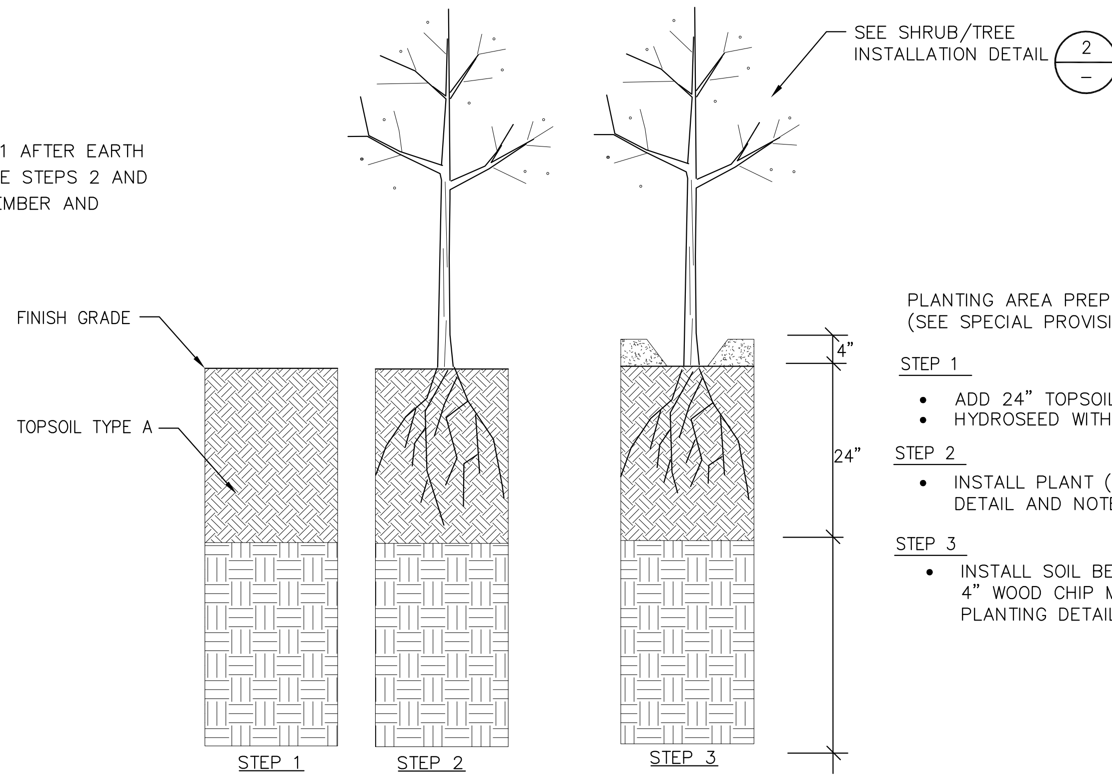
PLANT MATERIAL LIST

DRAWING P-3

Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\P-3.dwg Cad User: Laura Turnidge
Plot Date: 7/13/2010 5:51 PM

NOTE:

1. COMPLETE STEP 1 AFTER EARTH WORK. COMPLETE STEPS 2 AND 3 BETWEEN NOVEMBER AND FEBRUARY



PLANTING AREA PREPARATION (SEE SPECIAL PROVISIONS)

STEP 1
- ADD 24" TOPSOIL TYPE A
- HYDROSEED WITH SEED MIX

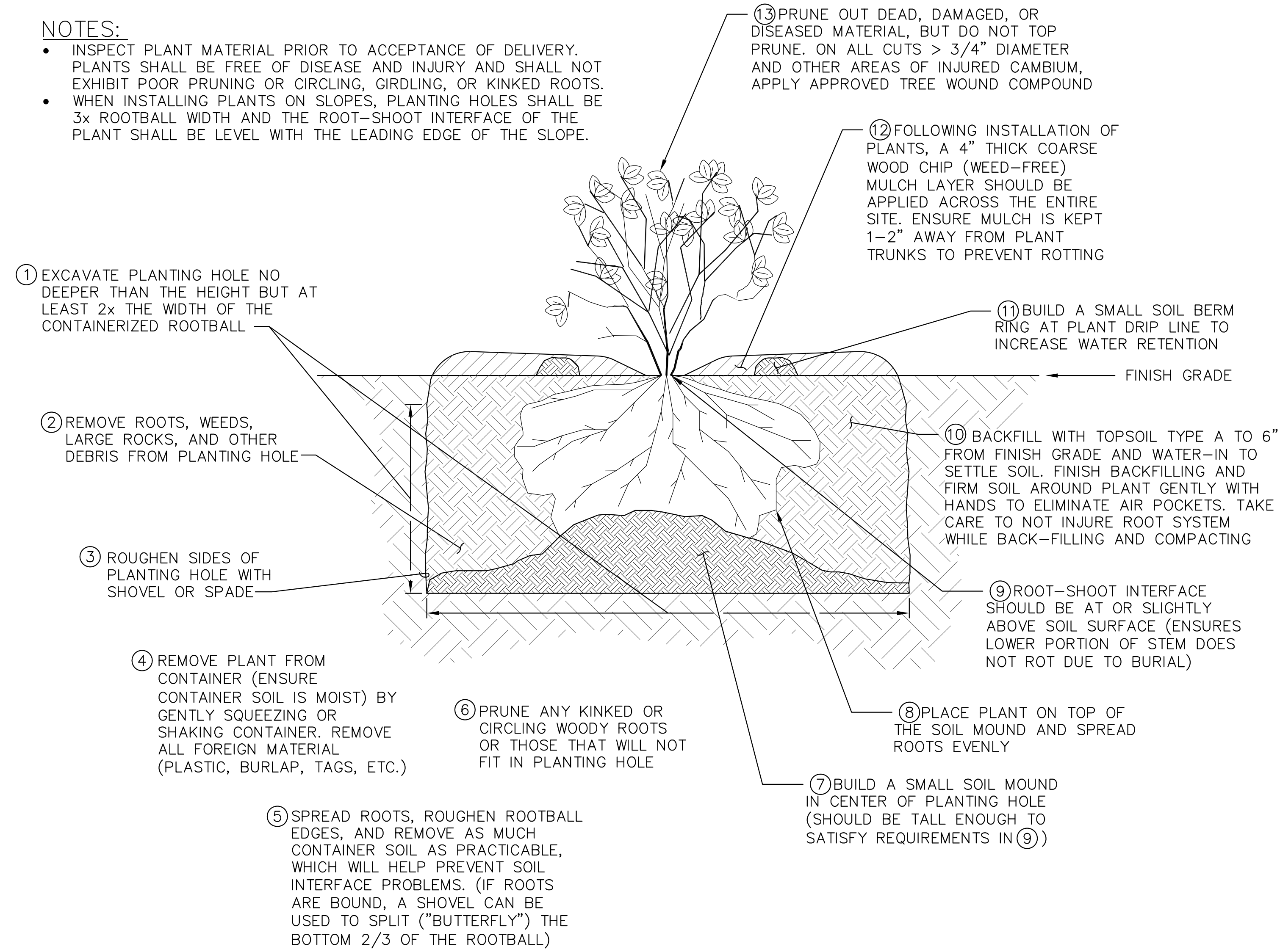
STEP 2
- INSTALL PLANT (SEE PLANTING DETAIL AND NOTE 1)

STEP 3
- INSTALL SOIL BERM RINGS AND 4" WOOD CHIP MULCH (SEE PLANTING DETAIL AND NOTE 1)

TOPSOIL TYPE A AMENDMENT AND PLANTING SEQUENCE OF WORK 1 –

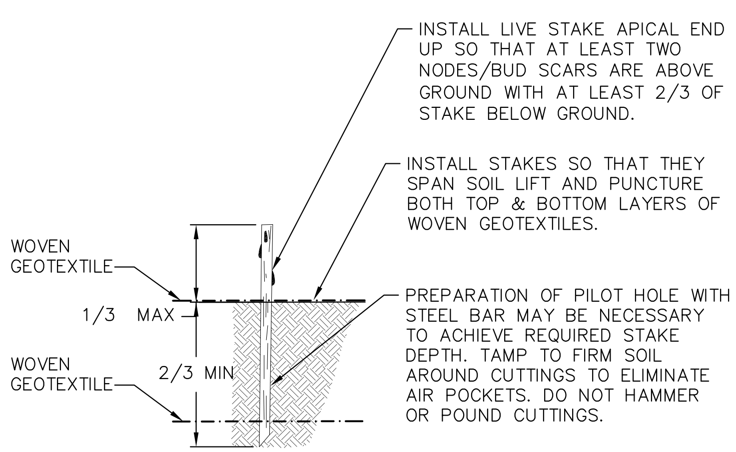
SCALE: NTS

NOTES:
- INSPECT PLANT MATERIAL PRIOR TO ACCEPTANCE OF DELIVERY. PLANTS SHALL BE FREE OF DISEASE AND INJURY AND SHALL NOT EXHIBIT POOR PRUNING OR CIRCLING, GIRDLING, OR KINKED ROOTS.
- WHEN INSTALLING PLANTS ON SLOPES, PLANTING HOLES SHALL BE 3x ROOTBALL WIDTH AND THE ROOT–SHOOT INTERFACE OF THE PLANT SHALL BE LEVEL WITH THE LEADING EDGE OF THE SLOPE.



CONTAINERIZED TREE/SHRUB INSTALLATION SEQUENCE 2 –

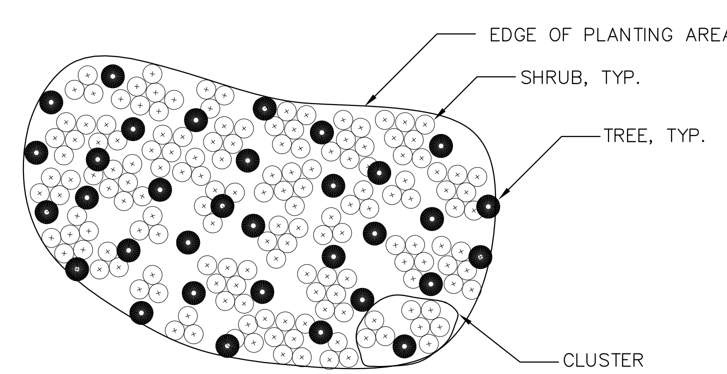
SCALE: NTS



NOTES:
1. SOAK WILLOW STAKES IN WATER FOR 24 HOURS PRIOR TO PLANTING.
2. BASAL END OF LIVE STAKES SHOULD BE 0.5–1.5 INCHES IN DIAMETER AND AT LEAST 36 INCHES IN LENGTH.
3. KEEP LIVE STAKES COVERED, COOL, AND MOIST AT ALL TIMES PRIOR TO PLANTING. AT NO TIME SHOULD LIVE STAKES BE EXPOSED AND ALLOWED TO DRY OUT.
4. WHEN PLANTING ON STREAM BANKS, ANGLE APICAL END OF STAKES SLIGHTLY DOWNSTREAM.

LIVE STAKE INSTALLATION 3 –

SCALE: NTS



NOTES:
1. PLANT SHRUBS OF SAME SPECIES IN CLUSTERS OF THREE, FIVE, OR SEVEN.
2. PLACE SHRUBS 3 FEET ON CENTER WITHIN EACH CLUSTER. PLACE TREES ON CENTER PER PLANT MATERIAL LIST ON DRAWINGS P–3 BETWEEN CLUSTERS. (PLANTING DENSITIES WILL BE GREATER IN AREAS WITH HERBS.)
3. EVENLY SPACE CLUSTERS THROUGHOUT PLANTING AREA.
4. INTENT OF SHRUB PLANTING ARRANGEMENT IS TO ENCOURAGE NATURAL, IRREGULAR PATCH FORMATION.

DATUM

NAVD 88/NAD 83

811 Know what's below. Call before you dig.

ONE INCH — AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

Path: O:\proj\Y2009\09-04582-000\CAD\Dwgs\P-4.dwg Cad User: Laura Turnidge
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DRAWN BY	DATE
M. EWBANK	07/2010
CHECKED BY	DATE

City of Bellevue UTILITIES

PLANTING DETAILS

DRAWING P-4

SHT 19 OF 19

Pyle, David

From: Karen Walter [KWalter@muckleshoot.nsn.us]
Sent: Friday, December 03, 2010 2:48 PM
To: Pyle, David
Subject: RE: City of Bellevue Utilities Sunset/Richards Creek Flood Control and Habitat Improvement Project, 10-121739-LO, Optional Determination of Non-Significance Notice Materials

David,
Thank you for sending the City's responses. We have no further questions at this time.

Best regards,
Karen Walter
MITFD

-----Original Message-----
From: DPyle@bellevuewa.gov [mailto:DPyle@bellevuewa.gov]
Sent: Thursday, October 28, 2010 3:48 PM
To: Karen Walter
Cc: ASantos@bellevuewa.gov; MCross@bellevuewa.gov; MPaine@bellevuewa.gov
Subject: RE: City of Bellevue Utilities Sunset/Richards Creek Flood Control and Habitat Improvement Project, 10-121739-LO, Optional Deteremination of Non-Significance Notice Materials

Karen-

Please find attached a letter in response to the questions previously presented on project 10-121739-LO - the Richards/Sunset Creek Flood Control and Habitat Improvement Project.

Please let me know if you have any questions.

David Pyle
Senior Land Use Planner
City of Bellevue
dpyle@bellevuewa.gov
(425)452-2973 (Office)
(425)452-5225 (Fax)
www.bellevuewa.gov

-----Original Message-----
From: Karen Walter [mailto:KWalter@muckleshoot.nsn.us]
Sent: Thursday, October 21, 2010 4:58 PM
To: Pyle, David
Subject: City of Bellevue Utilities Sunset/Richards Creek Flood Control and Habitat Improvement Project, 10-121739-LO, Optional Deteremination of Non-Significance Notice Materials

David,
The Muckleshoot Indian Tribe Fisheries Division has reviewed the Optional Determination of Non-Significance Notice Materials for the above referenced project. We have some questions and initial comments about this project as noted below:

1. Per the project drawing Sheet C-2, there is one 12" dbh red alder that will be removed. What is the fate of this tree? It should be placed back into the Sunset or Richards Creek as partial mitigation for its removal.

2. How many trees that are 4 inches in diameter and less than 8 inches in diameter that will be removed? Trees that are 4 inches in diameter and 6 feet in length meet the minimum size criteria to be considered as wood by most of the scientific literature and they too should be placed back into the stream as partial mitigation.

3. The revetment wood jam should have more trees with rootwads than shown. Currently, only 3 of the 10 logs will have rootwads. In addition, rock should be minimized for this log jam and more wood added if needed for ballast.

4. What technical information/analysis/rationale was used to determine the log structures proposed for habitat enhancement?

5. The Critical Areas Report briefly mentions a waterfall downstream of the project (Phase II) that is a fish passage barrier. We would like more information about this waterfall that was used to determine its barrier status. There is no mention of this waterfall in the Flood Control and Sediment Management Report from 2008. In addition, we would like to know how fish will benefit from the fish enhancement features of Phase II if the downstream waterfall is a fish passage barrier.

We appreciate the opportunity to review this proposal and look forward to the City's responses. We may have further comments subsequently.

Thank you,
Karen Walter
Watersheds and Land Use Team Leader

Muckleshoot Indian Tribe Fisheries Division
39015 172nd Ave SE
Auburn, WA 98092
253-876-3116

City of
Bellevue
Post Office Box 90012 ▪ Bellevue, Washington ▪ 98009 9012

October 28, 2010

Karen Walter
Muckleshoot Indian Tribe Fisheries Division
39015 - 172nd Avenue SE
Auburn, Washington 98092-9763

RE: 10-121739-LO – City of Bellevue Utilities Department Sunset/Richards Creek Flood Control and Habitat Improvement Project

Karen-

I am writing to respond to your questions submitted regarding project 10-121739-LO. We have considered your comments and have provided a response as follows:

1. Per the project drawing Sheet C-2, there is one 12" dbh red alder that will be removed. What is the fate of this tree? It should be placed back into the Sunset or Richards Creek as partial mitigation for its removal.

Wood in excess of that being removed will be placed in the stream in an effort to improve in stream and riparian habitat. The source of the wood is not regulated by city codes and the use of native volunteer wood is not required. Tree removal is typically mitigated through replacement. In this case additional mitigation beyond replanting is provided through the incorporation of wood in the stream channel.

2. How many trees that are 4 inches in diameter and less than 8 inches in diameter that will be removed? Trees that are 4 inches in diameter and 6 feet in length meet the minimum size criteria to be considered as wood by most of the scientific literature and they too should be placed back into the stream as partial mitigation.

Trees sized between smaller than 8 inches were not required for identification on the site plans and may be removed when a mitigation plan is proposed to restore the area impacted to an equivalent or better condition. In this case, clearing is required to re-grade the stream and adjacent riparian areas in an effort to stabilize the streambed and address conditions that amplify flood hazard potential. To mitigate for the impact of clearing and grading within the stream and adjacent riparian area the project proposal includes a restoration plan and habitat improvement plan that includes the placement of wood in stream (in excess of that being removed), and the planting of the adjacent riparian area. Replanting and wood placement is done at an advanced ratio to address impacts associated with construction and provide for future sources of wood and organic inputs to the stream system. In this case the source of the wood is not regulated, and trees removed are not required to be directly placed in the stream. Tree and plant materials will be imported to the project site based on the project design.

3. The revetment wood jam should have more trees with rootwads than shown. Currently, only 3 of the 10 logs will have rootwads.   In addition, rock should be minimized for this log jam and more wood added if needed for ballast.

Because logs are buoyant and rootwads add buoyancy, the log revetment structure was designed to include rootwads where they could maximize benefits for fish habitat, while at the same time not off-setting the balance of buoyancy and soil overburden required to achieve a necessary factor of safety. Rock has been included in the design for the very same reason of trying to counter-balance the logs' buoyant forces. The 90% design can revisit the addition of more rootwad pieces included by trying to lower the structure under the bank to obtain greater soil overburden depths, or by attaching the logs to ecology block deadman anchors buried below the structure. In addition, should the 90% design find that additional ballast is still necessary, rounded streambed boulders will be incorporated instead of rock.

4. What technical information/analysis/rationale was used to determine the log structures proposed for habitat enhancement?

Observations made during channel monitoring of Sunset and Richards Creek, and also documented in the Flood Control and Sediment Management Plan, have found that the existing channel and floodplain are artificially confined by development and armored banks. This confinement restricts sinuosity and physical habitat complexity and in general, pools for rearing habitat are scarce. However, localized obstructions such as small woody debris, branches, and roots have been found to encourage local scour pool formation and gravel sorting within Sunset and Richards Creeks. Therefore, the proposed habitat log structures have been designed to mimic these existing localized obstructions, by locally encouraging sinuosity, scour pools, and gravel sorting within the proposed channel floodplain throughout the restored Phase 2 reach. At the same time, the habitat log structures will provide structural stability to the proposed channel bench (two-staged channel), and the additional roughness from the log structures has been reflected in the hydraulic modeling analysis (Flood Control and Sediment Management Plan) to ensure that reach-wide goals for sediment transport and reducing flooding are maintained.

5. The Critical Areas Report briefly mentions a waterfall downstream of the project (Phase II) that is a fish passage barrier. We would like more information about this waterfall that was used to determine its barrier status. There is no mention of this waterfall in the Flood Control and Sediment Management Report from 2008. In addition, we would like to know how fish will benefit from the fish enhancement features of Phase II if the downstream waterfall is a fish passage barrier.

The waterfall barrier identified on pages 22 and 33 of the project Critical Areas Report dated September 7, 2010 was identified during field evaluation and downstream analysis related to the project currently under review. This barrier was not identified as part of the Flood Control and Sediment Management Report as the problem had not yet been identified. After identification, the Utilities Department has initiated a correction of this barrier through a separate project (Phase III) that will be submitted for permit review in the winter of 2010/2011. After implementation of Phase III, fish will benefit from the improvements made as part of Phase II as passage will be restored.

I hope this helps answer your questions. Please let me know if you need additional information.

Sincerely,

Sent Via Email

David Pyle
Land Use Planner

Cc: Abe Santos, COB Utilities Department
Mark Cross, COB Utilities Department
Michael Paine, COB Development Services Department

DEVELOPMENT SERVICES DEPARTMENT
ENVIRONMENTAL COORDINATOR
450 110th Ave NE., P.O. BOX 90012
BELLEVUE, WA 98009-9012

OPTIONAL DETERMINATION OF NON-SIGNIFICANCE (DNS) NOTICE MATERIALS

The attached materials are being sent to you pursuant to the requirements for the Optional DNS Process (WAC 197-11-355). A DNS on the attached proposal is likely. This may be the only opportunity to comment on environmental impacts of the proposal. Mitigation measures from standard codes will apply. Project review may require mitigation regardless of whether an EIS is prepared. A copy of the subsequent threshold determination for this proposal may be obtained upon request.

File No.	10-121739-LO
Project Name/Address:	City of Bellevue Utilities Sunset/Richards Creek Flood Control and Habitat Improvement Project SEPA Checklist 13200 SE 30th Street (Generally)
Planner:	David Pyle / dpyle@bellevuewa.gov
Phone Number:	425-452-2973
Minimum Comment Period:	**October 21, 2010**

Materials included in this Notice:

- [x] Blue Bulletin
- [x] Checklist
- [x] Vicinity Map
- [x] Plans
- [ ] Other:

ENVIRONMENTAL CHECKLIST

Sunset Creek/Richards Creek Flood Control and Habitat Improvement Project

City of Bellevue File Number 10-121739-LO
10/07/2010
City of Bellevue Utilities Department Sunset/Richards Creek Flood Control and Habitat Improvement Project
Project SEPA Checklist
13200 SE 30th Street (Generally)

SEPA Checklist Reviewed By:
David Pyle, Land Use Planner
425-452-2973 - dpyle@bellevuewa.gov

Prepared for

City of Bellevue
Department of Utilities

Applicant is City of Bellevue Utilities Department

September 2010

Reviewed By: David Pyle 09/08/2010

Note:
Some pages in this document have been purposefully skipped or blank pages inserted so that this document will copy correctly when duplexed.

ENVIRONMENTAL CHECKLIST

Sunset Creek/Richards Creek Flood Control and Habitat Improvement Project

Prepared for

City of Bellevue
Department of Utilities
450 – 110th Avenue NE
P.O. Box 90012
Bellevue, Washington 98009

Prepared by

Herrera Environmental Consultants, Inc.
2200 Sixth Avenue, Suite 1100
Seattle, Washington 98121
Telephone: 206/441-9080

September 7, 2010

Reviewed By: David Pyle 09/08/2010

Reviewed By: David Pyle 09/08/2010

Contents

Tables

Environmental Checklist

A. Background

1. Name of proposed project if applicable:

Sunset Creek/Richards Creek Flood Control and Habitat Improvement Project

2. Name of applicant:

City of Bellevue

Applicant is City of Bellevue Utilities Department

3. Address and phone number of applicant and contact person:

Abe Santos
City of Bellevue – Department of Utilities
450 – 110th Avenue NE
P.O. Box 90012
Bellevue WA 98009
425-452-6456

4. Date checklist prepared:

September 7, 2010

5. Agency requesting checklist:

City of Bellevue – Department of Planning and Community Development

City of Bellevue Development Services Department - Office of SEPA administrator.

6. Proposed timing or schedule (including phasing, if applicable):

The project is proposed for construction in the summer of 2011.

7. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.

The Sunset Creek/Richards Creek Flood Control and Habitat Improvement Project (hereafter, "the project") increases the capacity of the stream, prevents channel degradation, enhances connectivity between the stream and adjacent wetlands, and improves instream fish habitat diversity and cover. This project is Phase 2 of a three-phase project that is being completed by the City of Bellevue in accordance with the Flood Control and Sediment Management Plan for Richards Creek, Sunset Creek, and East Creek (Herrera 2008) in order to control flooding of the surrounding properties and improve the instream and riparian habitat for fish and other wildlife in Sunset, Richards, and East Creeks. The project vicinity is shown in Appendix A, Figure 1. The locations of the three phases are shown in Appendix A, Figure 2.

Historically, the channel configurations of Sunset Creek, Richards Creek, and East Creek within the project area were free to move laterally and shift course as sediment deposition filled channels and locally reduced sediment transport capacity, which is typical for channels on alluvial fans (see historic channel locations Appendix A, Figure 2). However, Sunset Creek, Richards Creek, and East Creek were realigned during development in the 1960s, when land was graded and buildings were constructed adjacent to the channel network (Figure 2). To maintain the altered channel locations, the banks of these streams were armored in several areas. This channelization ended the natural process of dynamic sediment deposition and channel relocation and concentrated sediment deposition along the constructed channel alignments, without ability for the channels to shift in response to the sediment deposition.

Since development has occurred, the Richards Creek, Sunset Creek, and East Creek channel network in the vicinity of SE 30th Street and Kamber Road has been directly impacted by channel realignment, channel confinement, and increased rates of sediment production associated with land development both local to the project area and in the upper watershed. These impacts include recurrent flooding and sedimentation problems, channel instability, and degraded habitat conditions.

The City of Bellevue is pursuing a number of projects over a phased timeline to address flooding, promote channel stability, and improve habitat conditions. In 2008, the City contracted with Herrera Environmental Consultants, Inc. (Herrera) to prepare the *Sunset Creek Flood Control and Sediment Management Plan*. This plan provides a comprehensive analysis and proposed solutions to ongoing sediment management and flooding challenges in these drainages, while producing a net improvement in habitat conditions.

Flood Control and Sediment Management Plan is attached as part of application materials and available in project file.

The first phase of this work was constructed in 2009 on Sunset Creek (the most upstream portion of the phased proposed stream improvement area). Phase 1 (referred to as SE 30th Street/Sunset Creek Flood Improvement Project) included a replacement culvert and sediment trap at SE 30th Street and channel modifications upstream and downstream to provide a stable streambed transition to the culvert inlet and outlet. The Phase 1 project was considered to have independent utility from future phases, and was permitted and implemented as a separate effort to address immediate needs.

Phase 1 was permitted under COB Development Services file #08-128529-LO.

The project discussed in this checklist, the Sunset Creek/Richards Creek Flood Control and Habitat Improvement Project, represents the second phase of work and continues with channel improvements and flood control measures along Sunset Creek downstream of Phase 1 to the confluence with Richards Creek. The project also entails stream improvements from the Optiva Curve (where Richards Creek turns sharply from north to east) to the historical Richards Creek flow split channel, approximately 300 feet upstream of the confluence with East Creek.

The third phase, East Creek Stream Channel Modification and Kelsey Creek Fish Passage Improvement project, will include flood control, channel stabilization, and channel and wetland habitat improvements downstream of Phase 2 in Richards and East Creeks (Appendix A, Figure 2). Both Phases 2 and 3 are planned to be constructed in 2011.

Any future planned work would require permit review, including public notice and open comment periods.

Reviewed By: David Pyle 09/08/2010

8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

▪ Joint Aquatic Resource Permit Application (JARPA)	**Pending**
▪ Sunset Creek Flood Control and Sediment Management Plan (Geomorphic Assessment and Basis of Design Report)	**Complete**
▪ Biological Assessment	**Pending**
▪ Critical Areas Report	**Complete**
▪ Wetland mitigation plan	**Pending**

Conceptual wetland mitigation plans have been submitted as part of this application. Final wetland mitigation plans that are consistent with the approved conceptual plan will be finalized prior to issuance of construction permits.

9. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain.

No other relevant projects or permit applications have been identified.

10. List any government approvals or permits that will be needed for your proposal, if known.

- Hydraulic Project Approval – Washington Department of Fish and Wildlife
- Clean Water Act Section 404 permit (under Nationwide Permit 3) – U.S. Army Corps of Engineers
- Clean Water Act Section 401 Water Quality Certification – Washington State Department of Ecology
- Endangered Species Act concurrence – National Marine Fisheries Service (no U.S. Fish and Wildlife Service jurisdiction species occur in the action area)
- Critical Area Land Use Permit – City of Bellevue
- Clearing and Grading Permit – City of Bellevue

11. Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include additional specific information on project description.)

The project background and setting are described, respectively, in parts A-7 and A-13 of this checklist. The project channel modifications include the following elements:

- Channel enlargement for a stable, wetted channel

- Installation of log grade control and habitat structures to prevent head-cut migration and provide stable, physical habitat
- Construction of a containment berm to limit the extent of flooding into neighboring properties
- Removal of invasive vegetation
- Revegetation with native plants
- Construction of a wetland bench within the proposed channel to promote the reestablishment of wetland species and provide low-velocity shelter areas for fish

Where feasible, native vegetation and mature trees greater than 8 inches in diameter at breast height (dbh) will be retained. The project includes site preparation, temporary flow diversion for fish exclusion, and temporary erosion and sediment control (Design Plan Sheets).

The project extends a total of about 900 feet downstream of the Phase 1 project (or about 1000 feet downstream of the SE 30th Street crossing), including channel work along 390 feet of Sunset Creek (to the confluence with Richards Creek) and about 380 feet of Richards Creek (downstream of the confluence with Sunset Creek) (Plan Sheets). The project includes protection of an approximate 180-foot-long reach of Richards Creek, immediately downstream of its confluence with Sunset Creek, because it contains good instream fish habitat and diverse riparian habitat with a mature tree canopy.

For the Sunset Creek portion, the banks will be slightly set back and an average depth of between 2.5 to 3 feet of sediment will be removed to increase conveyance capacity and to move the active channel away from the footings of adjacent buildings.

For the Richards Creek portion, the banks will also be set back and the channel bed dropped by about 0.75 feet on average to increase conveyance capacity. The finished channel bed slope will be approximately 0.9 percent, which corresponds to an equilibrium gradient for sediment transport and deposition through the reach. Log grade control structures are being installed to protect this channel gradient, and they will be spaced at a frequency to promote fish passage, and have been designed such that there is no more than a 4-inch elevation difference between structures. These grade control structures will also help to halt a recent head-cut that has caused severe channel incision immediately downstream of the project reach and which could continue upstream if no action is taken.

12. Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should

submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.

The project is located within, and adjacent to, the channel of Sunset and Richards Creeks in the City of Bellevue (Figure 1). The project area is within the Kelsey Creek Basin of Water Resource Inventory Area (WRIA) 8 – the Cedar/Sammamish Watershed. The legal description of this location is the northwest 1/4 of Section 10, Township 24 North, Range 5 East. See Appendix A, Figure 2 for the location of the project area and distinct project phases as described in the flood control and sediment management plan.

B. Environmental Elements

1. Earth

a. General description of the site (check one):

_X_ **flat**
____ **rolling**
____ **hilly**
____ **steep slopes**
____ **mountainous**
____ **other:** ____________________

b. What is the steepest slope on the site (approximate percent slope)?

The gradient of the Sunset Creek channel typically ranges from 5 percent upstream of SE 30th Street to about 1 percent within the project area. Stream bank gradients are up to 45 degrees, and riprap-armored stream banks are nearly vertical. Other areas in the vicinity of the project are nearly flat.

c. What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any prime farmland.

Soil at the project site is classified as urban land, indicating that the road corridor was constructed in highly disturbed or fill soils. Soils in the project vicinity are Everett-Alderwood gravelly sandy loam, Everett gravelly sandy loam, and Seattle muck.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

No (per King County sensitive areas map).

e. ***Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate source of fill.***

Channel and adjacent floodplain modifications involve excavation of 548 cubic yards of material above the ordinary high water mark (OHWM) and approximately 315 cubic yards below the OHWM (described in item B-3, below), and the placement of 41 cubic yards of fill above the OHWM and 67 cubic yards below the OHWM.

Table 1. Estimated volumes of excavation and fill above and below the OHWM for project construction.

Above OHWM		Below OHWM	
Amount of Excavation (cu. yds.)	Amount of Fill (cu. yds.)	Amount of Excavation (cu. yds.)	Amount of Fill (cu. yds.)
548	41	315	67

Fill will be in the form of washed, rounded river boulders and streambed gravel and cobble. Non-regulated fill in the form of structural logs, some with rootwads, will be incorporated into the channel bed and banks. All fill material will be recovered from onsite sources or imported from a licensed commercial source. Additional details regarding project construction, including channel grading, are provided in the *Critical Areas Report* prepared for the project.

f. ***Could erosion occur as a result of clearing, construction, or use? If so, generally describe.***

Clearing of riparian vegetation will be required for site access and to construct the project. Water quality impacts will be controlled through use of construction best management practices (BMPs), including temporary dewatering of the stream reach through the construction site (see Sheets ESC-1 and 2, and WM-1 in Design Plan Sheets). All disturbed areas will be restored with bioengineered bank stabilization techniques and appropriate native vegetation upon completion of construction.

BMP's will be applied as conditions of approval and reviewed through the Clearing and Grading application.

g. ***About what percentage of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?***

No change in impervious surface area will result from the proposed project.

No change in impervious is expected.

h. ***Proposed measures to reduce or control erosion, or other impacts on the earth, if any:***

Proposed BMPs are described below.

General Requirements

The proposed project will implement BMPs to avoid or minimize erosion-related impacts in accordance with regulatory requirements. The City of Bellevue will require its construction contractor to implement and maintain BMPs for temporary erosion and sediment control (TESC). These BMPs will be consistent with the Washington State Department of Ecology's 2005 *Stormwater Management Manual for Western Washington* (Ecology 2005) and are considered an integral part of the effect determinations made in the biological evaluation of the proposed project.

Construction Timing

All construction activities associated with stream channel grading, streamflow bypass, and installation of channel grade control structures will take place during the approved in-water work window for the project area (July 1 to August 31). Activities that may result in unavoidable short-term sediment releases to the stream will be scheduled to commence after July 1 to avoid adverse effects on sensitive fish life history stages.

Temporary Erosion and Sediment Control

TESC measures will be in place before work begins, and additional TESC measures will be implemented as work elements occur in different areas of the site. The TESC plan will include appropriate BMPs to be implemented throughout construction that will retain dust, soil, and stormwater runoff on site and prevent pollutants and turbid discharges from entering Sunset Creek.

Turbidity will be monitored during those construction activities with potential to release sediments to the stream. If measured turbidity 100 feet downstream of construction is more than 5 nephelometric turbidity units (NTU) greater than the background level, the activities causing the turbidity increase will be discontinued until additional measures necessary to achieve the required performance objectives can be implemented. TESC measures will be upgraded and added as necessary in response to unexpected storm events and changing site conditions (e.g., operation of additional pumps or relocation of silt fences).

The TESC plan will be maintained on site, and a recorded log of BMP implementation and TESC measure performance will be updated weekly. The plan and the log will be available on site for the duration of the project. Documentation will include (at a minimum) records of all BMP implementation and performance monitoring by the contractor's TESC lead as appropriate for the site conditions experienced during construction. Dewatering of the work area within the stream is planned as a major element of water quality protection during construction. Details on the dewatering plan are discussed later in this checklist.

Fueling and Lubrication

Fueling and use of lubricating oils and hydraulic fluids will be conducted offsite or at a designated staging area located at least 150 feet away from aquatic resources. All equipment working around aquatic resources, and that require hydraulic fluids, will use biodegradable hydraulic fluids.

The construction contractor will be required to develop a site-specific spill prevention, control, and countermeasures (SPCC) plan consistent with state law. The SPCC plan will address hazardous materials, fueling and maintenance of equipment, and spill containment and notification.

Removal of Best Management Practices

After the project is complete and disturbed soils are stabilized, all BMPs will be removed according to the following procedures:

- Evaluate the site to determine if the BMP is no longer needed (i.e., the area has been stabilized and the potential for sediment-laden water to exit the area has passed).
- Remove sediment buildup behind the BMP structures and dispose of sediments at an approved location offsite.
- Remove the BMP materials for reuse or recycling, if applicable.

Site Restoration and Revegetation

The boundaries of the clearing limits will be visibly flagged by a continuous tape or bright orange fencing before construction begins. As previously described, all disturbed areas within the clearing limits will be replanted with native trees and shrubs appropriate for the site. Soil in stream access points and other areas that have been compacted by heavy machinery will be tilled before replanting to enhance restoration and encourage infiltration of runoff.

Site erosion control and discharge management practices must be in compliance with the City's Clearing and Grading Codes. Review of the final erosion control and discharge control practices will be completed as part of the Clearing and Grading plan review.

2. Air

a. What types of emissions to the air would result from the proposal (for example, dust, automobile exhaust, odors, industrial wood smoke) during construction and when the project is completed? If any, generally describe and give approximate quantities if known.

Heavy equipment used during construction of this project will emit exhaust and create dust that could contribute to suspended particulates during project construction. However, these emissions will be short term. The proposed project area is located in an urbanized environment characterized by light industrial land uses.

The air quality impacts resulting from construction related heavy equipment use are expected to be indistinguishable from levels produced by typical levels of truck and other vehicle traffic in the affected neighborhood. Consequently, as long as construction equipment is properly maintained and operated to minimize emissions, no significant air quality impacts are expected to result from construction activities.

Automobile and heavy equipment emissions are not regulated by the City of Bellevue and are under the authority of the State of Washington.

b. ***Are there any offsite sources of emissions or odor that may affect your proposal? If so, generally describe.***

No.

c. ***Proposed measures to reduce or control emissions or other impacts on air, if any:***

Emissions from construction equipment and trucks can be reduced by using newer, well maintained equipment. Avoiding prolonged periods of vehicle idling also would reduce emissions. Construction contractors must comply with Puget Sound Clean Air Agency regulations requiring reasonable precautions to minimize odor and dust impacts. Best management practices for the control of windborne construction dust (such as applying water to the roadway) will be used, if needed.

3. Water

a. ***Surface water:***

1) ***Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, or wetlands)? If yes, describe and provide names. If appropriate, name the stream or river it flows into.***

There are extensive wetland systems within and around the project area that are hydrologically connected by surface and groundwater to Sunset and Richards Creeks.

Sunset Creek flows into Richards Creek, a tributary stream within the Kelsey Creek watershed. Kelsey Creek is a tributary to Lake Washington. Streams and wetlands in the vicinity of the project include Sunset Creek, Richards Creek, and associated wetlands described in detail in the *Critical Areas Report* prepared for the project. As described in item A-11, above, the project work area includes approximately 770 feet of stream channel within approximately 1000 feet of the SE 30th Street Crossing. The first segment (390 feet) is along Sunset Creek above the confluence of Richards Creek, while the second segment (380 feet) is downstream of the confluence, and downstream of the sharp turn in Richards Creek. The project area encompasses the dewatered exclusion areas (Design Plan Sheets, Sheet 15 of 19) and wetland impact areas located immediately adjacent to the streams. Dewatering areas and wetland impact areas are discussed in more detail in the *Critical Areas Report* prepared for the project.

2) ***Will the project require any work over, in, or adjacent to (within 200 feet of) the described waters? If yes, please describe and attach available plans.***

Work is proposed within and adjacent to wetlands associated with Sunset and Richards Creek.

The proposed project will require work including vegetation clearing, excavation, fill, flow control and habitat structure installation, and revegetation in Sunset/Richards Creek and immediately adjacent sensitive areas (floodplain and wetland), as described in items 11, and 3.a.(3) of the checklist. The project plan sheets are provided under separate cover.

3) ***Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.***

The existing channel bed and adjacent riprap and fill material will need to be excavated before channel grading and installation of grade control, bank protection, and habitat structures. The excavation dimensions will allow for installation of a pipe that will act as the temporary stream bypass adjacent to the channel. Volumes of excavation and fill below the OHWM for channel grading and installation of grade control and bank protection structures are summarized in Table 2.

Table 2. Estimated volumes of excavation and fill below the OHWM of the stream for project construction.

Impact	Sunset Creek	Richards Creek
Volume of excavation below existing OHWM (cy) [a]	220	95
Volume of fill below existing OHWM (cy) [b]	7	60

[a] Includes streambed material and riprap
[b] Includes streambed material and boulders
cy: cubic yards

Additional information regarding wetland impact areas, estimated at 0.26 acre of temporary impact and 0.036 acres of permanent impact is provided in the *Critical Areas Report* prepared for the project.

Grading of the channel will extend approximately 770 feet along the stream within the project area. Channel grading will include excavation of the existing channel bed, reshaping of banks, installation of log and boulder grade control structures, installation of stable channel substrate material consisting of cobble and gravel, and installation of gravel streambed material. This activity will be conducted in-the-dry after the streamflow bypass is in place and the project site is dewatered to minimize undesirable water quality effects. All in-water work will take place during the in-water work window.

Recovered riprap will either be stored on City property for use in future permitted projects, or will be provided to a permitted commercial facility for reuse. Any fill in the channel will be either boulders incorporated in grade control structures, a cobble mixture that will be placed in the channel bed to resist scour, or a gravel "fish" mixture that will be placed to form the streambed surface. These rock materials would be imported from a permitted commercial source. Boulders will be rounded and will be imported from a permitted commercial source. The grade control structures will be keyed into each bank to a distance that is equivalent to approximately one-third the width of the channel that is spanned.

Stream banks will be rebuilt and stabilized in all areas where they are disturbed. Bank toes will be protected from stream erosion using large woody debris and boulders that are buried into the stream bank as grade control structures. Higher portions of the bank that are disturbed will be stabilized with coir-wrapped lifts of soil. The coir fabric will be staked and the top layer will be secured with an anchor trench. These areas will then be replanted with native vegetation.

All fill materials will be imported from a licensed commercial source. All excavated materials that are not backfilled will be retained on City of Bellevue property for use in future permitted actions, or disposed of at a permitted commercial facility.

4) Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.

The two segments of channel within the project area will be temporarily dewatered. Streams will be diverted using sandbag and membrane coffer dams into a gravity or pump fed bypass pipe. Flows will be discharged back into the stream channel downstream of the work area.

Channel dewatering/rewatering and fish capture and relocation will be conducted consistent with WSDOT standard practices. The temporary flow bypass pipes will be a 36-inch diameter pipe (Sunset Creek) and 42-inch diameter pipe (Richards Creek) sized to carry up to approximately 45 and 95 cubic feet per second (cfs), respectively, which approximates 72 percent of the 1.01-year recurrence interval flow in Sunset Creek (53 and 101 cfs, respectively). Flow diversion details are shown in Design Plan Sheets, Sheet 15.

5) Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.

Yes. The 100-year floodplain has been designated along Sunset Creek. The Critical Areas Report provides a figure that shows the 100-year floodplain and has more details about the potential impacts to the floodplain.

6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.

No waste materials will be discharged to surface waters as a result of the proposed project. Minor surface erosion of restored bed and bank areas will occur during site rewatering, and during the "first flush" of the project area during initial exposure to storm flows.

b. Ground water:

1) Will ground water be withdrawn, or will water be discharged to ground water? Give general description, purpose, and approximate quantities if known.

Not applicable.

Not anticipated. Work is to be surface and channel related and no groundwater, accept channel/ground water inter flow is expected. A secondary source of stream hydrology, ground water, when encountered, will be managed in the same manner as surface water.

2) ***Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example, domestic sewage; industrial waste, containing the following chemicals; agricultural waste; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.***

Not applicable.

No waste materials are anticipated or allowed to be discharged from any source, accept for those incidental to typical construction practices and are planned for management through project site management BMPs.

c. ***Water runoff (including stormwater):***

1) ***Describe the source of runoff (including stormwater) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.***

The proposed project is designed to improve conveyance in Sunset Creek downstream of SE 30th Street and limit reoccurring flooding of the surrounding properties. The project will neither increase nor reduce impervious surface area in the project vicinity or modify existing stormwater collection or disposal systems. Runoff from adjacent buildings and parking lots into the stream is expected to stay the same until additional development occurs.

2) ***Could waste materials enter ground or surface waters? If so, generally describe.***

Potential spills from construction activities and equipment could enter surface or ground water; however, a Spill Prevention Plan (SPCC) will be in place to prevent or reduce impacts from accidental spills.

d. ***Proposed measures to reduce or control surface, ground, and runoff water impacts, if any:***

All construction work will be conducted within a dewatered exclusion area and on adjacent streambanks and uplands. Stormwater or alluvial flow entering the work area will be pumped into the municipal sewer system, or will be treated using a filtration system to remove suspended sediments and other pollutants before discharge back to surface waters.

During construction, an SPCC plan will be in place to prevent or reduce impacts from accidental spills, consistent with City of Bellevue requirements for construction activities near critical areas.

4. Plants

a. Check types of vegetation found on the site:

X **deciduous tree:**
- X **alder**
- X **maple**
- ___ **aspen**
- X **others:** Black cottonwood, Sitka willow, Pacific willow

X **evergreen tree:**
- X **fir**
- X **cedar**
- X **pine**
- ___ **others:**

X **shrubs**

X **grass**

___ **pasture**

___ **crop or grain**

X **wet soil plants:**
- ___ **cattail**
- X **buttercup**
- ___ **bulrush**
- ___ **skunk cabbage**
- X **others:** lady fern, big leaf sedge, slough sedge, giant horsetail, small fruited bulrush

___ **water plants:**
- ___ **water lily**
- ___ **eelgrass**
- ___ **milfoil**
- ___ **others:**

X **other types of vegetation:** Japanese knotweed, reed canarygrass, and Himalayan blackberry

b. What kind and amount of vegetation will be removed or altered?

The proposed project will result in temporary disturbance of approximately 0.45 acres of riparian vegetation. This disturbance is necessary to access the channel with construction equipment. The area to be disturbed includes a corridor that averages approximately 30 feet wide along the two segments described previously (Sunset Creek and Richards Creek), and indicated by clearing limits shown in Design Plan Sheets, Sheet 5.

Site access and construction will be managed to limit impacts to native vegetation to the greatest extent practicable. Following completion of the project, all disturbed areas will be replanted with site appropriate native vegetation (Design Plan Sheets, Sheets 16 through 19). Bioengineering methods used to stabilize reconfigured streambanks will emphasize the use of native vegetation, consistent with Washington State Integrated Streambank Protection Guidelines.

Currently, the affected area is poorly vegetated, characterized predominantly by a mixture of invasive and ornamental species. This vegetation will be replaced by native species that, in combination with riprap removal and bank reshaping, should increase habitat and riparian function.

c. ***List threatened or endangered species known to be on or near the site.***

No listed threatened or endangered plant species are known to be on or near the site.

d. ***Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:***

See response 4b above.

5. Animals

a. ***List the names of any birds and animals that have been observed on or near the site or are known to be on or near the site:***

Birds:	Songbirds
Mammals:	Raccoon, opossum, other urban mammals
Fish:	Salmon, steelhead, resident and adfluvial cutthroat trout

b. ***List any threatened or endangered species known to be on or near the site.***

Puget Sound Chinook Salmon and Puget Sound steelhead are known to have historically used this system. Before hydrological modification and subsequent changes in downstream habitat conditions, known or likely distribution in Sunset Creek extended up to (and perhaps beyond) SE 30th Street.

c. ***Is the site part of a migration route? If so, explain.***

Sunset and Richards Creeks are a migratory corridor and a preferential spawning location used by native, anadromous, and adfluvial salmonids. Chinook salmon and steelhead have not been observed in the system in recent years, potentially due to passage barriers imposed by extensive beaver dam complexes in downstream reaches of Richards Creek (Paulsen 2007). The affected reach of Sunset Creek is currently used by migratory adfluvial cutthroat trout for spawning.

d. ***Proposed measures to preserve or enhance wildlife, if any:***

During construction, the project includes several standard construction BMPs to avoid and minimize adverse impacts on fish and wildlife. The proposed project is intended to address chronic sediment and flooding issues, stabilize banks, and improve instream, wetland, and riparian habitat. Details of these improvements are discussed below.

First, the proposed project will improve fish passage in Sunset Creek. Sediment accumulation has aggraded this channel segment to the extent that it poses a barrier to fish passage under low flow conditions. Combined with the improved sediment management capacity afforded by Phase 1 of this project, the proposed Phase 2 channel improvements will eliminate this low flow passage barrier.

Second, the proposed channel and bank reconfiguration, and riparian restoration elements (reduced non-native invasive vegetation, and planted native vegetation) will result in improved habitat conditions. The project design incorporates large wood elements with root wads and strategically placed substrate integrated with vegetative treatments. The reconfigured channel will result in a decreased width/depth ratio, increased roughness, and increased pool density. In combination with riparian enhancements, these elements are expected to increase habitat complexity and productivity in the affected reach. Enhanced riparian conditions will also increase the value of this habitat for birds and wildlife species and its use as a migratory corridor (recognizing that these uses are probably limited in this urbanized environment). Before and during grading, non-native vegetation will be removed and replanted with a diverse selection of native vegetation. This will provide both shade for the stream (improving stream habitat conditions) and more diverse food and habitat structure for birds and small mammals. Conifers are absent from this area in the current condition. Where feasible, conifers will be planted to add additional diversity to restored plant community.

Finally, regarding construction BMPs, the proposed project has been designed to avoid and minimize adverse impacts on fish and wildlife. The primary concern in this respect is the potential for adverse effects on fish and aquatic habitats during construction. The in-water construction component of this project will take place entirely within the in-water work window for the Richards Creek system. The work area will be dewatered using a temporary flow bypass to avoid construction-related water quality impacts. The bypass and all related materials will be removed upon completion of the project.

Dewatering/rewatering, and fish capture and relocation will be conducted using an accepted protocol for these practices (i.e., the WSDOT standard protocol). Alluvial water and stormwater that collects in the work area during construction will be pumped to the municipal sewer system, or will be treated before discharge to surface waters to avoid suspended sediment effects. Turbidity monitoring will be conducted throughout construction to ensure BMP effectiveness. The performance threshold for monitoring is 5 NTUs or more above background levels. Should measured turbidity increase above this threshold, construction activities causing elevated turbidity will be halted and the BMPs will be addressed as necessary to achieve the desired performance. Consistent with City of Bellevue requirements, the construction contractor will have TESC and SPCC plans in place to avoid any water quality impacts, and will be required to diligently review and update those plans as site conditions warrant.

Impacts to habitat associated with species of local importance must be mitigated in accordance with the requirements of LUC 20.25H.150 through LUC 20.25H.170.

6. Energy and Natural Resources

a. What kinds of energy (for example, electricity, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

Not applicable.

Reviewed By: David Pyle 09/08/2010

b. ***Will your project affect the potential use of solar energy by adjacent properties? If so, generally describe.***

No.

c. ***What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:***

Not applicable.

7. Environmental Health

a. ***Are there any environmental health hazards, including exposure to toxic chemicals or risk of fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, describe.***

These potential hazards are addressed as part of the site management practices included as part of the project's Clearing and Grading Permit.

Environmental health hazards could occur from accidental spills of chemicals during project construction, and construction accidents related to the use of heavy equipment. Small amounts of materials likely to be present during construction include gasoline and diesel fuels, hydraulic fluids, oils, lubricants, and other chemical products. A spill of chemicals could potentially occur during construction as a result of either equipment failure or worker error. During construction, heavy equipment and fuels will be stored at a nearby location. Spills could also occur during refueling, from stored fuels, or from improperly disposed waste materials. Standard construction practices and safety measures will be employed to minimize the risk of spills or accidents.

1) ***Describe special emergency services that might be required.***

Emergency response during an incident would be the responsibility of the contractor. The contractor would require the assistance of the Washington Department of Ecology, Washington Department of Fish and Wildlife, or other agencies depending on the severity of the spill and the risk to people and the environment. It is expected that the contractor will rely on local emergency services for any accident related injuries.

2) ***Proposed measures to reduce or control environmental health hazards, if any:***

The contractor will develop and implement a SPCC plan according to City of Bellevue requirements, as defined in the bid documents. The SPCC plan will address hazardous materials, fueling and maintenance of equipment, and spill containment and notification. Any potentially hazardous waste discovered during project activities would be handled in accordance with Environmental Protection Agency, Department of Ecology, and local health regulations.

b. ***Noise***

1) ***What types of noise existing in the area may affect your project (for example, traffic, equipment operation, other)?***

None. Typical background noise levels in this urbanized environment are estimated to be 80 to 85 A-weighted decibels (dBA).

2) ***What types and levels of noise will be created by or associated with the project on a short-term or long-term basis (for example, traffic, construction, operation, other)? Indicate what hours noise will come from the site.***

Construction and operation noise is regulated by BCC 9.18. The proposed construction must meet the requirements of this section.

Heavy equipment used during project related materials transportation, staging, and construction will produce noise levels above ambient background. Estimated peak noise levels will range between 90 and 96 dBA. After completion of the project, occasional noise from equipment used for on-going routine maintenance and repair will occur. These noise levels will be consistent with those produced by current maintenance dredging activities. Once complete, the proposed project will have no effect on ambient noise conditions.

3) ***Proposed measures to reduce or control noise impacts, if any:***

The contractor will adhere to all applicable federal, state, and local noise regulations governing construction activities.

8. Land and Shoreline Use

a. What is the current use of the site and adjacent properties?

The project site is surrounded by commercial and industrial buildings and associated parking lots.

b. Has the site been used for agriculture? If so, describe.

No.

c. Describe any structures on the site.

The Sunset Creek channel and riparian buffer is bordered on both banks by commercial/light industrial buildings and associated parking lots.

d. Will any structures be demolished? If so, what?

No.

e. What is the current zoning classification of the site?

Light industrial (City of Bellevue 2007).

f. What is the current comprehensive plan designation of the site?

Light industrial (City of Bellevue, undated).

g. If applicable, what is the current shoreline master program designation of the site?

Not applicable.

Not in shoreline jurisdiction.

h. Has any part of the site been classified as an environmentally sensitive area? If so, specify.

See attached critical areas report for stream and wetland typing.

Environmentally sensitive areas include: 1) 100-year floodplain of Sunset Creek, 2) streams and wetlands and their buffers, and 3) habitats associated with species of local importance (stream and riparian areas).

i. ***Approximately how many people will reside or work in the completed project?***

None.

j. ***Approximately how many people will the completed project displace?***

None.

k. ***Proposed measures to avoid or reduce displacement impacts, if any:***

Not applicable.

l. ***Proposed measures to ensure that the proposal is compatible with existing and projected land uses and plans, if any:***

Not applicable.

9. Housing

a. ***Approximately how many units will be provided, if any? Indicate whether high, middle, or low-income housing.***

Not applicable.

b. ***Approximately how many units will be eliminated, if any? Indicate whether high, middle, or low-income housing.***

Not applicable.

c. ***Proposed measures to reduce or control housing impacts, if any:***

Not applicable.

10. Aesthetics

a. ***What is the tallest height of any proposed structure, not including antennas; what is the principal exterior building material proposed?***

Not applicable.

b. ***What views in the immediate vicinity will be altered or obstructed?***

None. Aside from temporary and minor changes in vegetation structure, views will not be altered or obstructed.

c. ***Proposed measures to reduce or control aesthetic impacts, if any:***

Not applicable.

11. Light and Glare

a. What type of light or glare will the proposal produce? What time of day will it mainly occur?

Not applicable.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

Not applicable.

c. What existing offsite sources of light or glare may affect your proposal?

Not applicable.

d. Proposed measures to reduce or control light and glare impacts, if any:

Not applicable.

12. Recreation

a. What designated and informal recreational opportunities are in the immediate vicinity?

The Sunset Ravine Open Space is located approximately 0.25 miles south of the project, and the Mercer Slough Nature Park is about 0.8 miles west of the project. No known formal or informal recreation occurs in the immediate vicinity of the project.

b. Will the proposed project displace any existing recreational uses? If so, describe.

The proposed project will not permanently displace any existing recreational uses.

c. Proposed measures to reduce or control impacts on recreation, including recreational opportunities to be provided by the project or applicant, if any:

Not applicable.

13. Historic and Cultural Preservation

a. Are there any places or objects listed on, or proposed for, national, state, or local preservation registers known to be on or next to the site? If so, generally describe.

No cultural resources or listed historic properties are known to exist in the project vicinity.

b. Generally describe any landmarks or evidence of historic, archaeological, scientific, or cultural importance known to be on or next to the site.

The project area is characterized by light industrial and commercial properties developed during the 1960s and 1970s. Historic development planning documents and existing conditions present no evidence of important cultural resources.

c. ***Proposed measures to reduce or control impacts, if any:***

Should evidence of cultural remains, either historic or prehistoric, be encountered during excavation, work in that immediate area will be suspended, and the find will be examined and documented by a professional archaeologist. Decisions regarding appropriate mitigation and further action will be made at that time.

14. Transportation

a. ***Identify public streets and highways serving the site, and describe proposed access to the existing street system. Show on site plans, if any:***

The project site will be accessed from SE 30th Street and Kamber Road and parking lots on private property adjacent to the stream channel (see Design Plan Sheets, Sheet 5).

b. ***Is the site currently served by public transit? If not, what is the approximate distance to the nearest transit stop?***

Yes, the nearest transit stop is at the intersection of SE 32nd Street and Richards Road, approximately 0.18 miles southwest of the project area.

c. ***How many parking spaces will the completed project have? How many will the project eliminate?***

Not applicable.

d. ***Will the proposal require any new roads or streets, or improvements to existing roads or streets, not including driveways? If so, generally describe (indicate whether public or private).***

No.

e. ***Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.***

Not applicable.

f. ***How many vehicular trips per day will be generated by the completed project? If known, indicate when peak volumes will occur.***

None.

g. ***Proposed measures to reduce or control transportation impacts, if any:***

Not applicable.

15. **Public Services**

a. ***Will the project result in an increased need for public services (for example, fire protection, police protection, health care, schools, other)? If so, generally describe.***

No.

b. ***Proposed measures to reduce or control direct impacts on public services, if any.***

Not applicable.

16. **Utilities**

a. ***Check utilities currently available at the site:***

X **electricity**
X **natural gas**
X **water**
___ **refuse service**
X **telephone**
X **sanitary sewer**
___ **septic system**
___ **other:** ________________

b. ***Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity that might be needed.***

Not applicable.

C. Signature

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature: Mark Cross

Date: 9/10/2010

Reviewed By: David Pyle 09/08/2010