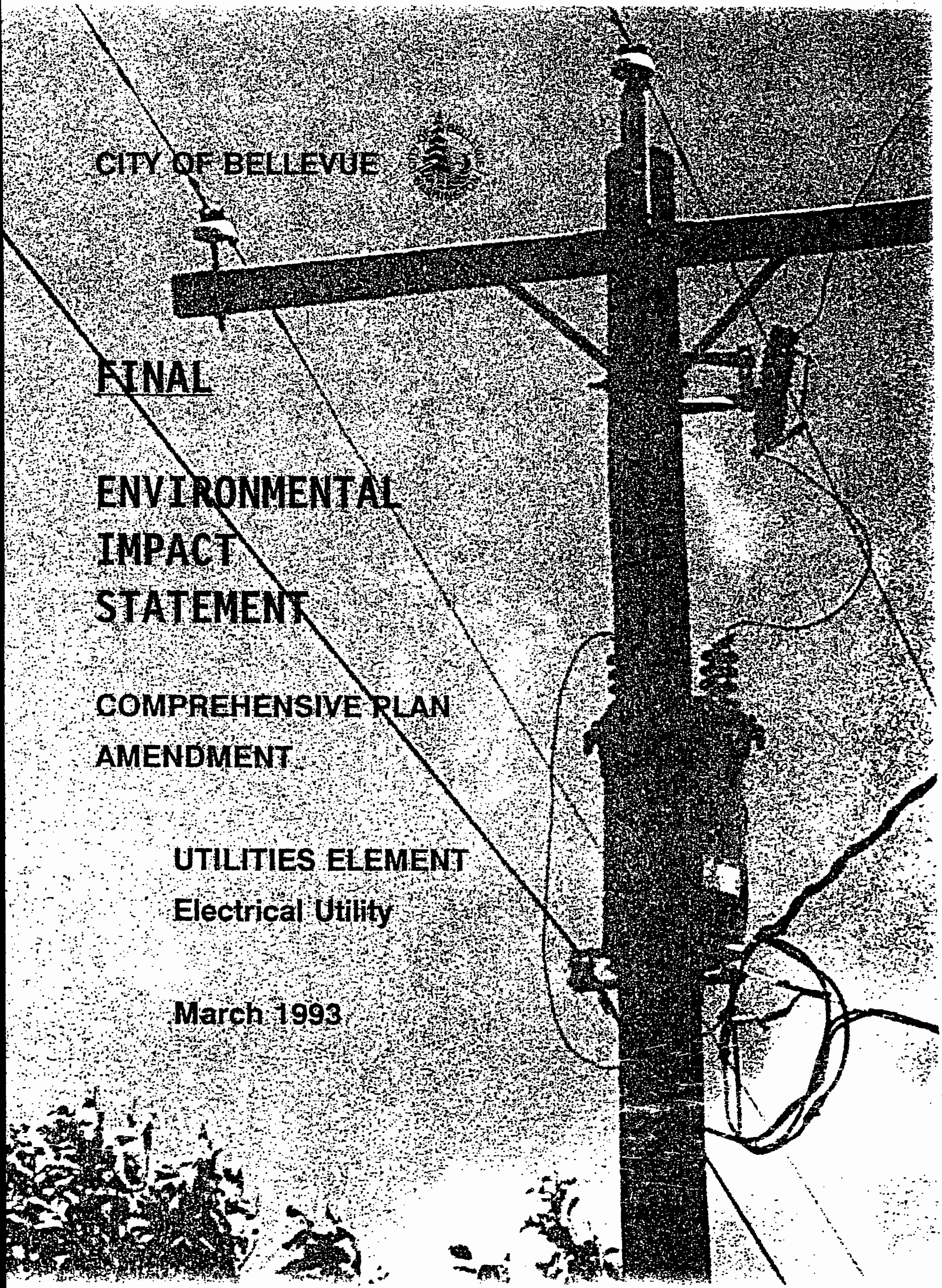

CITY OF BELLEVUE

FINAL

ENVIRONMENTAL IMPACT STATEMENT

COMPREHENSIVE PLAN AMENDMENT

UTILITIES ELEMENT
Electrical Utility

March 1993

City of Bellevue

MEMORANDUM

March 31, 1993

TO: Recipients of the Final Environmental Impact Statement for the Bellevue Comprehensive Plan, Electrical Utilities Element

This Final Environmental Impact Statement was prepared in conformance with WAC 197-11-560(5) and consists of the following:

1. Factual corrections contained in an **Errata** sheet;

2. The Summary from the Draft EIS with minor revisions.

3. The Description of the Proposal from the Draft EIS with minor corrections and with the March 5, 1993 proposal of the Planning Commission;

4. Minor revisions adding information to the **Health** element adding information about exposure to Electromagnetic Fields, but not changing the conclusions of the section;

5. Response to comments received on the Draft EIS;

6. An additional appendix, **Appendix E** containing the assumptions used for chages to the **Health** element.

The Environmental Impact Statement for this proposal consists of the **Final EIS** together with th **Draft EIS** issued December 4, 1992 and **Technical Appendices** issued with the Draft and Final EISs.

FINAL
ENVIRONMENTAL IMPACT STATEMENT

COMPREHENSIVE PLAN UTILITY ELEMENT
ELECTRICAL UTILITY

Prepared in Compliance with:

The State Environmental Policy Act (SEPA)
Chapter 43.21C. Revised Code of Washington

SEPA Rules, Effective April 4, 1984
Chapter 197-11, Washington Administrative Code

Chapter 22.02, Bellevue City Code

Date of Issue: March 31, 1993

Susan M. Sánchez

Susan Sánchez
Environmental Coordinator

FACT SHEET

TITLE OF PROPOSAL: Bellevue Comprehensive Plan Amendment, Utilities Element, Electrical Utility Policies and Map

DESCRIPTION OF THE PROPOSAL: <u>**Objectives of the Proposal:**</u> To create a list and schematic system map of necessary electrical transmission and distribution facilities and related policies to guide provision of adequate electrical power to meet the needs of projected growth and fulfill the mandate of the Growth Management Act.

<u>**Alternatives**</u>**:** Separate alternatives have been developed for the electrical Transmission System and the Distribution system.

<u>No Action Alternative</u> In the context of this proposed Comprehensive Plan Update, a No Action Alternative would mean that no Comprehensive Plan element would be adopted. Under such a scenario, Puget Power would continue to attempt to secure permits for those facilities it deemed necessary to continue to provide electrical power to the area.

<u>Transmission System</u>

The Transmission system considered in this EIS delivers electrical power from regional supplies such as provided by the Bonneville Power Administration to local distribution substations.

<u>T-1, 115 kV Overhead Grid System</u> - This alternative, developed by Puget Sound Power and Light Company, would add capacity to the system by linking together currently unconnected portions of the existing network into a grid system. About 10 miles of new transmission line would be built, three existing distribution substations would be enlarged to add switching capabilities, and two new switching stations would be built.

<u>T-2, 230 kV Overhead Raidal System</u> - Under this alternative the system would remain in its existing radial configuration. No new transmission lines or switching stations would be added. The entire existing 115 kV transmission system would be rebuilt to a 230 kV configuration in phases. This would require the rebuilding of approximately 35 miles of transmission lines and 14 distribution substations.

<u>T-3, 115 kV Increased Current Overhead Radial System</u> - As with the 230kv Alternative, under this alternative the configuration of the system would remain in the radial configuration that exists today. The existing 115 kV transmission system would be rebuilt to a higher capacity configuration in phases.

T-4, Underground Transmission System - This alternative would be laid out in a grid configuration. The total miles of transmission line would expand from approximately 46 to about 70. Transmission lines would all be underground. New facilities that would be required under this alternative would be similar to those discussed under Alternative T-1. All distribution substations would have to be rebuilt and some pumping stations for oil coolant would be required at or between substations.

Distribution Alternatives have been developed to illustrate alternative methods of serving increased demands within specific areas.

D-1, 12 kV Lines with 25 MVA Substations - This alternative would keep the distribution voltage at 12 kV and would require the addition of 9 new distribution substations throughout the Bellevue area.

D-2, 34 kV Lines with 50 MVA Substations - This alternative would reduce the number of substations by increasing the service area of existing substations to 34 kV distribution lines rather than 12 kV. 34 kV lines are capable of carrying greater loads over similar distances or similar loads over greater distances than 12 kV lines. No new distribution substations would be needed, but seven existing substations would need to be rebuilt and expanded.

D-3, 12 kV Lines with 50 MVA Substations - Under this alternative, the capacity of approximately 12 substations would be increased from 25 MVA to 50 MVA configurations with additional distribution lines added at the existing voltage of 12 kV.

LOCATION OF THE PROPOSAL: The proposed Comprehensive Plan amendment would apply within the City of Bellevue. The electrical system affected would extend from the Sammamish Substation in Redmond, south to the Lakeside Substation in Factoria and include portions of Redmond, Kirkland and unincorporated King County.

PROPONENT: City of Bellevue

LEAD AGENCY: City of Bellevue

RESPONSIBLE OFFICIAL: Susan Sanchez
Environmental Coordinator, City of Bellevue
P.O. Box 90012
Bellevue, WA 98009-9012

CONTACT PERSONS:	Comments and questions should be directed to the following persons:	
	For the EIS:	David Sherrard (206) 453-2970
	For the Proposal:	Leonard McGhee (206) 455-6880
REQUIRED LICENSES AND PERMITS:	None	
AUTHORS AND PRINCIPAL CONTRIBUTORS:	The Draft EIS was prepared by the City of Bellevue, Design and Development Department, Environmental and Land Use Division. Technical Research and Analysis was provided by: Marvin Klinger, PE Energetics Columbia, MD 21046	
DATE OF ISSUE, FINAL EIS:	March 31, 1992	
DATE OF FINAL ACTION:	Final action by the Bellevue City Council is anticipated to occur in July 1993.	
SUBSEQUENT ENVIRONMENTAL REVIEW:	Analysis in this EIS is of general system alternatives. Specific facilities proposed in the future will require environmental review in accordance with WAC 197-11. Future review may result in a Determination of Non-Significance (DNS), a Determination of Significance (DS) with adoption of this EIS, preparation of a Supplemental EIS, or preparation of new environmental documents.	
LOCATION OF BACKGROUND DATA:	Information used for the analysis can be seen during normal business hours at the Bellevue Design and Development Department and the Bellevue Planning Department, City Hall, 11511 Main Street, Bellevue.	
COST OF DOCUMENTS:	Final EIS	$ 3.00
	Draft EIS	$ 5.00
	Technical Appendix	$ 5.00

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ERRATA

Changes from the Draft Environmental Impact Statement text are indicated by double underlining.

Page I-2, paragraph 3.

T-2 230 kV Overhead Radial System - Under this alternative the physical configuration of the system would remain in essentially the same configuration that exists today. No new switching stations would be added and no new transmission lines would be added. However, the entire existing 115 kV transmission system would be rebuilt to a 230 kV configuration in phases. This would require rebuilding ~~about two thirds of the~~ approximately 35 miles of existing transmission lines and 14 distribution substations.

Page I-6, Paragraph 5.

Reliability During Construction of the System Alternative D-1 and ~~D-2~~ D-3 would involve less disruption to the system during the transition to the new system, because they would utilize the existing 12 kV distribution system. Also, existing substations would not have to be taken out of service while new substations were being built. Alternative D-2 would require significant expansion and/or reconstruction of existing substations. Alternative D-3 would require expansion of substations, but would not require changing the distribution voltage.

Page II-6, Paragraph 3.

The Sammamish and Lakeside transmission substations and the Lakeside switching station would need to be expanded to accommodate underground lines (assuming the Talbot to Lakeside transmission line is upgraded to 230 kV) and some pumping stations for cooling oil would be required at or between substations.

Page II-8, Paragraph 3.

D-3 12 kV Lines with 50 MVA Substations - This alternative is another method of serving additional projected demand with limited or no construction of new distribution substations. Under this alternative, approximately 12 substations would be converted from 25 MVA to 50 MVA configurations. However, rather than the additional power handled by each substation being distributed by increased distribution line voltage, additional distribution lines at the existing voltage of 12 kV would be added. Substation expansions under this alternative would differ from those associated with Alternative D-2 in that, rather than ~~adding~~ replacing 12 kV transformers with 34 kV transformers to handle different voltages, additional transformers would need to be added to handle more feeders of the same voltage.

Page III-1, Paragraph 2.

o Generation which produces electrical energy. The major portion of the generation serving Puget Power is provided by hydroelectric power purchased ~~from the Federal Bonneville Power Administration~~ central Washington public utility districts who own dams on the Columbia River and from coal-fired generating plants.

Page III-3, Paragraphs 2 and 3.

If, however, growth over time or peak demand conditions resulted in a demand at each of these substations of 25 MVA, the total load on the line would be 5 substations at 25 MVA per substation, or 125 MVA. Under such conditions, demand could not be met for all five substation from either "X" or "Y" with a transmission ~~system~~

line capacity of 110 MVA. However, only outages occurring between "X" and "1" or between "Y" and "5" during these extreme peak periods would cause end users to lose power for more than the time required to isolate the failed section and supply power from the other direction. In such a situation, the 110 ~~kV~~ MVA capacity of the line would be sufficient only for 4 of the 5 substations. One substation would lose service until the failed section was repaired.

The 110 ~~kV~~ MVA transmission ~~system~~ line would be able to adequately handle such an outage at any time other than peak or during the peak if the outage occurred anywhere else on the line. Even during such times of peak load, if a break occurred between substations "3" and "4", power from "X" could adequately supply substations "1" and "2", and "3" while power from "Y" could adequately serve the other two substations. Although this system would be able to handle almost any type of outage, since the one type of outage discussed above would take one substation out of service until repairs were made, this portion of the system would not be seen as meeting the "N minus 1" standard and the utility would likely seek to increase its capacity. Using a strict "N minus 1" standard, additional capacity would be needed. This basic phenomenon would apply to any of the three transmission lines depicted in the above graphic of a hypothetical radial system.

Appendix C: Draft Electric Facilities Plan for the Greater Bellevue Area
page 12, item 2.

The Lakeside Substation 230 kV Development: Puget Power is in the process of permitting construction of its proposed Lakeside 230 kV, substation, a 230 kV substation to be constructed in the City of Bellevue adjacent to the existing Lakeside (115 kV) Substation. A Conditional Use Permit for the substation expansion was applied for on and approved by the city on . A Clear and Grade Permit and Building Permit for the substation were applied for on and have not yet been approved. In conjunction with construction of Lakeside 230 kV Substation, Puget Power also proposes to rebuild its existing Talbot-Lakeside and Sammamish-Lakeside #1 and #2 115 kV transmission lines to 230 kV standards. The 230 kV substation and lines are needed to increase Puget Power's ability to move power into the City of Bellevue and immediately adjacent areas. Permits for the 230 kV transmission lines are required from the Cities of Bellevue, Renton and Redmond and from King County. Permits for the transmission lines have not yet been applied for.

1.00 SUMMARY

1.1 **Objectives of the Proposal:** To create a list and schematic system map of necessary electrical transmission and distribution facilities and related policies to guide provision of adequate electrical power to meet the needs of projected growth and fulfill the mandate of the Growth Management Act.

1.2 **Alternatives:**

The Draft EIS included two sets of policy alternatives. The Final EIS includes policies developed by the Planning Commission. Major differences between the Citizen Advisory Committee, City staff, and Planning Commission recommendations include: the CAC recommendation does not include a system map; Planning Commission, and City staff recommendations include a system map (equivalent to Alternative T-1, below); the CAC, recommended a policy which gives equal weight to a number of criteria for provision of utilities which is included in the Planning Commission recommendation; the City staff recommended prioritizing reliability and cost as first priorities; the CAC recommendation calls for avoidance of school and residential areas in the siting of new transmission lines and substations which is included in the discussion of Planning Commission Policy P-19; the City staff recommended deletion of the policy.

Separate alternatives have been developed for the electrical Transmission System and the Distribution system. The Transmission system considered in this EIS delivers electrical power from regional supplies to local distribution substations. The distribution system delivers electrical power from distribution substations to users. Although they are physically electrically connected, any of the transmission alternatives are compatible with any of the distribution alternatives, and vice versa. In other words, any one of the transmission alternatives could be combined with any one of the distribution alternatives to form a complete and functional system.

1.2.1 Transmission Alternatives:

No Action Alternative Although SEPA requires inclusion of a "No Action" alternative, in the context of this proposed Comprehensive Plan Update, a No Action Alternative would not mean that no electrical facilities would be built. Rather, it would mean that no Comprehensive Plan element would be adopted. It is assumed that under such a scenario, Puget Sound Power and Light Company would continue to attempt to secure permits for those facilities it deemed necessary to continue to provide electrical power to the area. The No Action Alternative would essentially be a scenario under which the facilities in Alternatives T-1 and D-1 would be constructed, but without the guidance and predictability offered by inclusion in the Comprehensive Plan.

T-1 115 kV Overhead Grid System - This alternative developed by Puget Sound Power and Light Company, would add capacity to the system by linking together currently unconnected portions of the existing network into a grid system, rather than by increasing voltage or current. This alternative includes enhancements of three existing distribution substations to add switching capabilities, creation of two new switching stations, creation of seven new transmission line segments (totaling approximately 10 miles), upgrading the Lakeside Switching Station to add 230 kV facilities, and upgrading of one major trunk transmission line from 115 kV to 230 kV. (kV stands for kilovolt and equals 1000 volts. Voltage is the measure of electric potential and can be thought of as electrical "pressure." As a comparison, household current is primarily 110 volts.)

T-2 230 kV Overhead Radial System - Under this alternative the physical configuration of the system would remain in essentially the same configuration that exists today. No new switching stations would be added and no new transmission lines would be added. However, the entire existing 115 kV transmission system would be rebuilt to a 230 kV configuration in phases. This would require rebuilding ~~about two thirds of~~ the approximately 35 miles of existing transmission lines and 14 distribution substations.

T-3 115 kV Increased Current Overhead Radial System - As with the 230kV Alternative, under this alternative, configuration of the system would remain in essentially the same radial configuration that exists today. No new switching stations would be added and no new transmission lines would be added. Much, if not all, of the existing 115 kV transmission system would be rebuilt to a higher capacity configuration in phases. Most, though likely not all, existing 115 kV transmission line wires would be replaced with higher capacity wires, and some lines would have to be rebuilt completely with additional poles to accommodate the heavier wires. Additionally, the "high sides" of some distribution substations would need to be rebuilt to handle greater incoming current.

T-4 Underground Transmission System - This alternative would be laid out in a grid configuration similar to that of Alternative T-1. Transmission lines would all be underground and would be energized at 230 kV, rather than 115 kV. A 230 kV underground system would not have significantly more capacity than a similarly configured 115 kV overhead system. Rather, the increased voltage would compensate for the power flow limitations of underground technology. New facilities that would be required under this alternative would be similar to those discussed under Alternative T-1. All distribution substations would have to be rebuilt and some pumping stations for oil coolant would be required at or between substations. Puget Power has indicated that such an alternative might be built with additional grid elements to provide greater reliability given longer repair times for underground systems.

1.2.2 Distribution Alternatives

Background Bellevue is currently served by 12 kV (kilovolt) distribution lines, except for the Central Business District in which newer buildings are served by 34 kV distribution. From each substation, there are generally 4-5 main 12 kV feeder lines that supply its area. Each feeder generally carries approximately 6 MVA over a distance approximately halfway to an adjacent substation.. The capacity of each of these lines is limited.

In order to increase its capacity, a line either has to be shortened or its voltage must be increased. In order for this system to serve anticipated additional load in the future, therefore, one of three things would need to happen.

o More distribution substations could be added between existing substations, which would have the effect of shortening existing distribution lines

- o The same number of lines of the same length could be kept, but their voltage would have to be increased.
- o More lines of the same length and voltage could be added between existing substations.

The following distribution alternatives each incorporates one of the above methods of handling the increased load that is anticipated as a result of projected growth in the Bellevue area.

D-1 12 kV Lines with 25 MVA Substations - This alternative would keep the distribution voltage at 12 kV and the capacity of most substations at 25 MVA. (MVA stands for Megavoltamperes and is a measure of the rate at which electricity is delivered.) This alternative would require the addition of 9 new distribution substations throughout the Bellevue area. Rather than increase the power that any given substation would have to distribute to the surrounding area, the power of each substation would remain the same, but additional substations would be added to handle the additional load needed to serve area growth.

D-2 34 kV Lines with 50 MVA Substations - This alternative represents one of two ways to serve anticipated growth in the area **without** construction of new distribution substations. Under this alternative, all existing 12 kV distribution lines running from the expanded substations would need to be rebuilt to 34 kV configurations. 34 kV lines are capable of carrying greater loads over similar distances or similar loads over greater distances than 12 kV lines. No new distribution substations would be needed, but seven existing substations would need to be rebuilt and expanded to step down from the transmission voltage to 34 kV.

D-3 12 kV Lines with 50 MVA Substations - This alternative is another method of serving additional projected demand with limited or no construction of new distribution substations. Under this alternative, approximately 12 substations would be converted from 25 MVA to 50 MVA configurations. However, rather than the additional power handled by each substation being distributed by increased distribution line voltage, additional distribution lines at the existing voltage of 12 kV would be added. Substation expansions under this alternative would differ from those associated with Alternative D-2 in that rather than adding transformers to handle different voltages, additional transformers would need to be added to handle more wires of the same voltage.

Methods to Reduce Peak Demand - One approach that needs to be taken into account in any comprehensive discussion of providing electrical power to the Bellevue area over the next 20-30 years is that of conservation and other methods to reduce peak electrical demand. Puget Sound Power and Light Company has an active conservation program in place currently and anticipates increased conservation practices over the life of this plan.

Such methods of reducing peak demand and, hence, peak loads are not discussed in this EIS as full alternatives. This is because the usual effect of such programs would be to delay the time when additional generation, transmission, or distribution facilities are needed. Only in rare circumstances when an area was nearly as developed as it ever could be, would such practices actually eliminate the need for a given facility or group of facilities.

1.3 Impacts

The impacts of the Alternative involve tradeoffs between the three major areas of impact discussed, Utility Service, Land Use/Aesthetics, and Human Health.

The transmission system alternative which provides the best performance for utility service reliability, T-4 - Underground Transmission System, also has the highest cost. It has the least land use and aesthetic impact and the greatest potential for reduction of exposure to Electromagnetic Fields which are a potential health concern.

The distribution system alternatives each have tradeoffs between developing additional substations in residential areas and providing less reliable or higher cost electrical service.

Utility Service

The analysis in the EIS looks at the transmission and distribution system alternatives in terms of reliability of electrical service, given projected increases in demand, the relationship with the regional system, the flexibility of providing service in the future beyond the time period of the demand projections and the flexibility to respond to growth rates less than projected.

Comparison of Transmission Alternatives:

Reliability: The capacity the electrical system is designed to provide is directly related to the reliability criteria which determines the extent of redundant or "backup" facilities needed. Puget Sound Power and Light Company, like most of the electrical utility industry, designs and operates their systems to achieve economical and reliable delivery of service to their customers. Reliability is often measured by an operating condition commonly referred to as "N minus 1". What this means is that if the total system of a number of facilities is referred to as "N", the system would still be able to serve all the load of customers even with the loss of one of those facilities.

All of the transmission alternatives could be designed to an "N minus 1" standard. The likelihood of outages causing loss of service is theoretically the same under any of the alternatives. The difference between the alternatives is primarily economic and environmental cost.

Each of the alternatives does vary in the potential for providing greater than N-1 service. In situations such as particularly heavy storm events, it is not unusual for more than one facility on a system to go down, resulting in service losses for end users. In comparing the alternatives when such service losses do occur, Alternatives T-4 Underground Transmission would be the most reliable alternative because it is less subject to failure due to the primary causes of outage for overhead lines such as falling trees and lightning strikes. It would also be more reliable if built in a denser grid because it meets a higher standard than N-1. The next reliable would be T-1 Overhead Grid because portions of the grid system proposed actually meet a greater than N-1 criteria over the projected demand. Because of the grid, any outage would affect fewer end users because the system is broken into smaller units. More end users would be affected by outages that would occur under Alternatives T-2 and T-3, the two radial alternatives. This is because each line in the existing Puget Power radial system serves more end users than each line in the grid system.

Reliability During Construction of the System: In terms of the reliability of the system during construction of new or expanded facilities, each of the alternatives could be built without affecting reliability. The primary differences would be in the cost and effort involved. Alternative T-1 would offer the least complications for reliability during construction. Existing facilities would not have to be shut off during construction of new or expanded facilities. The exceptions would be major upgrades of existing substations to add switching stations. Alternative T-3, the 115 kV increased current alternative, would be less easily converted than Alternative T-1, but would be easier than the two 230 kV alternatives (T-2 and T-4) which would need to replace both transmission lines and rebuild distribution substations. Most, if not all, affected substations would have to be taken out of service for some portion of the construction period.

Relationship with the Regional Power System In terms of the regional power system, the primary issue relating to the transmission system in the Greater Bellevue Area is that of north / south power flow through the system. In other words, the ability for power that is not needed in the Bellevue area to flow through the area relatively unimpeded is one aspect of system function that concerns power planners. In the case of a regional transmission failure, the grid system under Alternatives T-1 and T-4 would establish multiple parallel paths through the system, "pass through" power would be split between many lines, reducing the impact and operational dependence on any one line. It is not clear however, that given normal demands on the transmission system to serve local loads, that significant capacity would be available for regional transmission.

Flexibility of System to Expand to Serve Loads Greater Than 680 MVA: In terms of the flexibility of the system to handle loads greater than 680 MVA (if/when projected growth is exceeded), all alternatives other than the underground alternative (T-4) would ultimately be similar. Under Alternatives T-1, Overhead Grid and T-4, Underground Grid, considerable capacity is available beyond the projected demand of 680 MVA. For T-1, Puget Power has estimated a capacity of 965 MVA. Any expansion beyond that level of demand would consist of converting this grid system to a 230 kV configuration.

To upgrade Alternative T-2, the 230 kV radial system alternative, the most effective means of implementation would be to convert it to a grid configuration. Whether the starting point is to develop a grid system or to upgrade to 230 kV, the same ultimate system configuration would occur. However, the horizon date at which a full 230 kV grid would be required would be considerably beyond the planning horizon.

Alternative T-3, the 115 kV expanded capacity radial system, could be upgraded by either route, converting the radial system to 230 kV or converting the higher capacity 115 kV system to a grid, before ultimately ending up with a 230 kV grid system.

Because of the high cost and relative difficulty of rebuilding an underground system, Alternative T-4 would be somewhat less flexible than the first three alternatives. If the capacity of this system were exceeded, additional circuits would be required.

Flexibility of System to Delay Construction to Handle Loads Less Than 680 MVA: In terms of the effect of the alternatives on system flexibility to delay construction if load growth is slower than expected, the two 115 kV alternatives, Alternatives T-1, 115 kV Overhead Grid and T-3, 115 kV, Increased Current Radial System, provide the most flexibility. Under either of these alternatives, the system could evolve slowly from the current configuration to the planned configuration. Under Alternative T-1, new facilities or facility upgrades could be added slowly as demand grew in particular parts of the area, creating backup capability and capacity as it was needed.

With the two 230 kV alternatives, on the other hand, major portions of the system would need to be reconfigured simultaneously. For T-2, for example, entire transmission lines and all of the substations fed by them would have to be reconfigured at the same time and energized at the same time. This same phenomenon would occur with the underground alternative (T-4) for the same reasons.

Distribution System

Reliability As is the case with the Transmission Alternatives, all of the alternatives are theoretically similarly reliable. As with the transmission alternatives, the measure of reliability discussed in this EIS is how many end users are affected when more than one component on the facility is out of service and a loss of service is experienced. Alternative D-1, the 12 kV line, 25 MVA substation alternative, would experience the least impact in the case of such an outage because each individual distribution line would be shorter than those under the other two alternatives and would serve the least number of end users. As such, outages are anticipated to affect fewer people than under the other two alternatives. Alternative D-3 (more 12 kV lines), would be slightly less reliable than Alternative D-1 only because there would be slightly more people served by each line.

Reliability During Construction of the System Alternative D-1 and ~~D-2~~ D-3 would involve less disruption to the system during the transition to the new system, because they would utilize the existing 12kV distribution system. Also, existing substations would not have to be taken out of service while new substations were being built. Alternative D-2 would require significant expansion and/or reconstruction of existing substations. Alternative D-3 would require expansion of substations, but would not require changing the distribution voltage.

Flexibility of System to Expand to Serve Loads Greater Than 680 MVA or to Delay Construction to Handle Loads Less Than 680 MVA Any of the Alternatives could be expanded to handle greater loads than the projected 680 MVA. The greatest flexibility is provided by alternative D-1 in which additions are made in discreet units of standard substation size. The larger service areas of substations and the lack of compatibility with the existing system limit the flexibility of the other two distribution alternatives.

As was the case with the transmission alternatives discussed above, the two alternatives that involve expanding the capacity of the system without changing voltage can be phased in much more slowly and responsively than the alternative that does involve increasing voltage. Alternative D-1 can defer increasing capacity by only adding substations when they become necessary. Similarly, under Alternative D-3, substations could be expanded and feeder lines added as the need arises. It would not be necessary to reconfigure the entire system at once. Conversely, with Alternative D-2, the 34 kV alternative, essentially the entire portion of the system that was to be upgraded would have to be upgraded at once.

Land Use and Aesthetics

Impacts on land use and aesthetics are related because the perceptions of electrical facilities such as transmission lines or substations are the primary means by which the presence of facilities can affect land use choices.

Land use impacts of transmission and distribution facilities are likely to be based on the perceived aesthetic impacts of poles and wires, and substation, the perceived health impacts of electromagnetic fields and the perceived impacts of radio and television interference.

Specific features of the proposal likely to produce aesthetic and land use impacts include:

1) Location and character of new transmission lines,
2) Alteration of the size or configuration of existing transmission lines,
3) New substations or switching stations
4) Alteration to existing substations or switching stations.

Impacts will relate to the design of facilities and choice of materials. There are a variety of cost and engineering tradeoffs as well as aesthetic tradeoffs between the options. Sensitivity of viewers in office, retail or industrial land uses generally relates to the existing character of the area and the amount of time a viewer is exposed to a view.

Generally speaking, the visual impacts of transmission lines can be considered greatest in natural or open space, somewhat lower in residential areas, but may be affected by the extent of vegetation or other amenities. Impacts in retail, office, and industrial areas depends largely on the character of the environment but generally will be less.

Impacts of substations and switching stations are more localized than the corridor impacts of transmission lines. The extent to which new substations are perceived as a visual or land use intrusion are likely to be related to the surrounding land uses, the scale and appearance of substation facilities and the extent of landscaping or buffering provided. The visual impacts of facilities in substations can be reduced considerably by screening and landscaping. Where substations already exist, they may be accepted as features of the existing environment. In those cases, expansions may not be regarded as a significant new intrusion.

Comparison of Impacts of the Alternatives

Alternative T-1: 115 kV Transmission Grid: This alternative will have more new transmission corridors, more new substations and switching stations than the other alternatives. As such, it can be expected to have the greatest aesthetic and land use impacts of the alternatives.

Alternative T-2: 230 kV Overhead Radial System: This alternative will retain the existing radial system configuration and increase transmission voltage to 230kv. No new switching stations would be added. The existing transmission lines would be upgraded with taller supports and larger conductors to accommodate the higher voltage.

Compared to Alternative 1, Land Use impacts of transmission lines will be less because of the avoidance of approximately 10 miles of new transmission lines. Land Use impacts from perceived visual impacts of the larger poles on existing transmission lines is likely to be slight.

New switching stations would be avoided as would expanded substations for switching equipment. To upgrade to 230 kV, rebuilding of the high side of the substation. This could require expansion of the substations depending upon the existing configuration.

Alternative T-3: Expanded Capacity 115kv Overhead Radial System: Compared to Alternative 1, Land Use impacts of transmission lines will be less because of the avoidance of approximately 10 miles of new transmission lines. At the worst case, larger poles and insulators and/or closer spacing of poles would be required. Land Use impacts from perceived visual impacts of the larger poles on existing transmission lines is likely to be slight.

New switching stations and expanded substations would be avoided as with Alternative 2.

Alternative T-4: Underground Transmission System: This alternative would eliminate overhead transmission lines and the associated aesthetic impacts.

All substations in the system would require expansion to accommodate the pumping and cooling facilities for oil filled transmission lines. The same switching stations and expansion of substations to accommodate switching as proposed in Alternative 1 would be required. In the long term, an third transmission line feed would likely be provided to many substations in order to provide redundancy because of the long repair time required if underground transmission lines fail. This would require expansion of most substations to add space for circuit breaker switching.

Alternative D-1: 25 MVA Substations with 12.5 kv Distribution: This alternative would add approximately nine new substations throughout the city. All of the impacts of new substation construction would occur. Because most of the city is residential, and most of the city is developed a majority of these substations would likely be developed in or near to single-family neighborhoods.

Alternative D-2: 50 MVA Substations with 34 kv Distribution: This alternative would add no new substations. Existing Substations would require expansion in order to accommodate additional distribution transformers. In some cases, this may be accomplished within the existing substations. As a worst case, the substations affected would require expansion of perimeter fencing and may require acquisition and displacement of adjacent land uses. The difference in aesthetic character of 34 kv rather than 12.5 kv underground and overhead distribution feeders is unlikely to be noticeable to most observers.

Alternative D-3: 50 MVA Substations with 12 kv Distribution: This alternative would add no new substations. Existing Substations would require expansion in order to accommodate additional distribution transformers. In some cases, this may be accomplished within the existing substations. As a worst case, the substations affected would require expansion of perimeter fencing. Impacts would be similar to impacts of Alternative D-2.

Public Health

Many members of the public and the scientific community are concerned about the potential for Electromagnetic fields from electrical transmission, and distribution lines and appliances affecting human health. Results of epidemiological studies have indicated a potential link between proximity to certain types of electrical distribution facilities and childhood cancer.

Potential impacts of the alternatives relates to the strategies for reducing Electromagnetic Field (EMF) exposure which generally are related to the level of current, or the flow of electricity within facilities.

Transmission Alternative T-1, 115 kV Overhead Grid System: With this system, the existing levels of EMF are likely to increase in the future as the current in various transmission lines increases to accommodate additional demand. The construction of a grid system allows higher loading in each link of the grid since less capacity for redundancy is needed than in the linked radial system. The resulting higher current would lead to an increase in EMF levels. The maximum EMF levels would be experienced when segments of the system were out of service and higher loadings occurred on the remaining segments. The addition of new transmission links would result in additional EMF exposure along routes. The increase will depend on the design of new facilities. Increases in EMF exposure must also be evaluated from the perspective of the existing EMF exposure from distribution lines.

Transmission Alternative T-2, 230 kV Overhead Radial System: With this alternative, the increase in the voltage of the transmission system would reduce the EMF level for a given level of demand as indicated by the comparison between cases "A" and "D" in Figure 3.19. The level of change from increasing voltage is estimated by Puget Power at 30% to 40%. Actual levels would also depend on the specific design configurations of the transmission system.

Transmission Alternative T-3, 115 kV Increased Current Radial System: This system would increase EMF levels more than the other alternatives. This alternative would substantially increase the current on lines at the current voltage. Since EMF levels are related primarily to current, there would be substantial increases in EMF.

Transmission Alternative T-4, Underground Transmission System: If installed using fluid filled pipe type cable, this alternative would have the lowest EMF exposure from transmission lines of the alternatives. If a tighter grid were constructed as has been suggested by Puget Power, additional exposure would occur from new transmission lines. The EMF levels experienced from this type of underground transmission, however, generally are less than the exposure from existing overhead or underground distribution lines currently in place.

Distribution Alternative D-1, 12 kV Lines with 25 MVA Substations: The impacts of the alternative relate to the development of additional substations. The magnetic fields in the vicinity of new substations may result in locally higher magnetic fields depending on substation configuration. The character of magnetic fields near substations is not clearly defined. It is likely that a higher incidence of transient fields would be expected. However, the implications of transient fields are unknown.

Distribution Alternative D-2, 34 kV Distribution System: This alternative would reduce EMF by increasing voltage and decreasing current.

Distribution Alternative D-3, 12 kV Lines with 50 MVA Substations: With this option, higher EMF levels would result at the expanded substations and where new feeder lines are installed.

Background Information on Effects of Electromagnetic fields

Although there are electric and magnetic fields that are caused by natural phenomena, including electric fields by the sun and magnetic fields by the earth's molten interior, the electric and magnetic fields that are the focus of health effects studies are primarily those associated with the use of electricity at home and in the work place. These power frequency electric and magnetic fields occur when current is flowing through electric power transmission lines, distribution lines, substations and household wiring and electrical equipment.

Concern over the possible human health effects from exposure to power frequency electric and magnetic fields can be traced to Soviet research reports published in the late 1960s and early 1970s. These early epidemiological studies indicated that Soviet workers in high-voltage power switchyards suffered from a number of non-specific ailments. In the United States, scientific and public interest in this issue began to expand with the publication of an epidemiological report in 1979 by Dr. Nancy Wertheimer and Ed Leeper. In this study, childhood cancer was linked with proximity to certain types electrical distribution facilities in the Denver, Colorado, area in a case-control epidemiological study. Within the past few years, the volume of power frequency EMF effects research has expanded tremendously not only within the United States, but also in a number of foreign countries, particularly in Sweden and Canada.

Epidemiology Studies of EMF Health Effects. Epidemiology is the study of the distribution of disease (or illness) and factors related to the causes of disease (or illness) in human populations. Epidemiology relies on the use and interpretation of statistical data. Epidemiology is useful in hazard identification and risk assessment of environmental and occupational factors, because it provides real-world information on the target of such assessments--people.

Epidemiologic data are often used to *infer* causal relationships. Generally, epidemiological studies do not actually establish causality; actual proof is rarely attainable when dealing with environmental agents, including carcinogens. Often, laboratory results demonstrating a mechanism for the results identified in epidemiological studies is required prior to agreement upon a clear causal relationship.

In Epidemiological studies performed to date, a surrogate or proxy measure of exposure called "wiring configuration code" shows an association between cancer risk and this crude estimator of exposure. This method of estimating exposure describes and characterizes residences in a way that takes into account the distance, type, and physical arrangement of overhead power lines near homes.

Results from studies still leave the role of EMF in the development of leukemia unclear. In general, studies have indicated:

1) There is evidence of a relationship between wiring code and leukemia.
2) Little support for a relationship between measured magnetic field exposure and leukemia risk.
3) Support for a relationship between children's use of some electrical appliances and leukemia.

Currently, there is a great deal of attention and discussion focused on how to interpret these studies and on the differences in risks observed when exposure is approximated by wire codes versus measured field values. It is worth noting some of these issues:

- It could mean that the is no real risk posed by magnetic field exposure. Wire code results could really reflect some other factor(s) (related both to cancer and wire code) that is the underlying but undetected causal agent(s). Although wire code is correlated with average field strength, the correlation is not strong. This means that wire code probably represents more than that particular exposure measure, average field strength. Wire code may relate to other aspects of EMF exposure or to other agents altogether, or to both. Ideas about other etiological factors have focused on socioeconomic status, traffic density, or chemicals such as herbicides. Thus far, however, no confounding agent has yet been confirmed.

- It is also possible that some sort of methodological problem exists that introduces biases that produce erroneous risk estimates. The method by which a random sample for control selection has been criticized.

- The measurements made of magnetic fields have limitations. Measurements have to be made after cases are detected, that is, made after, not before, disease develops. The measurements that have been made are short-term in nature (instantaneous up to 72 hours) not long-term (months to years); vary in time; and are values for average field strength (because of available instrumentation).

  It has been argued that wire codes may better represent the long-term exposure condition. Wire codes are relatively stable over time and most likely represent conditions present at the time disease began.

They may also, in some way, better capture the complex nature of EMF exposure (peaks, intermittency, transients, and so forth) than does average field strength and therefore wire codes may better account for true exposure than measurements of average field strength.

Occupational Studies of EMF and Cancer

Over 30 studies have dealt with cancer in adults occupationally exposed to EMF. The majority of these studies have reported a positive association between EMF exposure on the job and cancer. However, despite these findings, epidemiological research has been unable to conclusively prove that electric and/or magnetic fields at work causes cancer for a number of reasons.

Laboratory Studies of EMF Health Effects

Research on whole animals includes the investigation of pineal gland function and melatonin production, immune system interactions and tumor/cancer initiation and/or promotion, behavioral modification and developmental studies, and genetics and protein production.

Studies in Pineal Gland Function and Melatonin Production

The pineal gland is a structure found in vertebrate animals (including humans) that secretes the hormone melatonin. The pineal gland has been described as a "biological timekeeper" because it mediates information on the external light conditions (daytime and nighttime) that appear to control certain physiological responses in both lower vertebrates and in humans. The disruption of normal circadian cycles is known to have negative effects on various physiological processes; it is thus of great interest to clarify any potential cause-effect relationship between EMF exposure and changes in these cycles. A number of investigators have demonstrated that the function of the pineal gland of animals exposed to magnetic fields is altered.

A second major area of research concerns the potential effect of EMF on the immune system and whether EMF could initiate or promote diseases such as cancer, or affect the immune response of animals in other ways. For cancer *initiation* by EMF to be accepted by the cancer research community, it must be shown that magnetic fields damage DNA. For cancer *promotion* to be demonstrated, it must be shown that the exposure to EMF (the promoter) can cause both benign and malignant tumors to appear.

These research results indicate that there may be effects of EMF on systems related to cancer and the immune system which warrant further inquiry, however the research results have not provided clear evidence of either initiation or promotion of cancer growth.

Studies have shown that EMF does affect some aspects of these cellular processes to varying degrees, however, the significance of these cell functions and the degree to which they may contribute to health effects is not currently known.

Summary

Reports of biological effects of EMF are disturbing to some observers, but it is important to remember that all these effects have not been found in any one animal or cell type, and that effects that occur in one animal or cell type may not occur in other animal or cell types. A conclusion that these biological effects indicate a health effect for one particular species (e.g., human beings) is therefore premature. In addition, the biophysical or biological mechanisms that would explain how EMF interacts with living systems to produce observed effects are still not understood. There is no definitive indication that EMF exposure does or does not cause adverse health effects.

Windows Theory and EMF Transients

There is a great deal of uncertainty surrounding what aspect(s) of EMF exposure present a risk to human health. For example, researchers do not know if the strength of the field, the change in field strength over time, the currents induced in the body, or the local geomagnetic field are contributors to possible health effects. To help determine which, if any, of these factors could contribute to health effects, scientists have turned to laboratory studies with animals and cells. Two of the most recent issues concerning the risk of EMF exposure are focused on "EMF windows" and "EMF transients".

Windows Theory

Some research findings indicate that at a particular frequency, some field intensities produce a biological effect while others do not. At the same time, if an effect is observed at a particular field intensity, the biological effect is eliminated if the frequency is changed. These window effects indicate that the paradigm "more is worse" does not apply with respect to field intensity. In other words, a higher field intensity does not necessarily mean that there will be biological effects.

EMF Transients

Transients are being investigated as one aspect of magnetic field exposure that may be biologically significant. Transient fields have not been well defined, and the characteristics of transients from appliances and other sources are not fully understood. The term "EMF transients" most often refers to those electric and magnetic field characteristics that exist during sudden changes in power usage. Such transients occur when electrical equipment is switched "on" and "off" (e.g., electronically controlled devices such as light dimmers and motor controls). The term "EMF transients" can also refer to the fact that the biological effect(s) of power frequency EMF last only a short time. With this type of transient, the effect of EMF exposure results in an initial increase in the response of the cell. This increase reaches a plateau and then gradually declines to either the normal state or to some other steady-state, even though the field exposure remains the same.

The possible existence of frequency and intensity windows, and EMF transients makes it difficult to determine what aspect(s) of EMF exposure could influence biological effects. With this realization has come an increase in exposure assessment research funding. Still, it may be some time before scientists understand the EMF exposure issue.

Risk Assessment

The concept of risk means different things to the expert involved in risk assessment and management and to the general public.

Technical understanding of risk is generally based on a quantitative risk assessment. Risk assessment is the use of facts to define the health effects of exposure of individuals or populations to hazardous materials and situations. In the environmental health field, the result of the risk assessment process is then compared to a regulatory standard that represents "tolerable risk". This comparison is part of the technical process of risk management. In risk management, policy alternatives are weighed and the most appropriate regulatory action is selected. To define a risk justifies the expenditure of scarce resources, risk analysis may attempt to determine a threshold above which risks are considered definitely unacceptable, and they may also conduct a cost/benefit analysis.

In contrast to the technical understanding of risk, the public understanding of risk is based on the public's *perception* of risk, and on a determination of the *acceptability of the risk.*

Research and experience has shown that public responses to risk are based on how the majority of individuals "feel" about the risks, rather than on some type of individual analytical process. Some experts believe that public *perception* of risk is based on many factors. These may include prior experience with risks, prior belief about risks, characteristics of the individual judging the risks, and qualitative facets of the risk itself. Most experts agree that there are a number of individual characteristics of risk or factors that significantly affect public opinion.

The public appears to be increasingly concerned over the EMF health effects issue. In a recent presentation on the public perception of the EMF issue, Dr. Chris Whipple suggested that there is an inherent distrust of risk management institutions; EMF risks are associated with "dread" effects, and that these effects are "unfamiliar"; and a fairness in the distribution of the risks and benefits is needed for public acceptance. Further explanation of this last suggestion is that it refers to the fact that the perceived EMF risks from a transmission line are localized to a limited number of people while a large number of people benefit from the line. On the other hand, the perceived EMF risk from appliances is distributed among a large number of people and the benefits are similarly distributed among a large number of people. This suggests that people may be concerned about the EMF risk from transmission lines than from appliances.

Mitigation Strategies

Prudent Avoidance

In response to concerns over health effects from the exposure to EMF, the controversial concept of "Prudent Avoidance" has been set forth by Dr. Granger Morgan of Carnegie-Mellon University. According to Morgan, prudent avoidance is the "idea of avoiding exposure to power-frequency electric and magnetic fields when it can be done at modest cost and [with] little inconvenience. Prudent avoidance measures can be exercised by policy makers, utilities, and individuals in response to concerns over possible health effects from EMF exposure. This idea has been praised and even adopted by some as an appropriate response to EMF concerns, but others have not adopted it, partly because of a current lack of knowledge and consensus about what level of EMF exposure might be considered as safe and the difficulty in determining what a "moderate" cost may be in a particular situation. Without a basis for determining safety, it is quite difficult to determine what a "modest cost" of reducing exposure to that risk might be.

Utilities may implement "prudent avoidance by implementing measures to limit human exposure to EMF for new power lines and facilities. Some measures are very costly, others are less so. However, the lack of a scientific consensus or regulatory standards for EMF make it difficult for utilities to justify increased rates to customers or regulatory bodies for recovery of additional costs of avoidance of EMF exposure. Such requirements impose additional considerations on the adoption of more costly EMF reduction measures , and therefore necessitates careful consideration.

Individuals may act prudently by avoiding exposure to some common sources of EMF. For example, pregnant women may wish to avoid exposure to electric blankets because some epidemiology studies indicate an increased risk from exposure. If electric blankets are used, they can be turned on prior to going to bed and then turned off just before the individual enters bed. Alternatively, there are now some "low field" electric blankets available. Similar prudent avoidance measures exist for other sources of EMF exposure.

<u>Mitigation Through Design of Electrical Facilities</u>

All EMF mitigation options are governed by the laws of physics and may only occur in these ways:

- Increase the distance between the field source and the exposed subject, or
- Decrease the propagation of the magnetic field at or near its source.

Impacts and mitigation options apply to both electrical transmission and distribution systems. Magnetic fields vary according to the current passing through the system. Because transmission systems tend to have higher current as well as higher voltage, EMF levels tend to be higher. Distribution lines, however, are a much more common source of EMF exposure. Most of the correlations of health effects with wire codes are based on the proximity of distribution system elements.

<u>Increasing the distance</u> between source and subject is technically straightforward to implement: either place the lines higher in the air, or increase their horizontal distance from people. The first case requires building higher poles/structures. The second option requires wider rights-of-way. Increasing pole height and widening the rights-of-way may be possible for new power lines, but difficult and expensive to retrofit.

Several possible options exist for decreasing the <u>propagation</u> of magnetic fields. One option is to reduce the magnetic fields emanating from the power conductors by field cancellation.

Field Cancellation is one way to cancel magnetic fields by positioning load-carrying conductors so that the magnetic fields from the conductor phase is opposed by the magnetic fields of other phases. This becomes possible when **multiphase** (three, six, or twelve) transmission and distribution lines are located on the same structures or are very close to each other. For single circuits, this situation is optimized when the conductors are located at 60 degrees, from each other in a **vertical delta** configuration. For **double circuits, split phase,** locating the various phases as close to a circle as possible, with similar phases in opposing quadrants gives best results.

With proper consideration to safety, another way to cancel fields is to place distribution circuits under transmission circuits. This will reduce the overall magnetic field exposure to subjects on the ground. For maximum field cancellation of the magnetic fields, the current flows should be balanced and flowing in the same direction.

Phase spacing is also used in reducing magnetic fields from **underground lines.** Simply burying transmission or distribution lines does not eliminate or significantly reduce magnetic fields. To achieve a significant reduction in magnetic fields requires undergrounding in a steel pipe filled with fluid, as depicted in Figures 3.19.I. The magnetic field reduction is due to cancellation from the phase spacing and not shielding.

Reducing propagation through *shielding* is generally not yet feasible. To date, economical options for shielding have not been developed.

2.0 DESCRIPTION OF THE ALTERNATIVES

2.1 Objectives of the Proposal

The objective of the proposal is to create a list of necessary electrical transmission and distribution facilities and a set of related policies. These will guide provision of adequate electrical power to meet the needs of projected growth in the Bellevue area. By creating this set of policies and a schematic system map, the proposal will also meet the requirements of the State of Washington Growth Management Act.

2.2 Proposed Policies and System Alternatives

Between October of 1991 and May of 1992, a Citizen's Advisory Committee (CAC) examined the issues associated with provision of several private utilities to serve anticipated growth in the Bellevue area. Given recent controversy over siting of new electrical transmission lines and substations, the CAC spent a significant amount of time dealing with issues associated with the provision of electrical power to the greater Bellevue area. After spending many meetings discussing issues ranging from electric service reliability, aesthetics, costs, technological options, and potential human health impacts attributed to electrical and magnetic fields (EMF) associated with electrical transmission and distribution equipment, the CAC created a set of recommended policies to be forwarded to the Planning Commission and, ultimately, to the City Council for adoption.

The policies that are directly or indirectly related to electric power facilities as recommended by the Planning Commission on March 5, 1993 are reprinted following page II-9. The Draft EIS contained recommendations of City staff where it they differed from the CAC recommendation. Major differences between the Planning Commission, City staff recommendations and the recommendations developed by the Citizen Advisory Committee occur in the following areas: the CAC recommendation does not include a system map; Planning Commission, and City staff recommendations include a system map (equivalent to Alternative T-1, below); the CAC, recommended a policy which gives equal weight to a number of criteria for provision of utilities which is included in the Planning Commission recommendation; the City staff recommended prioritizing reliability and cost as first priorities both the City Staff and Planning Commission recommend that the sequencing of implementation of components be determined by the utility; the CAC recommendation calls for avoidance of school and residential areas in the siting of new transmission lines and substations which is included in the discussion of Planning Commission Policy P-19; the City staff recommended deletion of the policy.

2.3 System Alternatives

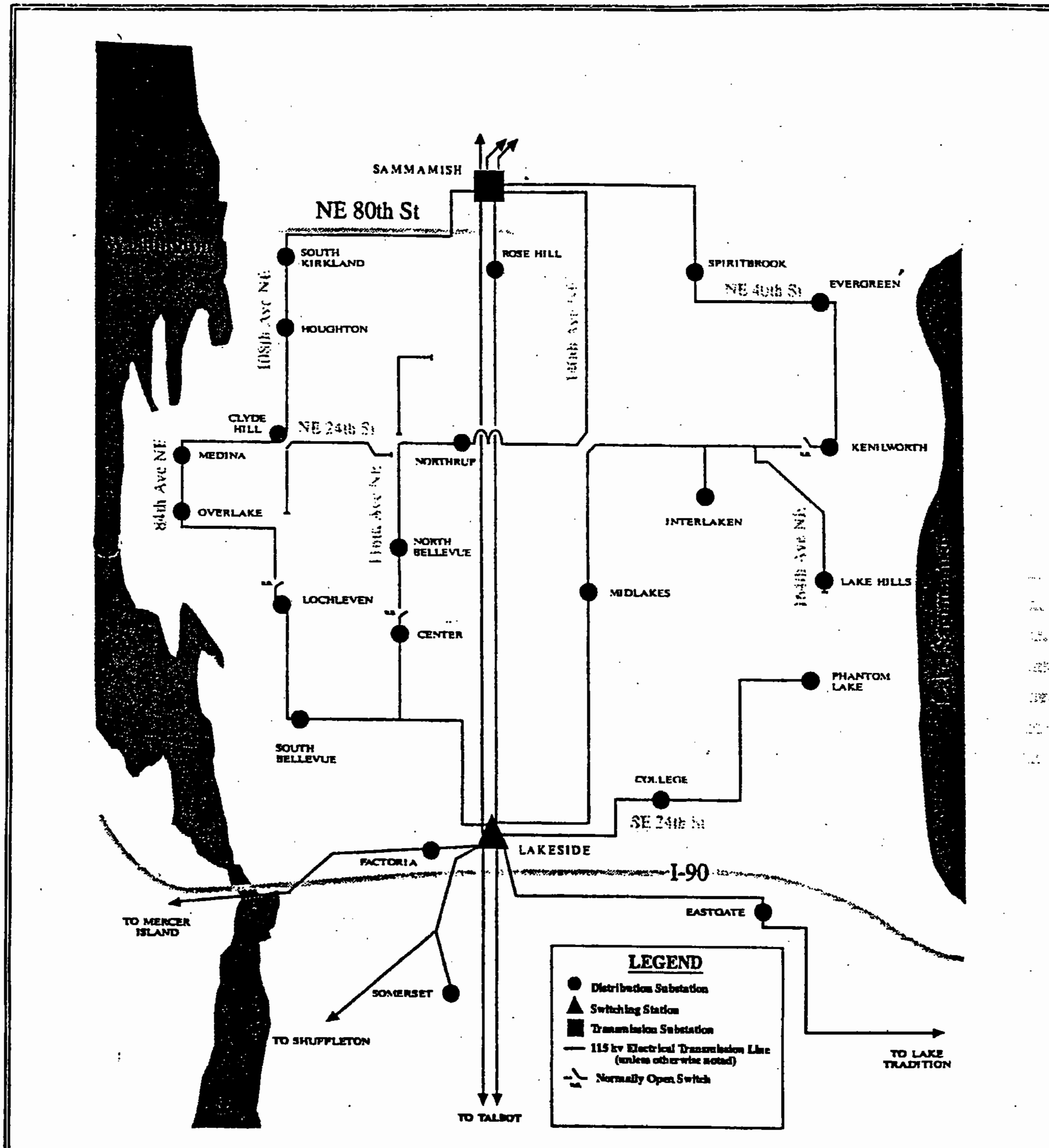
In addition to these recommended policies, an objective of this planning process is to comply with the Growth Management Act by creating a list of electrical facilities that will be necessary to provide adequate electrical power to the Bellevue area to the year 2020. This list of necessary electrical transmission and distribution facilities would not be so specific as to locate specific transmission line routes or substation locations, but would schematically illustrate the types of necessary facilities and general areas where they would be needed. The intent of adopting such a system plan and list of facilities would be to create greater predictability in locating necessary facilities for both Bellevue neighborhoods and the affected utility, Puget Power. Although there would continue to be issues associated with specific siting and routing of individual facilities, the question of the need for the facility would be settled at this planning level. This EIS analyzes several alternative system plans that would achieve this objective.

For the purposes of this analysis, the alternatives have been separated into Transmission Alternatives and Distribution Alternatives. The four transmission alternatives deal with delivery of power to the distribution substations, from which distribution lines carry power to the end users. The transmission alternatives involve different numbers and configurations of transmission lines, transmission substations, and switching stations. The distribution alternatives involve different numbers and configurations of distribution lines, distribution substations, and pole or pad mounted transformers that reduce voltage to that which is finally delivered to the end user.

The following are descriptions of each transmission alternative and each distribution alternative. In thinking about how these alternatives would function, it is important to note that **although they are electrically connected, any of the transmission alternatives are compatible with any of the distribution alternatives, and vice versa.** In other words, any one of the transmission alternatives could be combined with any one of the distribution alternatives to form a complete and functional system. It should be noted that each of these alternatives has been developed to handle a projected planning horizon year (approximately 2020) peak load of approximately 680 Mega Volt Amperes (MVA), a common measure of electrical capacity and load. Existing peak load for the same Bellevue service area is approximately 475 MVA. See Appendix B, "Electric Facilities Plan for the Greater Bellevue Area" for a more detailed discussion of the growth assumptions this projected electrical demand is based on.

2.3.1 No Action Alternative

In the context of this proposed Comprehensive Plan Update, a No Action Alternative would not mean that no electrical facilities would be built. Rather, it would mean that no Comprehensive Plan element would be adopted for dealing with the electrical transmission / distribution system and provision of this utility would continue as it has in the past. It is assumed that under such a scenario, Puget Sound Power and Light Company, the private utility that provides electric service to the Greater Bellevue Area, would continue to attempt to secure permits for those facilities it deemed necessary to continue to provide electrical power to the area. The system that Puget Power has proposed consists of the transmission system discussed under Alternative T-1, below, and the distribution system discussed under Alternative D-1, below. Therefore, it is assumed that a No Action Alternative would essentially be a scenario under which the facilities in those alternatives would be constructed, but without the guidance and predictability offered by inclusion in the Comprehensive Plan . A No Action Alternative, therefore, would be substantively the same as Alternatives T-1 and D-1.



City of Bellevue
Comprehensive Plan
Utilities Element
Electrical Utility

FIGURE: 2.1
Greater Bellevue
Existing Puget Power Transmission
Facilities

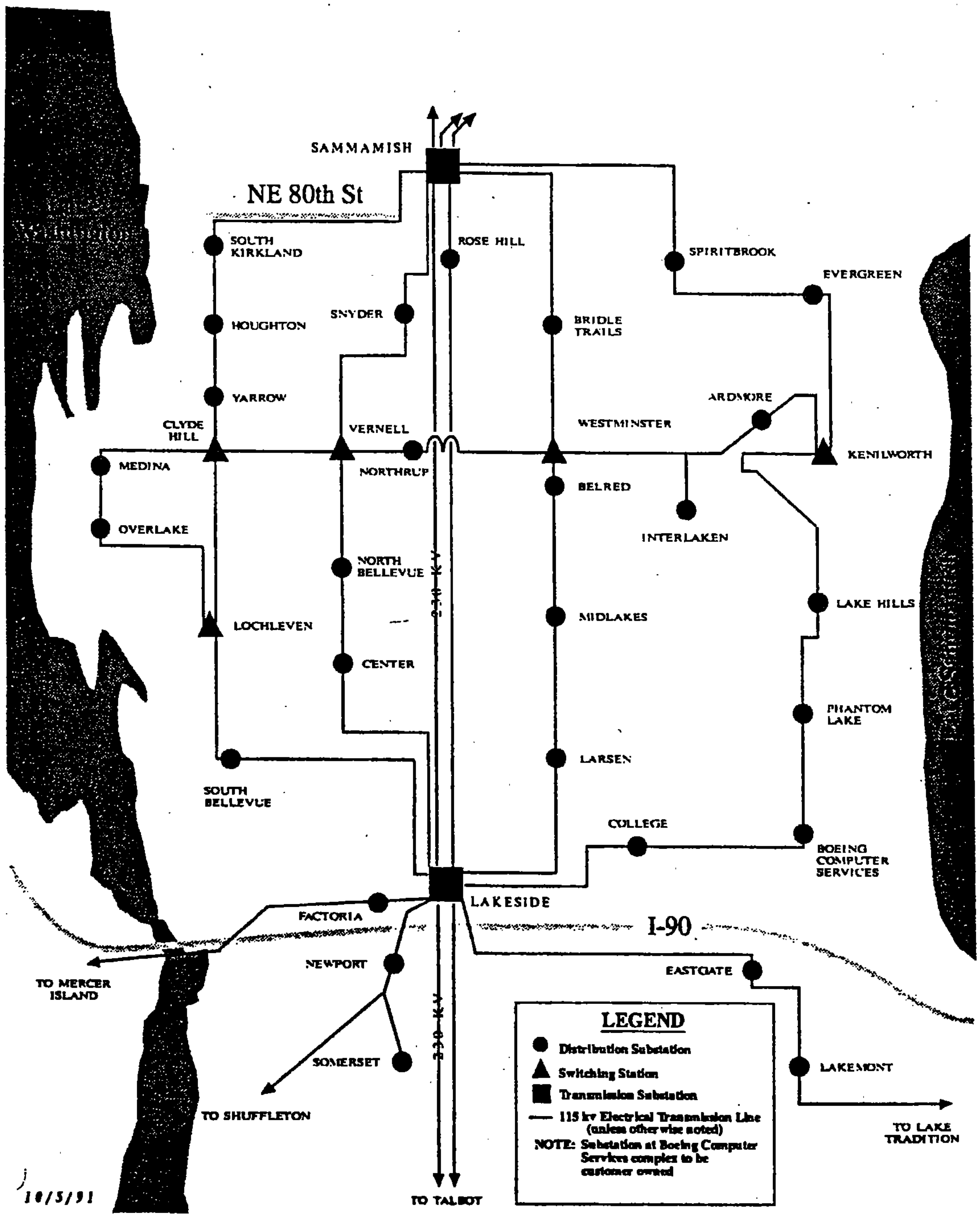
2.3.2 Transmission Alternatives

Existing System - The existing transmission system is depicted in Figure 2.1. This system serves not only Bellevue but portions of Kirkland, Redmond, Issaquah and unincorporated King Co.

Power is delivered to the Bellevue area from distant generation sources to Puget Power's 230 kV Sammamish Substation in Redmond and 230 kV Talbot Substation in Renton. Each of these substations lowers the voltage to 115 kV, where it is then passed through multiple 115 kV transmission lines to distribution substations serving a service area from Kent to Bothell. In the Bellevue area, the Sammamish Substation directly feeds several 115 kV transmission lines, which each supply several distribution substations (from which end users ultimately get their power). At the southern end of the system, 115 kV transmission lines run from the Talbot Substation to the Lakeside Switching Station in the Factoria area, from where several 115 kV transmission lines link up with those coming from the Sammamish Substation. . Most of these lines extend from the Sammamish Substation to the Lakeside Substation. However, each of these lines is broken into at least two sections by a switch which is normally open somewhere between the two substations. Therefore each line section is considered as operating as a "radial" line. An exception is the Phantom Lake line from the Lakeside Switching Station. The far end of this line does not connect to any substation and is therefore truly a "radial" line.

T-1 115 kV Overhead Grid System - This alternative (see Figure 2.2), developed by Puget Sound Power and Light Company, would add capacity to the system by linking together currently unconnected portions of the existing network, rather than by increasing the voltage or current carrying capacity of the existing system. This alternative would transform the existing radial system into a grid by adding switching stations and new transmission line segments. This alternative includes enhancements of three existing distribution substations to add switching capabilities, creation of two new switching stations, creation of seven new transmission line segments (totaling approximately 10 miles), upgrading the Lakeside Switching Station to add 230 kV facilities , and upgrading of one major trunk transmission line from 115 kV to 230 kV. Puget Power has calculated that this proposal has the capacity to serve a demand of 965 MVA. The sequence of developing new facilities has been developed by Puget Power to make maximum use of existing facilities and to built the least expensive improvements, largely transmission line links, prior to more expensive facilites such as switching stations.

T-2 230 kV Overhead Radial System - Under this alternative ,the system would remain in essentially the same radial configuration that exists today. No new switching stations would be added and no new transmission lines would be added. However, the entire existing 115 kV transmission system would be rebuilt to a 230 kV capacity in phases. Each existing 115 kV transmission line would be replaced by a 230 kV line and each distribution substation would have to be expanded and rebuilt to be able to step down from 230 kV to the distribution voltage, rather than from 115 kV to the distribution voltage, as is currently the case. This would require the rebuilding of approximately 36 miles of transmission lines ~~and~~ 14 distribution substations on portions of the system expected to experience



City of Bellevue Comprehensive Plan Utilities Element Electrical Utility	**FIGURE: 2.2** Greater Bellevue Planned Puget Power Transmission Facilities

increases in demand. Finally, the 230kv facilities at the Sammamish and Lakeside Substations, the transmission substations at each end of the system, would have to be expanded to accommodate the increased number of 230 kV lines

T-3 115 kV Increased Current Radial System - As with the 230kv Alternative, under this alternative the system would remain in essentially the same radial configuration that exists today. No new switching stations would be added and no new transmission lines would be added. About two thirds of the existing 115 kV transmission system would be rebuilt to a higher capacity configuration in phases. For those sections, existing 115 kV transmission line wires would be replaced with higher capacity wires. Where larger wires are installed lines would have to be rebuilt with stronger (bigger) poles and generally spaced closer together than current polesc. Additionally, the end structures at the "high sides" of some distribution substations would need to be rebuilt to handle greater incoming current. It has not been determined at this time which transmission lines would need to be reconductored and re-wired under this alternative, nor which substations would need alterations. Specific power flow analysis would have to be conducted to identify specific upgrades if this alternative is adopted into the Comprehensive Plan. It is possible for the conversion to higher current to be phased in as individual sections of transmission line reach capacity and the entire system would **not** have to be converted at once.

T-4 Underground Transmission System - This alternative would be laid out in a grid configuration similar to that of Alternative T-1. (Puget Power has suggested that a grid system with additional links might be developed for an underground transmission system based on longer repair times for repair of underground transmission lines.) Replacement of sections of transmission line could be phased for installation in complete circuits. The new transmission lines would all be underground and would ultimately be energized at 230 kV, rather than 115 kV. The higher voltage would be necessary because of limitations inherent in underground technology that limit the power flow through underground cables. A 230 kV underground system would not have significantly more capacity than a similarly configured 115 kV overhead system. Rather, the increased voltage would merely compensate for the power flow limitations of underground technology. New facilities that would be required under this alternative would be similar to those discussed under Alternative T-1. The primary differences would be that all new transmission lines would be underground, rather than built overhead. All existing transmission lines would have to be replaced with underground lines, all distribution substations would have to be rebuilt with a high side operating at 230 kV and to accommodate underground transmission, the Sammamish and Lakemont transmission substations and the Lakeside switching station would need to be expanded to accommodate underground lines, (assuming the Talbot to Lakeside transmission line is upgraded to 230 kV) and some pumping stations for cooling oil would be required at or between substations. It is assumed that all underground lines would be enclosed in fluid-filled, high pressure cable. (A grid with additional links as suggested by Puget Power also could include development of a mini-switching station at each substation to serve three to four rather than two incoming transmission lines at distribution substations. Under such a tighter grid, approximately 40 miles of additional underground transmission line would be constructed. Since Puget Power has not developed such underground systems, it is likely that such a system represents a worst case that could be modified considerably to eliminate redundant elements.)

2.3.3 Distribution Alternatives

Existing System - There are currently 22 distribution substations in the Greater Bellevue Service Area (see Figure 2.1). They are largely 25 MVA substations that distribute power to end users at 12 kV. The exception to this rule is the Bellevue Downtown area, in which newer buildings are served by distribution line voltage of 34 kV from two 50 MVA substations. For each of the 25 MVA, 12 kV substations, there are generally 4-5 main 12 kV feeder lines that supply the area served by the substation. Each feeder generally carries approximately 6 MVA over a distance approximately halfway to an adjacent substation. The capacity of each of these feeder lines is limited. The limited capacity of distribution lines is a major factor in the spacing of substations.

In order to increase its capacity, a line either has to be shortened or its voltage must be increased. In order for this system to serve anticipated additional load in the future, therefore, one of three things would need to happen.

- More distribution substations could be added between existing substations, which would have the effect of shortening existing distribution lines
- The same number of lines of the same length could be kept, but their voltage would have to be increased.
- More lines of the same length and voltage could be added between existing substations.

The following distribution alternatives each incorporates one of the above methods of handling the increased load that is anticipated as a result of projected growth in the Bellevue area.

D-1 12 kV Lines with 25 MVA Substations - This alternative would keep the distribution voltage at 12 kV and would require the addition of 9 new distribution substations throughout the Bellevue area. Rather than increase the power that any given substation would have to distribute to the surrounding area, the power of each substation would remain the same, but additional substations would be added to handle the additional load needed to serve area growth. A similar number of feeder lines would run from each existing substation, but they would be shorter in length than those existing today.

D-2 34 kV Lines with 50 MVA Substations - This alternative represents the option of increasing voltage to increase distribution line capacity. This allows service to anticipated growth in an area without construction of new distribution substations. Under this alternative, no new distribution substations would be needed, but seven existing substations would need to be physically expanded and electrically rebuilt and to step down from the transmission voltage to 34 kV, rather than to the existing 12 kV distribution voltage. Additionally, these seven substations would need to be expanded to be able to distribute 50 MVA of power, rather than the current 25 MVA configurations. Generally, this would mean an additional transformer or bank of transformers would need to be installed. All existing 12 kV distribution lines running from the expanded substations would need to be rebuilt to 34 kV configurations. 34 kV lines are capable of carrying greater loads over similar distances or similar loads over greater distances than 12 kV lines. In the areas converted to 34 kV, all underground cables, insulators, switches, fuses, lightning arrestors, transformers, and other equipment would need to be replaced. Finally, approximately nine other distribution substations would need to be expanded to handle both 12 kV and 34 kV distribution lines, so that the Bellevue system could connect back in to the rest of the system, which would still operate at 12 kV. Some pockets of the existing 12 kV distribution could remain for many years under this alternative, particularly in the Lake Hills area and in the Clyde Hill / Point Cities areas.

The idea behind this 34 kV alternative is that projected load growth would be served by a similar number of lines to today's system, each covering a similar length, but energized at a higher voltage. Each of the 34 kV substations would typically have four 34 kV feeder lines, which would each carry 12 MVA over a distance of approximately one mile. In the substations with both 12 kV and 34 kV, there would also be four 12 kV feeder lines, each of which would carry 6 MVA over a distance of approximately .6 to .7 miles.

D-3 12 kV Lines with 50 MVA Substations - This alternative is another method of serving additional projected demand with limited or no construction of new distribution substations. Under this alternative, approximately 12 substations would be converted from 25 MVA to 50 MVA configurations. However, rather than the additional power handled by each substation being distributed by increased distribution line voltage, additional distribution lines at the existing voltage of 12 kV would be added. Substation expansions under this alternative would differ from those associated with Alternative D-2 in that, rather than ~~adding~~ replacing 12 kV transformers with 34 kV transformers to handle different voltages, additional transformers would need to be added to handle more feeders of the same voltage. One potential difference is that a new substation in the Bridle Trails and Lakemont areas might still be necessary under this alternative (they would not be necessary under Alternative D-2) because the spacing of existing substations may be too great to operate under this alternative with only existing substations. Under this alternative, existing distribution lines would not have to be replaced, but additional lines at the same voltage would have to be installed. Each distribution substation that would have to be rebuilt would typically include a total of 10 underground feeder lines energized at 12 kV and covering a distance of just under one mile in length.

2.3.4 Methods to Reduce Peak Demand - One approach that needs to be taken into account in any comprehensive discussion of providing electrical power to the Bellevue area over the next 20-30 years is that of conservation and other methods to reduce peak electrical demand. Puget Sound Power and Light Company has an active conservation program in place currently and anticipates increased conservation practices over the life of this plan. Additional methods of reducing peak demand include load shedding[1] and fuel switching[2].

Such methods of reducing peak demand and, hence, peak loads are not discussed in this EIS as full alternatives. This is because the usual effect of such programs would be to delay the time when additional generation, transmission, or distribution facilities are needed. Only in rare circumstances when an area was nearly as developed as it ever could be, a condition known as "buildout", would such practices actually eliminate the need for a given facility or group of facilities. In Bellevue, it is anticipated that more aggressive methods of reducing peak demand might cause the projected 30 year facilities plan to become a 40 year plan. Conversely, less aggressive or ineffective programs might result in the 30 year plan actually being a 20-25 year plan. Since the focus of this plan is where facilities would be needed in the Bellevue area, these methods are not treated as a full alternative. Throughout this document, the effect that methods of reducing peak demand would have on impacts to specific elements of the environment will be discussed. It should be noted that fairly aggressive reductions in peak demand are assumed in calculating the projected 30 year demand of 680 MVA. For more discussion of these assumptions, please refer to page 7 of Appendix B.

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1 **Loadshedding** is a method of reducing demand during periods of peak load. An example of loadshedding would be a program whereby power to all water heaters in a certain geographical area would be shut down for certain hours of the day during certain times of the year. since electrical facilities are designed to handle peak loads, not average loads, such methods of reducing peak demand can reduce the need for new generation, transmission, or distribution facilities.

2 **Fuel Switching** programs are programs in which utilities and/or governments subsidize and encourage switching to non-electrical technologies. An example would be a utility paying for conversion from electric water heaters to gas water heaters or electric space heating to gas.

NON CITY-MANAGED UTILITIES

Electrical Lines

Puget Power builds, operates and maintains the electrical system serving the City of Bellevue. Puget Power is a private, investor- owned utility with the responsibility for providing service to over 750,000 customers in a nine county service area. The system serving Bellevue is part of a larger service area called the "Greater Bellevue Area" which is roughly an area between Lake Washington and Lake Sammamish. The area includes the entire cities of Bellevue, Beaux Arts, Medina, Hunts Point, Yarrow Point and Clyde Hill. This area also includes portions of Kirkland and Redmond and small portions of unincorporated King County.

Puget Power imports electrical energy from generation sources in Canada, on the Columbia River and from other generation sites inside and outside of Puget Power's service territory.

Based on population and employment forecasts for the next 20-30 years Puget Power estimates that there will be a peak winter load of approximately 680 MVA (Mega or million volts amperes) in the Greater Bellevue Area. In comparison, the winter peak load today is 475 MVA. New facilities including transmission lines and substations may have to be constructed in order to address this demand.

Natural Gas Lines

Washington Natural Gas (WNG) builds, operates and maintains natural gas facilities serving the City of Bellevue. WNG is an investor-owned utility serving nearly 400,000 customers in five (5) Western Washington Counties including King, Snohomish, Pierce, Thurston and Lewis Counties. There are approximately 18,900 customers within the City of Bellevue and approximately 23,900 in the Bellevue "planning area." Natural gas is delivered to a regional distribution network via an interstate pipeline system. Northwest Pipeline Corporation owns and operates the regional network that supplies gas to the states of Washington, Oregon and Idaho. The pipeline serving Bellevue consists of two pipelines running north-south, in an area east of Lake Sammamish.

Not only does the Pacific Northwest receive its gas from widely disparate regions of the United States, but a major contribution is drawn from significant resources in neighboring Canada.

Based on available population projections WNG proposes no major distribution facilities for next 20 years necessary to serve projected growth in the City of Bellevue.

Telecommunication Lines

Telecommunications is the transmission of information by wire, radio, optical cable, electromagnetic, or other similar means. For Bellevue telecommunication utilities include telephone, cellular telephone, microwave and cable television.

Approximately 80% of the telephone customers in the City of Bellevue are served by US West Communications. GTE Northwest Incorporated provides service to approximately 20% of Bellevue's telephone customers in the northern portion of the City.

Based on available population and employment projections no new major telephone facilities are planned for Bellevue for the next 20 years. However, an additional remote switch (telephone exchange) may be needed in the US West Communications service area to handle a growing demand for additional services.

Cellular telecommunication is a technology that allows people to have mobile telephone communications. The communication link is made by wireless transmission of messages on a network of strategically placed receivers. These receivers may be placed atop tall poles, lattice-type towers or buildings.

The Federal Communications Commission (FCC) licenses cellular companies to operate within strict guidelines. The license allows the awardee the right to use a group of radio frequencies to provide this telephone service. The FCC can award only two licenses per MSA (Metropolitan Statistical Area). The City of Bellevue is served by McCaw Cellular(also know as Cellular One) and US West Cellular (also known as US West New Vector).

Unlike other utilities the cellular telephone industry does not plan facilities far into the future and analyzes market demand to determine expansions into new service areas.

Cable television services in the City of Bellevue are provided by Viacom Cablevision. This service provides television broadcasting via a network of overhead and/or underground coaxial cables. Virtually all channels carried on the Bellevue cable system originate at Viacom's primary transmitter site located at 89th Street and Roosevelt in Seattle, and are transmitted to the Bellevue receiver located at Stevenson Elementary School on NE 8th Street via microwave.

Viacom's Bellevue cable system has the technical capacity to serve any anticipated new development in the city, as well as any potential areas of annexation.

Due to its central location and dynamic employment center Bellevue will continue to attract new and innovative technologies in the field of telecommunications. In most cases these services will utilize existing communication corridors (primarily City streets) and be able to provide services to most parts of the City relatively quickly.

WUTC and GMA

Current law suggests that two public entities have principal jurisdiction over actions of private utilities within Bellevue's City limits. The Washington Utilities and Transportation Commission (WUTC) has the authority from long-standing state law to regulate the services and define the costs that the utility can recover, and consequently has oversight to ensure that the utility acts prudently and responsibly. The State Growth Management Act (GMA) has given cities and counties the obligation and requirement to consider the location of existing and proposed utilities in land use planning including identification of lands potentially useful as utility corridors. Some conflicts may arise from a situation where several agencies have jurisdiction and may view costs and benefits in a different light.

Public Health

Many members of the public and the scientific community are concerned about the potential for electromagnetic fields (EMF) from electrical transmission and distribution lines affecting human health. Results of epidemiological studies have indicated a potential link between proximity to certain types of electrical system facilities and childhood leukemia. However, to date there has been no scientifically documented linkage between EMF and the incidence of childhood leukemia and other conditions which epidemiological studies associate with it. ~~To date there is no consensus in the scientific community on the subject.~~

GOALS

Goal G-1

To facilitate the development of all utilities at the appropriate levels of service to accommodate the growth that is anticipated to occur in the City of Bellevue.

Goal G-2

To facilitate the provision of reliable utility service in a way that balances legitimate public concerns over the safety and health impacts of utility infrastructures, consumers' interest in paying no more than a fair and reasonable price for the utility's product, Bellevue's natural environment and the impacts that utility infrastructures may have on it, and the community's desire that utility projects be aesthetically compatible with surrounding land uses.

Discussion (Goal G-2)

A wide variety of factors -- ranging from health and safety issues, to aesthetics, to environmental impacts, to basic economics -- are at stake in the consideration of any proposed utility expansion project. Ordinarily, the elimination or mitigation of known health or safety risks associated with a project should be given first priority. In particular cases, however, a severely negative impact of mitigation measures on the reliability of the service network, on the cost of service, or on environmental or aesthetic values may dictate the choice of a different option. In every case, cost is a factor that is to be considered, with particular attention to maintaining Bellevue's viability as a regional employment center. However, costs should be weighed against a full consideration of benefits, both tangible and intangible, that may be derived from more "costly" options. In no case should it be automatically assumed that the "cheapest" option is the least costly on a "net" or long-term basis or is the most desirable under these policies. Individual implementation issues arising under these policies should be resolved on a case-by-case basis in light of the considerations above.

GOAL G-3

To process permits and approvals for utility facilities in a fair and timely manner and in accord with development regulations which encourage predictability.

GENERAL POLICIES (Applicable to all non city-managed utilities)

Policy P-0.1

The serving utility shall determine the sequence of implementing components of the utility plan as contained herein.

Policy P-1

Require effective and timely coordination of all public and private utility trenching activities.

Policy P-1.1

Require notification to the City prior to a utility's maintenance or removal of vegetation in City right-of-way.

Policy P-2

Require the undergrounding of all new electrical distribution and communication lines where reasonably feasible and not a health threat. Encourage the undergrounding of all existing electrical distribution and communication lines where reasonably feasible and not a health or safety threat.

Policy P-3

Require the reasonable screening and/or architecturally compatible integration of all new above ground facilities.

Policy P-3.1

Encourage directional pruning of trees and phased replacement of improperly located vegetation planted in the right-of-way. Pruning and trimming of trees should be performed in an environmentally sensitive and aesthetically acceptable manner and according to professional arboricultural specifications and standards.

Policy P-4

Encourage the consolidation of utility facilities and communication facilities where reasonably feasible.

DISCUSSION (Policy P-4)

Examples of facilities which could be shared are towers, poles, antenna, substation sites, trenches, and easements.

Policy P-4.1

Encourage the joint use of utility corridors and non-motorized trails.

DISCUSSION (Policy P-4.1)

The City and utility company should coordinate the acquisition, use and enhancement of utility corridors for pedestrian, bicycle and equestrian trails and for wildlife corridors and habitat.

Policy P-5

Facilitate the conversion to cost effective and environmentally sensitive alternative technologies and energy sources.

Policy P-6

Facilitate and encourage conservation of resources.

DISCUSSION (Policy P-6)

Items the City should consider in implementing this policy include conserving the use of electric energy in its own facilities, and adopting practical and cost-effective energy building codes.

Policy P-7

Encourage the cooperation with other jurisdictions in the planning and implementation of multi-jurisdictional utility facility additions and improvements. Decisions made regarding utility facilities shall be made in a manner consistent with and complementary to regional demand and resources and shall reinforce an interconnected regional distribution network.

Policy P-8

Encourage communication among the City, the Washington Utilities and Transportation Commission (WUTC), and utilities regulated by the WUTC, about concerns with the distribution of costs for existing and proposed utility facilities; especially concerns about requirements for the undergrounding of transmission, distribution and communication lines exceeding statewide norms.

Policy P-9

Encourage the undergrounding of existing distribution and communication lines, especially in residential areas, by facilitating the development of local improvement districts (LIDs) or other means.

Policy P-10

Encourage system practices intended to minimize the number and duration of interruptions to customer service.

Policy P-11

Encourage the utilities to solicit community input on the siting of proposed facilities prior to seeking City approval for facilities which may have a significant adverse impact on the surrounding community.

Policy P-12

Encourage utility providers to erect limited on-site signage on all sites purchased for future major utility facilities to indicate the utility's intended use of the site.

Policy P-13

Require all telephone switching facilities to be fully enclosed in buildings/structures which are aesthetically compatible with the area in which they are placed and are landscaped accordingly.

Policy P-14

Require the placement of cellular communication facilities in a manner to minimize the adverse impacts on adjacent land use.

Policy P-15

Minimize visual intrusion of cellular communication facility towers and mono-poles in all areas. Provide relief to set-back requirements without introducing adverse impacts.

DISCUSSION (Policy P-15)

In order to provide relief to set-back requirements the City should amend its Land Use Code in a manner to ensure that adverse impacts are not introduced.

Policy P-16

Cellular communication facilities should utilize existing structures where feasible.

Policy P-17

Encourage the conservation of electrical energy especially during periods of peak usage through the dissemination of information to the public.

Policy P-18

The City shall actively participate in and encourage the utilities to actively participate in the development of a regional and statewide policies regarding exposure to EMF (electromagnetic fields).

Policy P 18.1

The City shall ~~periodically review the state of~~ monitor development in scientific research on EMF, and make changes to policies it situation warrants.

Policy P-19

The utility shall include the concept of *prudent avoidance* with respect to planning, siting, and construction of all electrical facilities.

Discussion (Policy P-19)

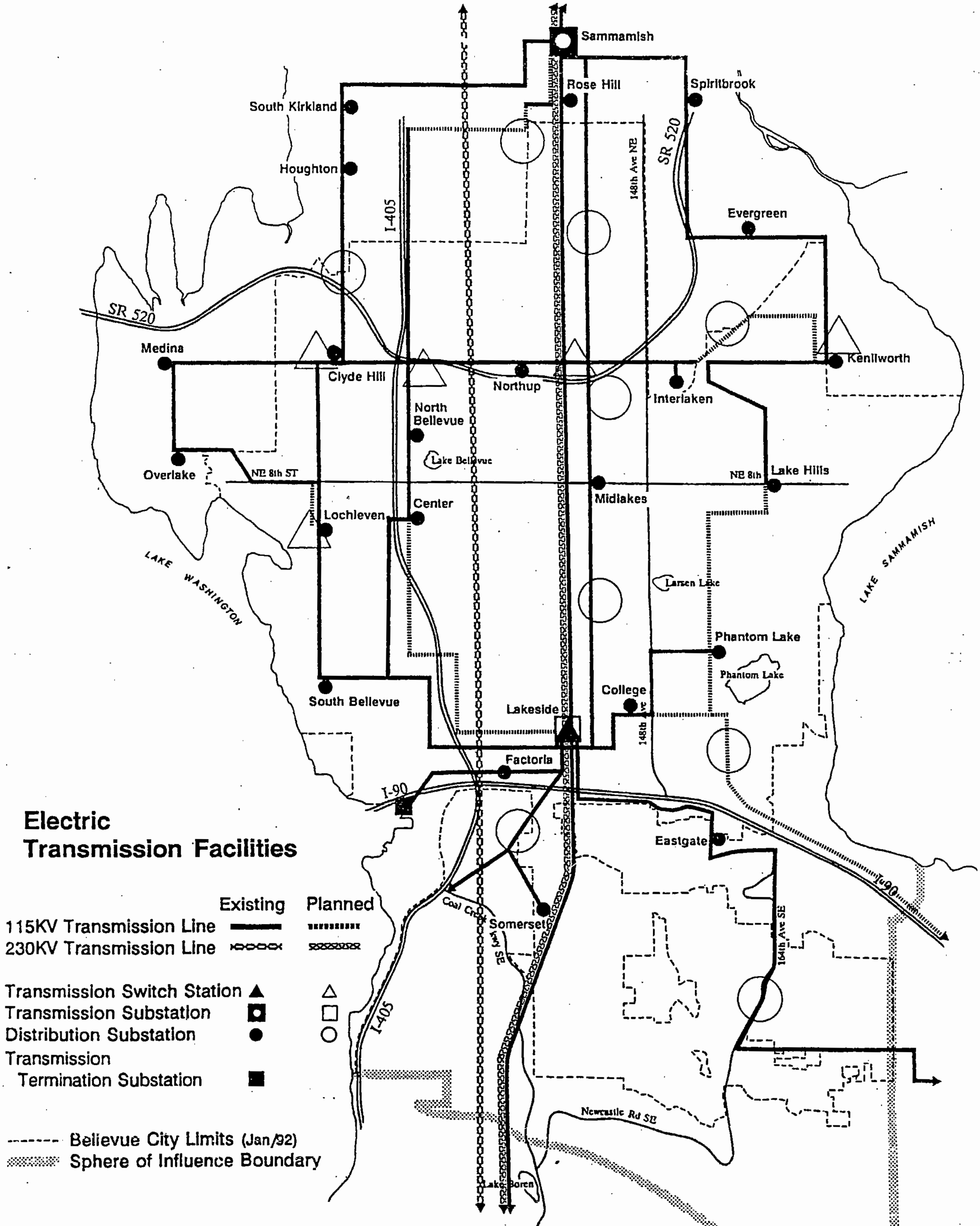
Prudent avoidance shall mean the striking of a reasonable balance between the potential health effects of exposure to electromagnetic fields and the cost and impacts of mitigation of such exposure, by taking steps to reduce exposure at a reasonable cost. With respect to transmission lines such steps might include, but are not limited to: (1) design alternatives considering the spatial arrangement and phasing of conductors; (2) routing lines to limit exposures in areas of concentrated population and group facilities such as schools and hospitals; (3) installing higher structures; (4) widening right-of-way corridors; and (5) burial of lines.

Policy P-20

Require the electrical utility to incorporate into its utility system design, lines and substations which result in the lowest EMF levels at the edge of right-of-way consistent with *prudent avoidance*.

REFERENCES

- PUGET SOUND POWER AND LIGHT COMPANY, BELLEVUE, WASHINGTON
- U S WEST COMMUNICATIONS, INC., RENTON, WASHINGTON
- GTE NORTHWEST INC., BOTHELL, WASHINGTON
- U S WEST NEW VECTOR GROUP, BELLEVUE, WASHINGTON
- MCCAW CELLULAR, KIRKLAND, WASHINGTON
- WASHINGTON NATURAL GAS, SEATTLE, WASHINGTON
- VIACOM CABLEVISION, EVERETT, WASHINGTON

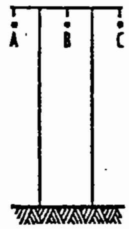
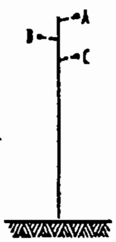
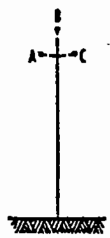
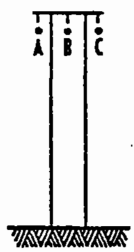
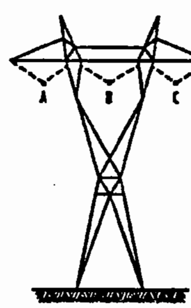


Note: Planned facilities shown on this map depict general locations and conceptual alignments. Actual facility locations of transmission lines, routes and substations are subject to City review processes and ultimately may differ from those depicted.

3.0 ADDITIONS TO TEXT

3.3 HUMAN HEALTH

Text which has been added is indicated by double underlining.

Description	Graphic of Configuration	Cost/Mile (thousands)	Magnetic Fields (milligauss)			Electric Fields (kilovolts/meter)		
			under	40'	200'	under	40'	200'
A. "Base Case" - 230 kV - 300 amps, - 125 MegaWatts - Wooden H-frame - 19 foot spacing		230-260	59.6	29.7	1.6	2.6	1.9	0.04
B. Vertical Delta*		220-250	27.0	11.0	0.6	1.9	0.7	0.04
C. Horizontal Delta		220-250	28.9	9.8	0.5	1.6	0.7	0.03
D. Decreased Voltage - 115 kV - 600 amps, - 11 1/2 foot spacing		200-230	91.5	34.4	1.9	1.0	0.6	0.01
E. Increased Voltage - 500 kV - 138 amps, - 30 foot spacing - Steel lattice tower		400-500	24.4	18.9	1.2	5.5	5.3	0.1

City of Bellevue
Comprehensive Plan
Utilities Element
Electrical Utility

FIGURE: 3.20
Transmission Line Electromagnetic Field Reduction

From: Washington State Dept. of Health, 1992

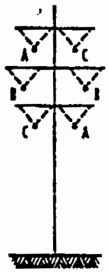
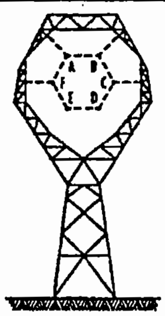
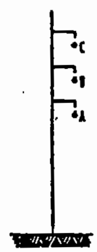
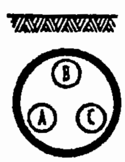
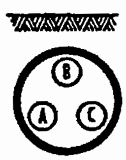
Description	Graphic of Configuration	Cost/Mile (thousands)	Magnetic Fields (milligauss)			Electric Fields (kilovolts/meter)		
			under	40'	200'	under	40'	200'
F. Double Circuit/Split Phase - 150 amps per conductor - Steel pole		350-400	14.5	4.8	0.1	1.7	0.6	0.02
G. Multiphase - 6 phase line - 132 kV - 150 amps per conductor - Steel structure		380-450	16.7	6.7	0.4	2.5	0.9	0.05
H. Single Circuit Steel Pole - vertical configuration		275-350	36.2	22.1	1.5	2.7	0.8	0.1
I. Underground Line - Fluid Filled Steel Pipe - buried 5 feet below the earth's surface		1500-2000	4.9	0.2	0.01	0	0	0
J. Underground Line - Dry Type Cable, Non-Magnetic Pipe - buried 5 feet below the earth's surface		1500-2000	14.7	0.6	0.03	0	0	0

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FIGURE: 3.20
Transmission Line Electromagnetic Field Reduction
From: Washington State Dept. of Health, 1992

Description	Graphic of Configuration	Cost/Mile (thousands)	Magnetic Fields (milligauss)				Electric Fields (kilovolts/meter)			
			under	20'	40'	200'	under	20'	40'	200'
A. "Base Case" - 12.5 kV - 6.5 MegaWatts - 40 ft. pole - 10 ft. crossarm - 4 foot sag		50-70	22.4	14.9	7.7	2.2	0.05	0.05	0.03	.003
B. Increased Pole Height** - 55 ft. pole		60-80	10.1	8.1	5.3	2.1	0.02	0.02	0.02	.004
C. Increased Voltage - 25 kV - 47.5 foot pole		60-80	6.9	5.1	3.1	1.0	0.07	0.06	0.04	.007
D. Compact Delta		55-75	13.1	8.8	4.9	1.9	0.03	0.03	0.01	.003
E. Double Circuit/ Split Phase - 47.5 foot pole		80-120	3.3	3.1	2.5	1.2	0.03	0.03	0.01	.003

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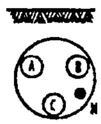
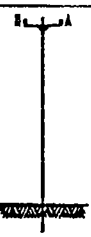
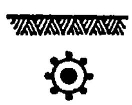
FIGURE: 3.21
Distribution Line Electromagnetic
Field Reduction
From: Washington State Dept. of Health, 1992

Description	Graphic of Configuration	Cost/Mile (thousands)	Magnetic Fields (milligauss)				Electric Fields (kilovolts/meter)			
			under	20'	40'	200'	under	20'	40'	200'
F. Random Lay Underground - buried 3 feet deep - 7.5 inth phase spacing		120-600	56.3	9.8	4.7	1.9	0	0	0	0
G. Underground Line In Conduit - buried 3 feet deep - 2.5 inch phase spacing		120-600	31.2	8.4	4.4	1.8	0	0	0	0
H. Single Phase Crossarm - 7.2 kV - 0.72 MegaWatts		30-40	14.5	12.8	8.6	3.6	0.09	0.08	0.04	.010
I. Single Phase Headpin - 7.2 kV - 0.72 MegaWatts		30-40	8.5	8.3	6.4	3.2	0.08	0.06	0.03	.008
J. Single Phase Underground - 7.2 kV - 0.72 MegaWatts - buried 3 feet deep - concentric neutral		100-450	51.3	15.4	8.0	3.2	0	0	0	0

City of Bellevue
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Electrical Utility

FIGURE: 3.21
Distribution Line Electromagnetic Field Reduction
From: Washington State Dept. of Health, 1992

On a limited basis this concept has been proven, but to do it widely on the electric network would be prohibitive because of the electrical losses in the shield conductors, and the cost of sensing and following the load current. Research continues on methods to accomplish this type of shielding.

Another type of shield can be created with expensive metals that can be built around a room or around the source to buffer the magnetic fields. These special materials do not appear to be economical solutions in the foreseeable future. Estimates for shielding an experimental room 15 feet on a side with a 15-foot ceiling could cost over $250,000.

Ground Currents

Electrical current always follows the path of least resistance. In many cases, this current path includes the ground itself. For example, distribution circuits frequently experience substantially unbalanced currents between conductors. In these situations, the unbalanced currents must find a path back to the substation. When the earth's ground resistance is less than the return conductor resistance, this portion travels through the ground. Since the ground sits below the distribution lines by 20 or more feet, the currents are not close enough for the magnetic fields to be countered.

The solution to ground currents is to install multiphased circuits with balanced current. Where single phased circuits are the only option, it is necessary to either reduce the distance between the load-carrying conductors and the return or provide a conductor neutral. In the distribution system, utilities can install larger conductors for the neutral return. Where this is done, the neutral conductor can provide a lower resistance path than the ground, causing the return current to flow through the conductor rather than the ground. In this case, magnetic fields are reduced because of the neutral conductor is closer to the load conductors.

In the home or office, the mitigation option requires rerouting the return current through a conductor rather than a water pipe or the building steel structure. Commonly, homes and offices are constructed so that water pipes or the building's structure is used as the neutral. Instead of countering the magnetic fields, the fields are broadcast through the pipes or the building structure. It has been estimated that ground currents in homes provide 30-50% of all magnetic fields.

Reduce Current in the Load-Carrying Conductor

An effective way to reduce magnetic fields in transmission or distribution systems is to **increase the operating voltage** Since magnetic fields vary directly as the current flowing in the conductor, it follows that reducing the current by 50% will also reduce the magnetic field that same amount. if the total power transferred in a circuit remains constant, increasing the voltage on a transmission line from 115 kilovolts to 230 kilovolts will cut the magnetic fields significantly from 91.5 as shown in Figure 3.20.D to 59.6 mG in Figure 3.20.A. A similar reduction is experienced from increasing distribution voltage. For a 12.5 kV distribution system, the calculated EMF is 22.4 mG as shown in Figure 3.21.A. This falls to 6.9 mG for a 25kV system as indicated in Figure 3.21.C.

3.9 Impacts of the Alternatives

Potential impacts of the alternatives relates to the strategies for reducing EMF exposure outlined above.

Transmission Alternative T-1, 115 kV Overhead Grid System: With this system, the existing levels of EMF are likely to increase in the future as the current in various transmission lines increases to accommodate additional demand. The construction of a grid system allows higher loading in each link of the grid since less capacity for redundancy is needed than in the linked radial system. The resulting higher current would lead to an increase in EMF levels. The maximum EMF levels would be experienced when segments of the system were out of service and higher loadings occurred on the remaining segments. The addition of new transmission links would result in additional EMF exposure along routes. The increase will depend on the design of new facilities. Increases in EMF exposure must also be evaluated from the perspective of the existing EMF exposure from distribution lines.

Transmission Alternative T-2, 230 kV Overhead Radial System: With this alternative, the increase in the voltage of the transmission system would reduce the EMF level for a given level of demand as indicated by the comparison between cases "A" and "D" in Figure 3.20. The level of change from increasing voltage is estimated by Puget Power at 30% to 40%. Actual levels would also depend on the specific design configurations of the transmission system.

Transmission Alternative T-3, 115 kV Increased Current Radial System: This system would increase EMF levels more than the other alternatives. This alternative would substantially increase the current on lines at the current voltage. Since EMF levels are related primarily to current, there would be substantial increases in EMF.

Transmission Alternative T-4, Underground Transmission System: If installed using fluid filled pipe type cable, this alternative would have the lowest EMF exposure from transmission lines of the alternatives. If a tighter grid were constructed as has been suggested by Puget Power, additional exposure would occur from new transmission lines. The EMF levels experienced from this type of underground transmission, however, generally are less than the exposure from existing overhead or underground distribution lines currently in place.

Distribution Alternative D-1, 12 kV Lines with 25 MVA Substations: The impacts of the alternative relate to the development of additional substations. The magnetic fields in the vicinity of new substations may result in locally higher magnetic fields depending on substation configuration. The character of magnetic fields near substations is not clearly defined. It is likely that a higher incidence of transient fields would be expected. However, the implications of transient fields are unknown.

Distribution Alternative D-2, 34 kV Distribution System: This alternative would reduce EMF by increasing voltage and decreasing current.

Distribution Alternative D-3, 12 kV Lines with 50 MVA Substations: With this option, higher EMF levels would result at the expanded substations and where new feeder lines are installed.

EMF Exposure Levels

Comparison of Electromagnetic Field exposures for the various alternatives are contained in Tables 3.2 and 3.3. The comparisons for the alternatives were derived using information in Figures 3.20 and 3.21.

For the Transmission system, "Case B. Vertical Delta" from Figure 3.20 was chosen as the most typical installation configuration for the Puget Power system. "Case B" in Figure 3.20 is for a 230 kV system. Puget Power's existing transmission system in Bellevue is at 115 kV. Additional information on the derivation of EMF levels from this example is found in Appendix E.

Alternative T-2, 230 kV Overhead Radial System coincides with the "vertical delta" case in Figure 3.20. EMF levels would be 27.0 mg under the transmission line, 11.0 mg at a distance 40 feet and 0.83 at a distance of 200 feet as indicated in Figure 3.20.

For *Alternative T-3, 115 kV Overhead Radial System* the decrease in the voltage by one half to 115 kV compared to the 230 kV in T-2 would require the current to double for the same load. EMF levels are directly related to current. The estimated EMF levels for this system would be twice that of Alternative T-2, or 54 mg directly under the line and 22 mg at 40 feet.

For *Alternative T-1, 115 kV Overhead Grid System* EMF levels were derived from Alternative T-1 by making two adjustments, one for the lower voltage and an additional adjustment for lower current. In the grid transmission system, the current to serve a given demand would be spread over a larger number of lines. Alternative T-1 would have 8 lines from transmission substations serving the same load as would be served by 5.5 lines in Alternative T-3. This is a 45% increase in the number of line which would result in a reduction in current of the inverse of this amount, or 69%. These two factors would resulting in a decrease of EMF to 37.3 mg.

For *Alternative T-4, Underground Transmission System* Case "I" in table 3.20 is applicable. To estimate EMF levels, two alternative grid systems have been assumed - one similar to the grid system in Alternative T-1, and another for an underground system with a tighter grid. For the grid system similar to T-1, the same 45% increase in the number of lines would result in an EMF reduction of 69% and an EMF level of 3.4 mg directly over the lines. For a tighter grid system with 12 lines instead of eight, the increase in lines would be 118% and the decrease in EMF would be 56% for a level of 2.4 mg directly over the lines.

An approximation of the number of dwelling units or businesses exposed to Electromagnetic Fields is provided by the number of miles of transmission line required under each alternative shown in the right column in Table 3.2. A rough estimate of the number of residences exposed to EMF from transmission lines in suburban single family neighborhoods is 200 to 300 dwelling units with 600 to 900 residents per mile of transmission line. For transmission lines on public right-of-way, about half can be expected to be within 40 feet of a transmission line on the same side of the street and about half can be expected to be separated by the width of the street right-of-way and front yard setbacks and therefore be about 80 to 100 feet from conductors. In multi-family neighborhoods, about 800 to 1600 dwelling units per mile with approximately 1,500 to 2,900 residents can be expected to be on lots adjacent to the lines. Of these, approximately one quarter would be within 40 feet of the lines, another quarter within 100 feet, and the remainder more than 100 feet away. Exposure of businesses and employees is more difficult to assess due to the variety in size of commercial sites, structures and employment density. In additional, commercial and office buildings in suburban settings tend to be setback from street either to accommodate parking or office-park landscaping, thereby reducing exposure.

EMF exposure from the electrical distribution system alternatives is represented in Figure 3.21. The EMF exposures are representative of the major distribution lines at the point where they leave the substations which is where they have the highest flow of current. Further from the substation, the current flow decreases as fewer customers are served. The current level of lines serving individual neighborhoods would be determined by the demand on the individual line and would be lower.

TABLE 3.2

EMF LEVELS OF ALTERNATIVES

(At Normal Peak Operating Conditions)

DEIS ALTERNATIVE	EMF LEVELS (milligauss)			Total Line Miles
TRANSMISSION	Under/Over	@ 40"	@ 200"	
T-1, 115 kV Overhead Grid System	37.3	15.2	0.83	44
T-2, 230 kV Overhead Radial System	27.0	11.0	0.60	31
T-3, 115 kV Increased Current Radial System	54.0	22.0	1.20	31
T-4, Underground Transmission				
System (with T-1 grid)	3.4	0.14	0.007	44
(with tighter grid)	2.3	0.09	0.005	73
DISTRIBUTION				
D-1, 12 kV lines, 25 MVA Substations				
overhead lines	22.4	7.7	2.2	287
underground lines	56.3	4.7	1.9	680
D-2, 34 kV lines, 50 MVA Substations				
overhead lines	22.4	7.7	2.2	287
underground lines	56.3	4.7	1.9	680
D-3, 12 kV lines, 50 MVa Substations				
overhead lines	22.4	7.7	2.2	287
underground lines	56.3	4.7	1.9	1047

TABLE 3.3

EMF RANGES OF ALTERNATIVES

(For Peak, Average, and Minimum Normal Operating Conditions)

DEIS ALTERNATIVES	EMF FIELD LEVELS (milligauss under/over line)		
	PEAK	AVERAGE	MINIMUM
TRANSMISSION			
T-1, 115 kV Overhead Grid System	37.3	20.5	9.3
T-2, 230 kV Overhead Radial System	27.0	14.9	6.8
T-3, 115 kV Increased Current Radial System	54.0	29.7	13.5
T-4, Underground Transmission System			
(with T-1 grid)	3.4	1.9	0.9
(with tighter grid)	2.4	1.3	0.6
DISTRIBUTION			
D-1, 12 kV lines, 25 MVA Substations			
overhead lines	22.4	12.3	5.6
underground lines	56.3	31.0	14.1
D-2, 34 kV lines, 50 MVA Substations			
overhead lines	22.4	12.3	5.6
underground lines	56.3	31.0	14.1
D-3, 12 kV lines, 50 MVA Substations			
overhead lines	22.4	12.3	5.6
underground lines	56.3	31.0	14.1

NOTE: Normal operating average conditions would be approximately 55% of peak values and normal operating minimum conditions woule be 25% of peak values

For Alternative D-1, 12 kV Lines with 25 MVA Substations, typical EMF levels are represented in Figure 3.31 by the "A. Base Case" for overhead distribution and by case "F. Random Lay Underground" for underground installation with EMF levels of 22.4 mg and 56.3 mg respectively directly below or above the lines. For most customers, at least 20 feet of separation from conductors is provided by front yards. Because the electric distribution system serves virtually ever dwelling and business, most of the residents and employees within Bellevue can expect exposure to EMF from the distribution system.

For Alternative D-2, 34 kV Lines with 50 MVA substations the increase in voltage from 12 kV would normally result in less current flow *given the same demand served by a 12 kV line.* If this were the case, EMF levels would be about one third that of the 12 kV system alternatives. However, the combination of this distribution voltage with larger capacity 50 MVA substations as compared to the 25 MVA substations in Alternative D-1 would increase the service area of substation and therefore increase current on each of the major distribution lines leaving the substation. This alternative would require rebuilding the distribution system for 34 kV capacity. In doing this, the utility can be expected to design the system to efficiently use the higher voltage. Therefore the system would be designed to operate at about the same current flow as the 12kV alternative. Operation a the same current level would result in EMF levels about the same as Alternatives D-1 and D-2 for the most heavily loaded portions of the system. In some cases, the geographic distribution of customers may result in loading of individual lines at less than rated capacity which would result in decreased EMF levels. In individual neighborhoods, the level of current would be determined by the number of customers served by short sections of distribution line. In cases where the same number of customers would be served by a line, the current and therefore the EMF levels would be less with a 34 kV system than with a 12 kV system.

For Alternative D-3, 12 kV Lines with 50 MVA substations the voltage and current and EMF levels on distribution lines would be the same as Alternative D-1. The greater capacity of substations and larger service area would result in approximately twice as many distribution lines leaving the substation. In this case, EMF levels from each of the distribution lines would be the same as Alternative D-1, but more lines would leave each substation, and potentially more adjacent uses would be affected.

As indicated above, the cases illustrated in Table 3.2 are representative of the most heavily loaded portions of the system where current, and therefore EMF levels are highest. The the most heavily loaded portion of the radial transmission or distribution line is that portion closest to the feed substation. These levels also representative of peak loading of the lines. For the grid transmission system represented by Transmission Alternative T-1, the peak condition represents the most heavily loaded portion of the line. Table 3.3 provides a range of EMF levels which represent different levels of loading based on peak, average and minimum demand conditions. These demand levels are representative of changes in system loading on an hourly basis through the day, with the highest levels occurring during morning and early evening hours, and lowest levels during the night. They also represent changes in the seasonal demand for electricity. For the distribution system, these levels are indicative also of the decrease in EMF levels experienced in portions of the system further from substations which carry less load.

Mitigation Measures For Alternatives: The alternatives outline the basic mitigating strategies of converting to higher voltage or specific underground transmission designs which reduce EMF. The mitigating measures outlined above are applicable to all the alternatives with overhead transmission lines. The greatest potential reductions in EMF would result from double circuiting proposed new transmission lines wherever possible. The options for doing this are very limited since new transmission lines generally fill in missing links where transmission facilities do not presently exist. The location of more than one line on a single pole also expose more circuits to interruption if a automobile should strike a pole or a falling tree or lightning interrupt a segment. Delta designs can be used to reduce EMF on single circuit installations.

Elements of the various alternatives could be implemented for new transmission links. However, implementing short sections of underground transmission lines presents a number of operational complexities and higher cost to the utility. To be feasible, a section of underground transmission line would generally be installed from one substation to another. This would generally require expansion of the substation on each end and addition of oil pumping and cooling apparatus. Only a limited number of underground sections could be installed without causing significant power flow disruptions to the system due to the lower current carrying capacity of underground transmission lines. Undergrounding the proposed 230 kV Talbot to Sammamish transmission line would limit its capacity and limit its usefulness in fulfilling its function of providing an additional 230 kV source to the system.

Installing higher voltage 230 kV transmission lines could not be implemented for portions of the system smaller than an entire circuit from the Sammamish Substation to the Lakeside Substation. There are two such circuits in the existing system. This also would require the proposed upgrading of the Talbot to Lakeside transmission line to 230 kV to provide feed to the circuit from the south unless connection could be made to the existing Seattle City Light transmission line which currently serves regional transmission needs.

IV. COMMENTS ON DRAFT EIS AND RESPONSES

Summary of Comments Recieved and Responses

Comments

Letters

Janet Bannes
Neighborhood Utility Watch of Bellevue
Puget Power
Gelen E. Ross
Jack F. Martin

Public Hearing

Jim Nabor
Joseph Calmes
Norm Hansen
William Bricken

IV - SUMMARY OF COMMENTS RECEIVED AND RESPONSES TO COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

Comments on the Electrical Utility element Draft Environmental Impact Statement (Draft EIS) are summarized and responded to below. In most cases, similar comments made by more than one person and/or agency have only one response. The comments are grouped into General Comments and EIS topic headings.

General Comments:

1. **Comment:** A number of comments were received on the Draft EIS that relate primarily to the merits of the alternatives under consideration. The comments indicate whether the person prefers one alternative, policy option, or potential mitigating measure over another.

   Response: Where comments are related to the merits of alternatives or policies, or support or oppose a specific component of an alternative or policy, the comment has not been directly responded to in this Final Environmental Impact Statement (Final EIS). The purpose of the Draft Environmental Impact Statement is to analyze environmental impacts to be used by decision makers along with other relevant considerations. Where comments do not address areas where the analysis in the EIS may be inadequate or incorrect, where the methodology used in inappropriate, or where additional information is required response or revision is not required to provide information to the decision maker. (WAC 197-11-448, 550 and 560) Comments related to the merits of the proposal or to the desirability of specific elements of the proposal are included for consideration by the decision makers. Such comments are not directly relevant to the adequacy of the analysis in the EIS.

2. **Comment:** Puget Power made a number of comments which suggest minor rewording of specific statements in the EIS which are intended to clarify the description of impacts.

   Response: Where the proposed rewording does not add to the clarity of the statement in the EIS, or change the conclusions, a change has not been made.

3. **Comment:** Puget Power made comments which correct errors of fact or terminology.

   Response: Revisions have been made in an "Errata" section to correct errors. None of the corrections result in a change in the conclusions of the EIS.

Alternatives

4. **Comment:** Puget Power commented that the consideration of alternatives other than the plan which Puget Power has proposed is outside the scope of the mandate the City may prescribe through it's Comprehensive Plan.

Response: The proposed action is the adoption of policies and a plan map for the Electrical Utilities element of the Comprehensive Plan as required by the Growth Management Act. Those policies and map will guide the exercise of the City's regulation of construction of new facilities by Puget Power, primarily through the Conditional Use review of new projects. Specific policies in the Comprehensive Plan will guide decision makers in determining what facilities to approve in the future. The alternatives considered in the EIS are system alternatives that meet the overall objectives and which highlight various "tradeoffs" in environmental impacts which are also reflected in the policies of the proposed plan. As such, the alternatives include actions, such as avoiding new transmission corridors, increasing the voltage of transmission lines, underground transmission, and avoiding new substations which illustrate means of reducing impacts on specific elements of the environment. The consideration of the alternatives is consistent with WAC 197-11-440(5)(b) and WAC 197-11-442. The decision of whether to pursue such alternatives is dependent upon the corporate decisions of Puget Power in the permit applications it submits as well as the City of Bellevue in decisions on permit applications.

5. **Comment:** Puget Power commented that decisions on the types or voltages of facilities and the reliability standards are design criteria for the electric system and are service issues under the jurisdiction of the Washington Utilities and Transportation Commission.

Response: In general, local government has authority over the siting of utility services within it's jurisdiction. The local jurisdiction is also required to provide assurance of provision of adequate utility service for future population growth through the Growth Management Act mandated inclusion of a utilities element in the Comprehensive Plan. The Act requires the City to consider the location and capacity of utilty systems (RCW 36.70A.070(4)). The City is also required by the State Environmental Policy Act to attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences (RCW 43.21C.020). The City exercises this authority through decisions both on it's Comprehensive Plan and individual permit applications. The Washington Utilities and Transportation Commission (WUTC) has jurisdiction over the services, rates, facilities and practices of public utilities. Puget Power has not requested, nor has the WUTC approved or endorsed a particular facilities plan for providing service to Bellevue. No information has been provided to the City to indicate that the alternatives considered in the EIS conflict with any approval, order or regulation of the WUTC.

6. **Comment:** Puget Power commented that changes to Puget Power's reliability criteria require coordination with the Western Systems Coordinating Council.

Response: The Western Systems Coordinating Council is an industry association which coordinates various utility activities. The Council also may provide a consensus of industry opinion on what constitutes prudent utility practice which is directly applicable to Puget Power's decisions on reliability criteria for facilities which may affect the operation of other utilities through utility system interties. Puget Power's adherence to the agreements and protocols of the Wester Systems is unlikely to be affected by decisions on transmission and distribution system reliability at the local level addressed by this plan where Puget Power has the flexibility to respond to a variety of service and cost issues.

7. **Comment:** Puget Power commented that Map on page II-20 omits the existing transmission line which connects Center Substation to the Lakeside-South Bellevue transmission line segment.

Response: The Comprehensive Plan map is intended to show transmission lines in a conceptual schematic format. The map was changed in the March 5, 1993 Draft which is printed in this Final EIS.

8. **Comment:** Several comments requested an alternative which would underground new or rebuilt lines in the future.

Response: The Draft Environmental Impact Statement was designed to present a range of alternatives consistent with different approaches for an overall system for providing electrical service to Bellevue. It is possible to combine the basic transmission and distribution alternatives in a variety of permutations for mixed alternatives which conceivably could include some underground transmission lines, some 230 kV overhead transmission lines, and some 115 kV lines with increased capacity through larger wire size, any of which could be combined with distribution alternatives. The purpose of the Draft EIS in developing alternatives for consideration of Comprehensive Plan Policies is not furthered by developing a range of mixed alternatives. The potential for phased installation of underground transmission lines is discussed in the Draft EIS on pages II-6 and III-8.

Utility Service

9. **Comment:** Puget Power commented on pages I-5 and III-6 that Alternatives T-2 and T-3 would not affect reliability only if existing lines remained in service while new lines were built.

Response: Puget Power correctly identified an assumption in the Draft EIS analysis that prudent utility practice would dictate that existing lines would remain in service until new lines were constructed and in service.

10. **Comment:** Puget Power commented that the statement on page II-6 paragraph 3, referring to underground transmission "Replacement of sections of transmission line could be phased for installation in complete circuits." is not a true statement and should be deleted.

Response: The statement in the EIS refers to the necessity of replacement of sections of transmission line in units large enough to convert the voltage of the system to 230 kV in order to compensate for the power flow limitations of underground technology. This would necessitate the conversion of an entire section, or circuit, between major transmission substations with a 230 kV energy source.

11. **Comment:** Puget Power commented that the statement on page II-7 regarding an underground transmission system at a tighter grid proposed by Puget Power which reads: "Since Puget Power has not developed such underground systems, it is likely that such a system represents a worst case that could be modified considerably to eliminate redundant elements." is an unsubstantiated editorial comment.

Response: This evaluation is based on the professional opinion of the City's independent electrical transmission and distribution system consultant Marvin Klinger, P.E. It is based on a preliminary review of the scope of additional transmission line links assumed by Puget Power. The city included in the description of the underground system, the assumption that the system could be a grid similar to Alternative T-1 and also reported Puget Power's assumption of a tighter grid with additional transmission line links and milage. Puget Power, however, was not able to provide a specific conceptual plan. Based on evaluation of other systems utilizing underground transmission lines, it appears that some of the redundant facilities Puget Power has apparently assumed could be modified based on an analysis of specific system needs if that level of engineering analysis were to take place in the future.

Land Use and Aesthetics

12. **Comment:** Puget Power commented that without documentation, some of the conclusions in the Land Use section appear to be mere supposition and also commented that they support the DEIS's conclusions stated on page III-34.

Response: Puget Power has not identified the conclusions it labels as mere supposition. Absent disagreement with specific conclusions and given specific comments supporting the conclusions, changes in the text are not warranted.

13. **Comment:** Puget Power commented that the statement "Viewers engaged in recreation are generally the most sensitive to visual quality, followed by persons in residential areas..." is unsubstantiated.

Response: The statement is consistent with the conclusions of a large body of Visual Impact Assessment research which is referred to in the text. References specific to electrical transmission facilities can be found in the Bibliography in the Bonneville Power Administration publication "Substation Visual Simulation Techniques," September 1982.

14. **Comment:** Several comments requested additional consideration of the cost of alternatives and the effects of transmission lines on residential property values.

Response: Cost is not specifically addressed in the EIS and is not considered an element of the environment pursuant to RCW 43.21C.110(l)(f) and WAC 197-11-448. Cost and other considerations are anticipated to be taken into consideration by decision makers in addition to environmental impacts. Impacts on property values are not specifically considered in the EIS, as is stated on page III-12 although the same factors which affect land use may have a parallel impact on land values.

15. **Comment:** Puget Power commented that the use of telephoto lenses appears to make power poles appear closer together in Figures 3.10 and 3.13.

Response: The lens focal length used on the photos in the aesthetics section vary from 50mm to 100mm. The focal length of a lens affects the perception of depth and field of vision. The human eye has a normal field of vision approximately equivalent to a lens focal length of 85mm, although the scanning movement of the eye in human vision often results in a perception of a wider field of vision. The apparent distance between poles in Figure 3.10 is more a function of the angle from which the photo was taken, rather than the lens. Both Figures 3.10 and 3.13 were taken with a lens focal length setting of 85mm.

Human Health

16. **Comment:** A comment requested calculation of Electromagnetic Field (EMF) levels for the existing transmission system and the alternatives considered in the EIS.

Response: Information on EMF levels for key components of the transmission system are contained in revised text on page III-58 through III-58D and the accompanying table in this Final EIS.

17. **Comment:** A comment requested inclusion of studies on Electromagnetic Fields (EMF) recently completed in Sweden.

Response: The referenced Swedish studies are discussed in the Technical Appendix D at pages 28 and 29. The findings of these studies are similar to previous studies. The conclusions of epidemiology studies of EMF are discussed on pages III-38 to III-42 of the Draft EIS.

18. **Comment:** Several commentors requested that the Draft EIS text be changed on the one hand, to conclude that there is enough information to conclude that EMF is a significant health impact and on the other hand to conclude that there is no scientific basis to conclude that EMF exposure causes adverse human health effects.

Response: The Draft EIS text and the Technical Appendix D both summarize the existing state of scientific information on possible EMF effects on health. These findings are summarized in the Draft EIS on pages III-41, III-42 and III-45. In addition, the Draft EIS and Technical Appendix discuss risk assessment and options for addressing scientific and public perceptions of risk.

The SEPA rules address this situation in WAC 197-11-080(2) "When there are gaps in relevant information or scientific uncertainty concerning significant impacts, agencies shall make clear that such information is lacking or that substantial uncertainty exists."

WAC 197-11-800(3)(b) further states: "If information relevant to adverse impacts is important to the decision and the means to obtain it are speculative or not known; Then the agency shall weigh the need for the action with the severity of possible adverse impacts which would occur if the agency were to decide to proceed in the face of uncertainty. If the agency proceeds, it shall generally indicate in the appropriate environmental documents its *worst case* analysis and the likelihood of occurrence, to the extent this information can reasonably be developed (emphasis added).

19. **Comment:** Several commentors requested discussion of the conclusions of state and national regulatory bodies regarding the significance of EMF on human health and appropriate mitigating measures.

Response: The EIS does not attempt to provide an assessment of the current status of regulations regarding EMF. The purpose of the EIS is to provide information on environmental impacts. The EIS does contain discussion of a variety of mitigating measures and uncertainties associated with various mitigating strategies. The decisions of regulatory bodies necessarily includes the consideration of the general welfare, social, economic and other considerations that are outside of the scope of the environmental analysis required by the State Environmental Policy Act as provided in WAC 197-11-448 and RCW 43.21C.110(1)(f). Information on the decisions of regulatory regarding this issue certainly can be presented to decision makers in addition to information in the EIS.

20. **Comment:** Puget Power commented that if there is no scientific basis [to] conclude EMF causes adverse health effects, then there is no basis to require mitigation under SEPA.

Response: This issue is addressed in WAC 197-11-800(3)(b):

> "If information relevant to adverse impacts is important to the decision and the means to obtain it are speculative or not known; Then the agency shall weigh the need for the action with the severity of possible adverse impacts which would occur if the agency were to decide to proceed in the face of uncertainty. If the agency proceeds, it shall generally indicate in the appropriate environmental documents its *worst case* analysis and the likelihood of occurrence, to the extent this information can reasonably be developed (emphasis added).

Based on this direction, it is reasonable to address the potential impacts and potential mitigation.

21. **Comment:** Puget Power comments that it misleading to imply through the concept of "prudent

avoidance" that lowering EMF levels is a way to reduce potential health risks.

Response: The Draft EIS on page III-50 discusses the concept of prudent avoidance and on page III-51 addresses mitigation measures to reduce EMF levels. These mitigating strategies are based on reduction in exposure. The text on page III-51 states that "what might be considered safe in one situation might not be considered safe in another ... due to a change in what is considered safe over time ... or to slightly different circumstances."

RECEIVED
JAN 19 1993
DESIGN & DEVELOPMENT DEPT.

4604 137th Ave NE
Bellevue 98005
Jan 19. 1993.

To the Environmental Co-ordinator,

With regard to the Utilities EIS. I would like you to consider the following.

1. Although the effects of EMF are not yet fully understood, there is now a strong suspicion that they do infact adversely affect the health of those constantly exposed to them. With this in mind it would be unconscionable to increase this risk by increasing an EMF in the vicinity of homes - schools etc. 1
I wonder infact, if the utility & possibly the city could be subject to future law suits if the warnings are ignored & a future connection is made between EMF & cancer for instance.

2. "Prudent Avoidance" may have a technical definition in the report. But to the man on the street it means "if in doubt stay away" We should be foolish indeed to stand by & watch our homes "polluted" by increased (& yes even continued) EMF in our neighborhoods. 1

3. King Co. is passing ordinances regarding pollution of water from pet waste - mandatory bycycle helmet wear etc. EMF is much more important than any of these!

4. Page III 50 of the EIS states "In the end subjective judgements will determine public tolerance of the risk"
I can tell you that this has happened. - People are not willing to take the risk. "The Power Lines" are already affecting the desirability of our homes - many

people will not even consider looking at a house
near the power lines. Realtors will confirm that
prices have dropped already - so it will only get
worse as public awareness grows.

Transmission lines MUST be rendered completely 1
harmless - if this means under-grounding or increasing
the rates - so be it. You will find no opposition
from any thinking person weighing increased cost - against
the life & health of individuals.

The city of Bellevue has made a big fuss about
septic systems - which are ecologically a very sound concept
- & no-one has ever suggested they caused cancer - Yet
we have seen absolutely no leadership in the field
of EMF. - Please - start the ball moving in the
right direction!

Sincerely
Janet Barnes. (885-6431)

cc. Planning Com.

NEIGHBORHOOD UTILITY WATCH
of BELLEVUE

P.O. Box 70515
Bellevue, Washington 98007

January 19, 1993

Mr. David Sherrard
City of Bellevue
Post Office Box 90012
Bellevue, Washington 98009

Re: Comments on Draft Environmental Impact Statement - Comprehensive Plan Amendment - Utilities Element (Electrical Utility)

Dear Mr. Sherrard:

Members of NUWBELL have reviewed the draft Environmental Impact Statement and the technical appendices as referenced above.

We are concerned that the electromagnetic field (EMF) discussion in the draft Environmental Impact Statement is extremely generic and does not address the EMF levels in the present system nor in the proposed alternatives. While it is true that there are over 150 pages in the two volumes of the EIS devoted to EMF, the information is as applicable to Baltimore as it is to Bellevue.

The level of detail as to the EMF considerations in the four alternative proposals are limited to statements that indicate that T-1, the transmission alternative favored by Puget Power and Bellevue City staff, would have an EMF increase, while T-2 would have a decrease, T-3 would have the greatest increase, and T-4 would emit the lowest level EMF. There is a similar ranking for the distribution alternatives. However, without some quantification, those rankings are not very meaningful.

First, we need some baseline values for EMF in the present system, both in the transmission and distribution lines. The distribution lines are just as important as the transmission lines, because the strength of the EMF field is determined by the amperage in the lines, which may be as great or even greater in major distribution feeders than in the transmission lines. 16

The EIS should show what the ranges and medians of the EMF levels are on the present transmission lines, on the major distribution feeders and throughout typical neighborhood distribution systems. Computer modeling can be employed to give probable EMF levels throughout the system for each of the proposed alternatives. Without that type of quantification, trying to compare the various alternatives from the EMF point of view is almost meaningless. For instance, we do not know whether the anticipated increases in EMF associated with the T-1 alternative would be a 3% increase or a 300% increase.

The other aspect of the EMF impact which should be detailed is the differing number of living units and businesses which would be affected by EMF in the various alternative configurations. For instance, the information in the EIS regarding T-1 indicates that due to the grid system there would be more transmission lines and more people would be exposed to EMF. Again, without some quantification it is very difficult to make a value judgment as to the impact that may have on the citizens of Bellevue. A supplemental study should be performed to complete the missing information. 16

In September, 1992, which was apparently after the EMF portion of the draft EIS was completed, two major epidemiological studies were released in Sweden. As a result of these studies, Sweden has formally recognized an EMF-cancer link. Early reports of the studies have indicated that the studies have found a solid statistical correlation between EMF at levels of 3 mG and greater and substantially increased incidences of leukemia, especially in children. In the wake of this new development, the draft EIS should be amended to address those Swedish studies. 17

There are certain substantial noise levels associated with high voltage transmission lines and substations. The draft EIS has not dealt with this issue, which seems to be a serious oversight.

Very truly yours,

NEIGHBORHOOD UTILITY WATCH
OF BELLEVUE

Joseph C. Calmes
President

JCC/khs

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PUGET POWER

JAN 20 1993

January 20, 1993

Ms. Susan Sanchez
Environmental Coordinator
Design and Development Department
City of Bellevue
P.O. Box 90012
Bellevue, WA 98009-9012

Re: Comments on Comprehensive Plan Amendment Utilities Element DEIS

Dear Ms. Sanchez:

Thank you for the opportunity to comment on the Draft Environmental Impact Statement the City of Bellevue (the "City") has prepared in connection with the proposed amendment of its Comprehensive Plan Utilities Element. Puget Sound Power & Light Company ("Puget Power") is very interested in the City's amendment of the comprehensive plan and implementation of the Growth Management Act because our planned facilities are directly addressed.

The DEIS reflects thoughtful consideration of a number of complicated technical issues. In the spirit of cooperation and support for the City's effort, Puget Power has both general and technical comments on the DEIS. Submittal of the following comments, however, is not meant to imply an endorsement of the scope or analysis of the document. We have not made a comprehensive effort to bring to your attention misspellings, missing words, inconsistencies, or other typographical errors found in the text.

GENERAL COMMENTS

1. Design of the Electric System

As we stated in our scoping comments, we believe the discussion in the DEIS of postulated impacts of alternative hypothetical transmission and distribution systems, was not necessary. The City's alternative transmission and distribution systems, T-2, T-3, T-4, D-2, and D-3 require rebuilding most or all of Puget Power's system. Puget Power has not proposed to build any of these systems. **4**

[00000-0000/BA930210.008]

Nor would these alternatives be reasonable alternatives 4
to any facility improvements Puget Power has proposed or may
propose. The City may not mandate through its Comprehensive
Plan under GMA or through SEPA (under WAC 197-11-440(5)(b)),
that Puget Power rebuild its existing system to a different
voltage, capacity or configuration.

The City is not the proper body to be considering the 5
types or voltages of facilities Puget Power builds, what level
of service reliability and efficiency is appropriate, and what
costs are appropriate for our ratepayers to bear. These are
all issues which in effect are the design criteria for the
electric system. And as such, they are service issues that
are the jurisdiction of the Washington Utilities and
Transportation Commission (the "WUTC"). See, e.g., RCW
80.28.010(2) & (8); RCW 80.01.040(3); RCW 80.28.090, .110 &
.130; General Telephone v. Bothell, 105 Wn.2d 579 (1986).
Changes to Puget Power's reliability criteria also require
coordination with the Western Systems Coordinating Council
(industry association of utilities of the western United
States).

In particular, replacement of Puget Power's current 1
transmission system with underground facilities (as suggested
in the DEIS) is not a viable option. To begin, undergrounding
of 230 kV power lines in the same configuration as Puget
Power's planned system would not result in a system with
similar capacity. It would result in noticeable land use
impacts as streets and other areas are excavated for
installation of cable and additional sites are developed as
substations, switching stations and pumping stations. An
underground system would be immune from damage due to falling
tree limbs and car/pole crashes, but it would be subject to
equipment failure and damage from other excavation, which
could take months to repair as opposed to hours.
Undergrounding is extremely expensive, and provides no
electric service benefit. As the City is aware from, for
example, Arnold Tomac's October 13, 1992 letter to Susan
Sanchez (copy enclosed), the City's theoretical 230 kV
underground alternative would cost on the order of $560 to
$840 million, 20 to 25 times the $20 to $30 million cost of
completing the 115 kV grid system. These costs, moreover, do
not even consider the regional difficulties inherent in the
creation of a "City by City" utility system. To require it
would be asking ratepayers outside Bellevue to subsidize a

local non-electric amenity. It could result in very substantial rate increases for our Bellevue customers.

GMA allows the City to regulate where Puget Power builds facilities, as long as we can continue to reasonably serve our customers. WAC 197-11-442(4) provides:

> The EIS's discussion of alternatives for a comprehensive plan . . . shall be limited to a general discussion of the impacts of alternative proposals for policies contained in such plans, . . . and for implementation measures. . . . The EIS content may be limited to a discussion of alternatives which have been formally proposed or which are, while not formally proposed, reasonably related to the proposed action.

The DEIS addresses each of these issues, but also goes 1
further. The City's plan should describe the location and capacity of existing (and proposed) utilities--not consider theoretical replacements for Puget Power's existing system.

Puget Power's system plan is the reasonable way to ensure 1
reliable service to our Bellevue customers as it reflects the final build-out stage in the evolution of our transmission and distribution system in the Bellevue area. This planned configuration is typical of electric utility system development. A system begins with the construction of a single radial line to serve the initial electrical load. As additional areas and load are added, additional lines are added. The system continues to be operated as a radial system by maintaining normally open switches, even as its physical configuration begins to resemble a grid system. Finally, to provide reliable service to the most customers with minimum additional facility expansion, the grid is physically completed and the system is operated as a true grid. It is the completion of the grid system in Bellevue which Puget Power anticipates will be necessary to ensure continued reliable power service to our Bellevue customers.

2. EMF

a. EMF Conclusions (Public Health Section, p. I-9 and Part 3.3.6 "Summary")

The DEIS does not clearly state the consensus of the scientific community that there is no scientific basis to conclude EMF exposure causes adverse human health effects. The DEIS makes reference to numerous studies without providing the reader with clear sense of the relative significance of the studies or how they fit into the general body of scientific knowledge with respect to EMF. After reading the DEIS, readers may be left with the impression that it is only a matter of time until a cause-and-effect relationship between exposure to extremely low frequency EMF and adverse health affects is established. 18

However, the consensus of the scientific community, not summarized in the DEIS, is stated as one of the conclusions of Energetics' technical appendix--at page 108: 18

> Overall, the existence of various biological effects is of concern; however, **to conclude that these biological effects mean adverse health effects for humans is premature.** For example, many of the studies pointing to the existence of biological effects have not been confirmed by multiple investigators. **The types of studies that could link biological effects to adverse health effects have not been conducted.** In addition, the biophysical or biological mechanisms that would explain how EMF interacts with living systems to produce these biological effects are not understood.
>
> . . . .
>
> The body of scientific evidence regarding health effects from EMF exposure remains unclear. **While there are biological effects associated with exposure, there is no definitive indication that EMF exposure does or does not cause adverse human health effects.** Such a definitive indication may not be forth coming for several more years.

It is also important to note that biological effects are not necessarily harmful--they are just detectable biological changes (for example, an increase in temperature).

b. Risk Assessment (Part 3.3.7)

The EMF risk assessment discussion does not address the 19
numerous state and local governments that have undertaken thorough risk assessments of the subject matter and have consistently concluded that there is no public health basis to regulate low frequency magnetic field exposure. At the state level, the only "exceptions" are the states of New York and Florida. In both cases, the regulations promulgated are not based upon public health criteria (and permit normal operation of utility facilities). We think that, if the concept of "professional" versus "political" risk assessment is to be discussed, the document should acknowledge that the weight of authority (EPA, Washington State, etc.) is that no basis exists to regulate EMF exposure.

See, e.g., 1989 Washington Laws ch. 143 at 597; Electro-Magnetic Health Effects Committee (appointed by the Texas Public Utility Commission) "Health Effects of Exposure to Powerline-Frequency Electric and Magnetic Fields," (March 1992) at Section 1.1; Conn. Academy of Science & Eng., "Electromagnetic Field Health Effects," (April 1992) at pages 7, 9. In a report to the California State Legislature by the California Public Utilities Commission in cooperation with the state's Department of Health Services (CPUC/CDHS 1989), the Commission recommended no regulation to limit field exposure. The Commission summarized its position as follows:

> [N]ot only are we unsure a significant health 1
> problem exists, we also do no know what action would be protective of public health, even if we wanted to take immediate action on the chance that there is a problem.
>
> The obvious protective approach--reducing society's overall level of exposure to electric and magnetic fields--could, based on a reading of the available science, conceivably make any existing problem worse, not better. **For example, current scientific evidence suggests that there may be particular field strengths which activate biological field strengths which**

> **activate biological responses, while fields either below or above such strengths may cause little or no effects.** Regulatory actions aimed at reducing overall levels of exposure could therefore conceivably increase the number of people exposed to harmful fields.

Id. at p. C-21.

c. "EMF Mitigation" (Part 3.3.8)

Mitigation is defined by WAC 197-11-768 as avoiding, 20
minimizing, rectifying, reducing or eliminating, compensating for and/or monitoring an impact of a proposal. It has not been established that there are adverse impacts from EMF, nor is it clear that reducing EMF levels associated with electric transmission or distribution facilities would minimize, reduce or eliminate potential adverse health effects. If there is no scientific basis conclude EMF causes adverse health effects, then there is no basis to require mitigation under SEPA.

d. The DEIS Misuses "EMF Mitigation" to Mean "EMF Reduction"

"EMF Mitigation" as used in the DEIS is inherently 21
misleading. It is used to describe "prudent avoidance" and techniques to reduce EMF exposure. This implies that lowering EMF levels associated with electrical facilities is a way to reduce potential health risks, something the science does not support.

e. The DEIS Does Not Support "Prudent Avoidance"

The DEIS indicates staff's recommendation that policies 1
P-19 and P-20 proposed by the Citizen's Advisory Committee be deleted. The DEIS and Energetics' report both show that a policy of "prudent avoidance" cannot be supported on the basis of health or other environmental grounds. Common sense feelings that "more is worse" or that obvious sources of EMF (powerlines and substations) are "worse" are not supported by the available science. Puget Power can support reasonable efforts to design new facilities to reduce EMF consistent with cost and other good engineering practices, but this is a response to customer desires rather than public health criteria.

The DEIS suggests an even split between jurisdictions accepting and rejecting "prudent avoidance." This is not accurate. Colorado is one of a few states that has chosen to regulate in this area. The Colorado rule is not based on scientific criteria. The City's DEIS acknowledges the uncertainty that makes regulation unwarranted at pages I-13 and III-45 (for example), where the theory of EMF Windows is discussed. See also Energetics at page 101. Both the DEIS and Energetics' report also discuss the theory that biological effects may result from exposure to transient fields-fields that are turned on and off, such as those emanating from household appliances. (See DEIS at I-13 and III-45, Energetics at page 101.) Energetics states, and the EIS should reflect, that: 19

> Some research indicates that biological effects occur from exposure to transient fields. That is, fields that are turned off and on, such as those emanating from household appliances. . . . [As a regulatory matter,] you would not reduce the fields emanating from transmission lines if it were found that transient magnetic fields needed to be controlled. This is because there are almost no transient fields emanating from transmission lines.

It is for reasons such as these that a host of jurisdictions have refused to adopt or encourage the practice of "prudent avoidance". It leads to endless public debates, not based on any scientific criteria, as to what expense or other engineering compromise might be deemed "prudent". 1

Apart from the absence of scientific criteria supporting a prudent avoidance policy, it is not an appropriate policy for the City of Bellevue to adopt. The policy would influence decision making with respect to facilities which are multi-jurisdictional in nature. As such, the appropriate regulatory body (if any) to adopt such a policy is the Washington Utilities and Transportation Commission ("WUTC"). The WUTC, not the City, is the entity that determines what costs are appropriate for Puget Power's ratepayers to bear. 1

f. Undergrounding New Transmission Facilities in Bellevue Would not Fit the Prudent Avoidance Concept

The EIS should explicitly state what is clear from a detailed reading of the DEIS. In the context of potential system development in Bellevue, burial of transmission lines is highly unlikely, under normal circumstances based on the current science, to be justified if one were to apply a "prudent avoidance" policy. In Mr. Tomac's letter, as noted above, we provided a cost estimate for the City's "230 kV underground" alternative -- 20 to 25 times the cost of the 115 kV grid. The Energetics draft, at page 115, states (in an assertion apparently "adapted" from a 1992 Washington State Department of Health study) that "[t]he cost of implementing [a generic fluid filled steel pipe undergrounding 'option'] is six to seven times that of building a flat horizontal configuration." The cost differential between the transmission "Base Case" and "Underground Line - Fluid Filled Steel Pipe," shown at pp. III 53-54 of the DEIS, shows undergrounding as approximately 5.5 to 9 times as expensive as overhead installation. Even using the generic cost estimates in the DEIS (which might be significantly lower than those that would be entailed in a cost comparison of overhead/underground transmission facilities that might be built in Bellevue), the additional cost of undergrounding would not be a "reasonable or modest" cost to lower EMF levels, even without considering the capacity and other system implications associated with such a choice. 1

3. Land Use Impacts

The phrase "perceived impacts" in the discussion of potential land use impacts is inaccurate (see, e.g., the third full paragraph, p. III-12). The DEIS states that "land use impacts of transmission and distribution facilities are likely to be based on perceived aesthetic impacts of poles and wires, the perceived health impacts of electromagnetic fields and the perceived impacts of radio and television interference." (Emphasis added.) The discussion clearly indicates, however, that the true issue under discussion is whether residents or others viewing the electrical facilities will take action, based on their perceptions about electrical facilities, which cumulatively creates a real (not perceived) land use impact. 2

Where particular land use impacts are postulated, the 12
analysis is speculative. Per WAC 197-11-060(4) and 197-11-080, an EIS should discuss the direct, indirect, and cumulative impacts of Bellevue's proposal that are likely, not merely speculative, and should make clear where uncertainty exists. The DEIS does not reference research to support the "negative association" discussed. Without documentation, some of the conclusions appear to be mere supposition. Source documents, if any, should be referenced.

It would be unwarranted to conclude that there is any 1
reasonable likelihood that a significant adverse land use impact will result from negative community perceptions of Puget Power's electric transmission or distribution facilities (or the City's comprehensive plan policies applicable to such facilities), whether those facilities are constructed in open space, residential or other areas. For this reason, we support the DEIS's conclusion, stated at page III-34 of the DEIS, that "the presence of transmission lines and substations has not lead to a change in land use" and that "the evidence is that viable residential uses coexist with [and are compatible with] transmission lines and substations such as are included in [Puget Power's plan]." We believe (i) this conclusion should be explicitly stated at the beginning of the discussion and (ii) the DEIS summary of land use impacts should state the conclusion of the text that Puget Power's plan will not result in significant adverse land use impacts.

TECHNICAL COMMENTS

The following comments and suggested revisions do not 2
duplicate the general comments of the preceding section, although there may be some overlap. Nor are these specific comments comprehensive. We hope the format is helpful to the City in preparing its Final EIS.

Page i, para 7. "This would require the rebuilding of 2
approximately...<u>36</u> miles of transmission lines and 14 distribution substations." Comment--See page II-6.

Page ii, para 4. Comment--Alternative D-2 would <u>not</u>
reduce the number of substations, rather the service 2
area of existing substations would be enlarged.

Page ii, para 4. "No new distribution substations 2
would be needed, but <u>16</u> existing substations would need

to be rebuilt and/or expanded." Comment--See p. II-7 and 8.

Page ii, para 5. "Under this alternative, the capacity of approximately 12 substations would be increased from 25 MVA to 50 MVA configurations with <u>the construction of new 12 kV</u> distribution lines...<u>and the installation of additional transformers</u>. Comment--Rather than replace the transformers in Alternative D-2, Alternative D-3 requires the addition of transformers to handle the additional cables. 2

Page I-1, para 3. "Although they are physically electrically connected, any of the transmission alternatives are <u>technically</u> compatible with any of the distribution alternatives, and vice versa." 2

Page I-2, para 1. "As a comparison, <u>the voltage of</u> household...<u>power is</u> 110 volts. 2

Page I-2, para 2. "This would require rebuilding... approximately <u>36</u> miles of existing transmission lines and 14 distribution substations." Comment--Per the description of Alternative T-3 on p. II-6, it is this alternative which requires two thirds of the existing transmission lines to be rebuilt, not Alternative T-2. 2

Page I-3, para 3. "(MVA stands for...<u>Megavoltamperes</u> and is a measure of the rate at which electricity is delivered.)" 2

Page I-3, para 4. "No new distribution substations would be needed, but <u>16</u> existing substations would need to be rebuilt and expanded to step down...the transmission voltage to 34 kV." Comment--See p. II-7 and 8. 2

Page I-3, para 5. "Substation expansions under this alternative would differ from those associated with Alternative D-2 in that rather than ...<u>replacing</u> transformers to handle different voltages, additional transformers would need to be added to handle more wires of the same voltage." Comment--See correction page ii, para 5. 2

Page I-4, para 3. Comment--The statement that Alternative T-4, among the four transmission system alternatives, provides the best performance for utility service reliability, has the least land use impact, and has the greatest potential for reduction of exposure to EMF is misleading. This alternative does have higher operating reliability, so customers should experience fewer outages than any of the other transmission system alternatives. However, should there be a fault in one of the underground lines, customers could experience a loss of power significantly longer than any of the other three transmission system alternatives. As described on p. II-6, "all existing transmission lines would have to be replaced with underground lines." This re-construction of the existing 36 miles of transmission lines within the city limits, even if phased over several years, would disrupt Bellevue neighborhoods. This land use impact would be significantly greater than the construction involved in the other transmission alternatives. 2

Page I-4, para 6. Comment--The first two paragraphs in the section, Comparison of Transmission Alternatives, discuss two separate issues. It is suggested that they be split into two paragraphs: one addressing system capacity and the other addressing operational reliability. Suggested replacement language for these two paragraphs follows. Appropriate language for comparison of the alternatives is also presented. 2

"System Capacity: The way the electrical system is designed is directly related to the criteria which determines the extent of redundant or "backup" facilities needed. Puget Power, like most companies in the electric utility industry, designs and operates its system to achieve economical and reliable delivery of service to customers. Capacity is often measured by an operating criteria commonly referred to as "N-1." What this means is that if total system consists of "N" elements, the system would still have the capacity to serve all the electric load, even with the loss of one of the system elements. These system elements are electrical components such as switches, transformers, transmission lines, and circuit breakers."

"All of the transmission alternatives could be designed to an "N-1" capacity standard. That is, all of the alternatives would be designed such that any one element could be taken out of service and still maintain service to customers."

"Operational Reliability: Operational reliability refers to the power outages experienced by customers due to system component failures. These outages are temporary, lasting from minutes to hours (or longer). Outages remain until the failed system component is identified, isolated from the rest of the system, and power re-routed through remaining components restoring service to customers.

"Each of the alternatives vary significantly in terms of the operational reliability to customers, if all would be designed to an "N-1" capacity standard. Alternatives T-1 and T-4 both would offer high operational reliability due to the fact that any single system element failure affects fewer customers than Alternatives T-2 or T-3. Customers would experience more outages from T-1 than T-4, but outages from T-4 could last significantly longer than those under T-1. Alternative T-2 and T-3 offer lower operational reliability because any single element failure affects many more customers than with Alternatives T-1 and T-4. In addition, transmission line outages with T-2 and T-3 would be longer than with T-1, due to the longer length of transmission line that would need to be patrolled in these alternatives."

Page I-4, para 8. Per the comments immediately stated above, the text in this paragraph should be modified as follows. **2**

"...In situations such as particularly heavy storm events, it is not unusual for more than one facility on a system to go down, resulting in service losses for... customers. In comparing the alternatives when such service losses do occur, Alternative T-4 Underground Transmission would be the most reliable because it is less subject to failure due to the primary causes of outages for overhead lines such as trees and lightning strikes. It would be more reliable if built in a denser grid because...fewer customers would be affected by any one element failure. The next reliable would be T-1 Overhead Grid....Because of the grid, any outage would affect fewer end users because the system is broken into smaller units......"

Page I-5, para 2. Comment--The statement, "each of the alternatives could be built without affecting reliability" during the construction of the new system is misleading. Construction of power lines and substations requires momentary, and sometimes lengthy, power outages. Depending on the existing system capacity design criteria and the nature of the construction activities, these outages may or may not be experienced by customers. But, should an unplanned outage occur to a system simultaneously as a planned construction outage, customers on an N-1 design system will experience power interruption. Depending of the transmission system alternative, a greater or lesser number of customers could experience planned construction outages or combined planned/unplanned outages. 2

The only way that the construction of Alternatives T-2 or T-3 would not affect reliability would be for the rebuilt" lines to be new lines on new routes to allow the existing lines to remain in service while the replacement lines are built. This is not anticipated in the alternative description, thus significant reductions in reliability would occur for Alternatives T-2 and T-3 during construction. 9

Page I-5, para 3. "In terms of the regional power system, the primary issue relating to the transmission system in the Greater Bellevue Area is that of north/south power flow through the system. In other words, the ability for power...to flow....from one region to another relatively unimpeded is one aspect of system function that concerns power planners. It is very important that the transmission system must meet regional as well as local needs. In the case of a regional transmission failure, the grid system under Alternatives T-1 and T-4 would establish multiple paths through the system, "pass through" power would be split on many lines, reducing the impact and operational dependence on any one line....It would be best, because the capacity of overhead transmission lines are greater 2 than the capacity of underground transmission lines. T-2 and T-3, which are radial, do not readily accommodate north/south pass-through power. The exact needs of north/south pass-through power in the future, however, are not specifically known. Any changes to the existing system, however, would need to accommodate the regional needs as well.

Page I-6, para 5. "Alternative D-1 and...D-3 would involve less disruption to the system during the transition to the new system, because they would utilize the existing 12 kV distribution system. 3
Comment--Alternative D-2 requires the conversion of the existing 12 kV facilities to 34 kV and would be very disruptive to the system reliability during construction (see p. III-9). 9

Page I-10, para 2. Comment--Statements concerning EMF from Alternative D-1 relating to the development of additional substations are misleading. EMF levels are related to current and not substation equipment configuration. 2

Page II-2, para 3. "In thinking about how these alternatives would function, it is important to note that although they are electrically connected, any of the transmission alternatives are technically compatible with any of the distribution alternatives, and vice versa." 2

Page II-2, para 4. "The system that Puget Power...plans to construct approximates the transmission system discussed under Alternative T-1, below, and the distribution system discussed under Alternative D-1, below." 2

Page II-6, para 3. "Replacement of sections of transmission line could be phased for installation in complete circuits" is not a true statement and should be deleted. 10

"All existing transmission lines would have to be replaced with underground lines. All distribution substations would have to be rebuilt with a high side operation at 230 kV. And to accommodate underground transmission, the Sammamish and...Talbot transmission 2 substations and the Lakeside switching station would need to be expanded to accommodate underground lines. In addition, some pumping stations for cooling oil would be required at or between substations.

"Since Puget Power has not developed such underground systems (Alternative T-4), it is likely that such a system represents a worst case that could be modified considerably to eliminate redundant elements." Comment--This statement is an unsubstantiated editorial comment. 11

Page II-8, para 3. "Substation expansions under this alternative would differ from those associated with Alternative D-2 in that, rather than...replacing 12 kV transformers with 34 kV transformers to handle different voltages, additional transformers would need to be added to handle more feeders of the same voltage." Comment-- See correction page ii, para 5. 3

Page II-20, map. The Electric Transmission Facilities Map omits the existing transmission line which connects Center Substation to the Lakeside-South Bellevue transmission line segment. 7

Comment--The Growth Management Act requires the adoption of an Utilities Element and a map of electric transmission facilities as part of its Utilities Element. The inclusion of a map of electric facilities is a new component in a comprehensive plan and perhaps deserves an explanation of its use in the comprehensive plan utilities element.

It is Puget Power's understanding that the purpose of the electric facilities map is to indicate the general location and capacity of existing and proposed facilities. The actual location of facilities, as proposed or as permitted, may differ from the general locations conceptually shown on the electric facilities map. Adoption of the map with the goals and policies denotes consistency between these two components of the Utilities Element as well as the other elements of the comprehensive plan. Both the map, and the goals and policies, will guide the City's permit review for electric facilities proposed in the future. Permitted facilities should be consistent with the map and the goals and policies.

Page III-1, para 2. "The major portion of the generation serving Puget Power is provided by hydroelectric power purchased from...central Washington public utility districts who own dams on the Columbia River and from coal-fired generating plants." Comment-Puget Power purchases little power directly from the Bonneville Power Administration. 3

Page III-2, para 2. Comment--As discussed above (referring to p. I-4, para 6), this section of the DEIS mixes discussions of system capacity criteria and operational reliability. Appropriate changes should be made to the text. 2

Page III-2, para 2. "In addition, Puget Power does not attempt to meet the N-1 criteria in extreme peak demand periods." 2

Page III-2, para 2. "This excludes the extreme peak demand periods for electrical heating in the winter and air conditioning in the summer." 2

Page III-2, para 2. "For example, if a given power line containing five distribution substations and connected to two transmission substations (one at each end),...a single break in that line ...would cause customers served by that line to lose power until the break is isolated and service restored by switching power from the other end of the line. 2

Page III-3, para 1. "Generally, when a fault occurs, the entire affected section of line will be automatically shut down by circuit breakers at X...or Y." 2

Page III-3, para 2. "Under such conditions, demand could not be met for all five substations from either "X" or "Y" with a transmission ...line capacity of 110 MVA....In such a situation, the 110...MVA capacity of the line would be sufficient only for 4 of the 5 substations." 3

Page III-3, para 3. "The 110...MVA transmission ...line would be able to adequately handle such an outage at any time other than peak or during the peak if the outage occurred anywhere else on the line." 3

Page III-3, para 4. "One of the policy questions that decision-makers could consider is whether this...capacity criteria justifies the economic or environmental costs associated with building systems to meet these standards, or whether putting up with less reliability is a reasonable price to pay for fewer electrical facilities. Page III-3, para 4. Comment--The decision-makers referred to in this paragraph cannot solely be local decision-makers. Rather, questions regarding reliability are primarily decided by those of the Washington Utilities and Transportation Commission. Changes in Puget Power's reliability deign criteria also must be reviewed with the Western States Coordinating Council. 6

Page III-4, para 2. "Consider the following graphic of the radial system discussed earlier, but with grid connections added and the normally open switches closed." Comment--The graphic is representative of Alternative T-1. 2

Page III-5, para 2. Comment--The development of Alternative T-4 is conceptual and may not meet a strict design criteria of "N-1" or "N-2" capacity. 2

Page III-5, para 3. Comment--It is true that all of the alternatives could be designed to an "N-1" (capacity) standard. The reliability of service as measured by number, length, and impact of customer outages, however, would differ significantly between the various transmission system alternatives. Alternatives T-1 and T-4 would offer higher operational reliability than Alternatives T-2 and T-3. Customers under Alternative T-1 would experience more outages than T-4, but outages from T-4 could last significantly longer than T-1. Under Alternatives T-2 and T-3, more customers would be affected by any single outage and outages would likely be longer than under T-1 due to the increased time needed to patrol the longer transmission lines. 2

Page III-5, para 4. Comment--It is incorrect to state 2
that "each of the alternatives does vary in the potential for providing greater than N-1 service." N-1 is a design capacity criteria, not a measure of capability to provide reliable service to customers. A system either meets an N-1 or N-2 design criteria, or it does not. It cannot provide "greater than N-1 service." Delete this sentence. Furthermore, the discussion in this paragraph primarily speaks to the reliability during storms and a subheading to that effect would be helpful to the reader.

"It would be more reliable if the system were built in 2
a denser grid...as fewer customers would be affected by any one element failure in the system. The next reliable system would be T-1...An outage within a grid system would affect fewer end users as the system is broken into smaller units."

Page III-6, para 2. "In terms of the reliability of
the system during construction of new or expanded 2
facilities, there is a significant difference between alternatives...Alternative T-1...(cont.)..." Comment--The only way that Alternative T-2 and T-3 would not affect reliability would be for the "rebuilt" lines to be new lines on new routes to allow the existing lines to remain in service while the replacement lines are being built. This is not anticipated in the alternative description.

Page III-6, para 3. "The primary challenge that would
occur with this alternative would be a result of having 9
to rebuild the transmission lines to handle the higher currents and the "high side" of distribution substations to handle these current that is the basis of this alternative."

Page III-6, para 5. Comment--This section of the text 2
should be modified per comments stated above for page I-5, para 5.

Page III-7, para 3. "In terms of the flexibility of the system to handle loads greater than 680 MVA (if and when project growth is exceeded), all alternatives other than the underground alternative (T-4) could ultimately be converted to a 230 kV grid configuration,

<u>although for T-3, the system effectively would be rebuilt twice in accomplishing such a conversion</u>. Under Alternative T-1, Overhead Grid,...any expansions...would consist of converting this grid system to a 230 kV configuration."

Page III-16, para 5. "Viewers engaged in recreation are generally the most sensitive to visual quality, followed by persons in residential areas" is an unsubstantiated subjective statement. 13

Page III-17 through III-26. Comment--Several of the photographs in Section III have apparently been taken with telephoto lens. The use of this type of camera distorts the distances between objects, making the power poles appear much closer together than they actually are. This distortion is especially true in Figures 3.10 (p. III-21) and 3.13 (p. III-24). 15

Page III-25, para 2. The statement, "options to mitigate the visual appearance of substations include enclosing all or some of the equipment in structures" should be expanded to included vegetation screening and other landscaping elements such as fencing or berming. 2

Page III-58, para 5. "It is likely that a higher incidence of transient fields would be expected. However, the implications of transient fields are unknown." These statements are not justified comments referring to Alternative D-1 considering "transient fields have not been well defined, and the characteristics of transients from appliances and other sources are not fully understood" (see p. III-45). 2

Thank you again for the opportunity to comment on the City's Comprehensive Plan Utilities Element Draft EIS. We will continue to offer our assistance to City's citizens, staff, and officials toward the adoption of the Utilities Element. We are confident that this effort will lead to a utilities element in which the City's vision of growth management is compatible with Puget Power's public service obligations.

Sincerely

Betsy J. Minden, AICP
Environmental Scientist

Attachment
cc: Leonard McGhee
    Rita Perstac

[00000-0000/BA930210.008]

4421 137th Ave. NE
Bellevue, Wa. 98005
January 20, 1993

The Planning Commission
City of Bellevue
Bellevue, Wa.

Dear Members:

I am concerned about the "Utilities Element" of the Bellevue Comprehensive Plan Amendment. I believe two of the staff modifications to the CAC recommendations regarding city policy must be rejected. "Safe" must be the highest priority criterion for any utility equipment, and "environmentally sensitive" should have equal weight with "greatest reliability" and "lower cost". It would be rash to delete the CAC recommendation that schools and residential areas should be avoided in siting new substations and transmission lines. 1

It might be a major mistake to allow new above ground transmission lines anywhere at this time.

My husband's and my son, Donald, who grew up by the power line, was diagnosed with bone cancer at eighteen in 1983. Seven difficult years later he died. I have no idea whether EMF's were a factor. I do know that about a year ago his oncologist at the Tumor Institute in Seattle told me that there was enough evidence in medical literature linking EMF's and childhood leukemia that he would move if he lived with children near a power station.

"Annals of Radiation The Cancer at Slater School," by Paul Broderur, appears in the December 7 1992, issue of "The New Yorker," pages 86-119. It's purpose is to expose a suspected coverup by the EPA, but I mention it because it refers to several recent studies (including one from The Fred Hutchison Cancer Research Center). They are more recent than those cited in the EIS.

Early studies on any medical subject seem to involve small numbers of people and to raise questions ~~the~~ rather than give answers. Research from different parts of the world with much larger samples always follows. We seem to be at that stage now with questions of EMF's relationship to cancers and other diseases. Let our policy encourage Caution and restraint. Let's hold off building new above ground transmission lines or putting schools under existing ones until we get some answers. It wont be long. 1

Yours truly,

Helen E. Ross

January 25, 1993

RECEIVED
JAN 26 1993
DESIGN & DEVELOPMENT

Ms. Susan Sanchez
Design & Development Dept.
City of Bellevue
11511 Main Street
Bellevue, WA. 98004

Re: City of Bellevue GMA Draft EIS

Dear Susan:

I must apologize for my delay in responding formily in regards to the EIS in preparation by the City. Storm damage and power played havic with our family.

As you are aware I most recently served as the chairman of the CAC for the Utilities Element and was a former member of the most recent Comprehensive Plan Review for the Bridal Trails subarea. But, my comments for the EIS are written on behalf of my family and myself and are my personal observations and opinions.

My main concern is the health and welfare of the citizens of Bellevue. In regards to health, electro-magnetic forces(EMF) is my primary concern on how it will be monitored and regulated. While we do not know everything about the effects of EMF my readings tell me we need to concern ourselves with the health and welfare of our citizens both adult and most definitely children.

If we can adopt a policy of prudent avoidance(see attached definition) and keep in mind the siting of power lines, substations and electrical equipment in the home we can prevent, reduce and minimize EMF exposures to the citizens of Bellevue. The CAC worked for a year to develop and propose good policy. In addition, the Planning Commission took one step further in proposing adoption of the Public Utilities Commission of the State of Colorado policy concerning prudent avoidance (see attached). 1

Now is the time for us to inact good policy and guidelines to place the engineering and design of electrical components to minimize its health effects on the public. We may only be in the early stages on learning

JANURAY 25, 1993
MS. SUSAN SANCHEZ
PAGE 2

HEALTH RISKS OF ELECTRICAL SYSTEMS BUT WE CAN INITIATE POLICY THAT CAN WORK WITH THE UTILITIES TO INSURE PRUDENT AVOIDANCE OF ANY PROBLEMS. WE SHOULD ALSO LOOK TO INSURE THAT THESE POLICIES ARE REVIEWED AGAIN IN ANOTHER FIVE YEARS WHEN WE MAY KNOW SIGNIFICANTLY MORE ABOUT EMF AND ITS HEALTH RISKS. THANK YOU FOR YOUR WORK WITH THE CAC AND THE EIS.

SINCERELY,

JACK F. MARTIN
13838 NE 48TH PLACE
BELLEVUE, WA. 98005

(Decision No. C92-1381)

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF COLORADO

* * *

IN THE MATTER OF THE RULES FOR ELECTRIC UTILITIES OF THE COLORADO PUBLIC UTILITIES COMMISSION, 4 CODE OF COLORADO REGULATION-723-3 CONCERNING ELECTRIC AND MAGNETIC FIELDS	)	DOCKET NO. 92R-259E

Effective Date: November 30, 1992
Publication Date: November 10, 1992

STATEMENT OF ADOPTION

EXCERPT

THEREFORE, THE COMMISSION ORDERS THAT:

1. The Commission's Electric Service rules are modified to add the following language:

Rule 18 (i):

The utility shall include the concept of prudent avoidance with respect to planning, siting, construction, and operation of transmission facilities. Prudent avoidance shall mean the striking of a reasonable balance between the potential health effects of exposure to magnetic fields and the cost and impacts of mitigation of such exposure, by taking steps to reduce the exposure at reasonable or modest cost. Such steps might include, but are not limited to: (1) Design alternatives considering the spatial arrangement of phasing of conductors; (2) Routing lines to limit exposures to areas of concentrated population and group facilities such as schools and hospitals; (3) Installing higher structures; (4) Widening right of way corridors; and (5) Burial of lines.

Rule 18 (j)

With respect to transmission facilities, the applicant shall describe those actions and techniques being evaluated pursuant to the requirements of Section (i) of this Rule 18.

2. This Rule will be effective on November 30, 1992, following publication by the Colorado Secretary of State, in the Colorado Register on November 10, 1992.

CITY OF BELLEVUE
PUBLIC HEARING - ELECTRIC UTILITIES ELEMENT
COMPREHENSIVE PLAN

January 14, 1993

SANCHEZ: Today is January 14 and we are opening the public hearing on the draft EIS for the Utilities Element of the Comprehensive Plan, Bellevue City Hall, Council Conference Room at 5:05 p.m. I'm Susan Sanchez. I'm the Environmental Coordinator for the City of Bellevue, and with me is David Sherrard, Senior Environmental Planner in the Design and Development Department. David and I will be sharing the responsibility of chair for the hearing. The purpose of this public hearing is an opportunity for public comment on the EIS.

I have a few announcements to make and we will also be discussing the process for the EIS. This draft EIS is available in public libraries, the Department of Design and Development, and it can also be purchased at City Hall in the Cashier's office during normal business hours. This evening there is a copy available in the room with the hearing and copies may also be purchased in the lobby. Written comments may be submitted in addition to or instead of providing testimony. Comments are to be provided to the Environmental Coordinator by January 20, 1993. The purpose of this EIS is to meet State Environmental Policy Act requirements, or SEPA. SEPA assures that decision makers are able to consider environmental impacts prior to making decisions.

The objective of this proposal is to create a list and schematic system map of necessary electrical transmission and distribution facilities and related policies to guide provision of adequate electrical power to meet the needs of projected growth and fulfill the mandate of the Growth Management Act. The alternatives considered in the EIS include a No Action Alternative, four Transmission Alternatives and three Distribution Alternatives. The process for the EIS includes taking written comments and oral comments tonight. Those comments will be responded to in the final EIS. The Bellevue Planning Commission will hold a public hearing on the proposed policies and plan on February 17. They will have the benefit of the Environmental Impact Statement prior to taking action this spring, and the Bellevue City Council is expected to take action on the proposal by spring. At this point, I will stop the tape because there are no speakers present.

SHERRARD: This is David Sherrard acting as hearing officer for the public hearing on the Electric Utilities Draft EIS. It is approximately 6:50. Before you start your testimony, I would appreciate it if you would give your name and address into the record. Also, just as an introduction, I would like to point out that this is a public hearing on the Environmental Impact Statement and the purpose of comments on the EIS are to assure that the EIS is complete and provides an adequate record of the environmental impacts of this proposal. In addition to this hearing which is focused on the EIS, there will be a hearing before the City Planning Commission on the specifics of the proposed polices, map and other aspects of the Electrical Utilities Element.

NABOR: My name is Jim Nabor and we are six year residents of the Bellevue area. I am addressing the Environmental Coordinator and staff, as I understand it. I have reviewed portions of the draft EIS for the electrical utilities element of the comprehensive plan.

If you would note in there Puget's own numbers and through the text of the report, there are basically 50 miles of Puget Power and Seattle City Light transmission lines in a 32 square mile area known as Bellevue. If you're familiar with some of the residential areas, you find this number of 50 linear miles of transmission lines per 32 square miles to be quite high. I've looked around and it is almost impossible to find any other residential area which has this kind of concentration of transmission lines. Clearly, 50 miles of transmission lines presents unique service, health, economics, and aesthetic and reliability issues for the city. One alternative for addressing these issues is to underground new transmission lines, and if a careful study is performed, they will address each one of these issues in a positive way.

Unfortunately, in my review of the draft EIS I have found that you dismiss 8
undergrounding with a one paragraph type of statement. My feeling is
that undergrounding should be addressed in the EIS as a viable
alternative, particularly for new and upgraded facilities. One of the
reasons that I've found that undergrounding has been dismissed is because
of cost. Puget claims that this is too costly. However, I find this to be a
one-sided issue. No consideration is given to the residential property 14
values and depreciation of these values which border these transmission
lines. I'm speaking here of residential property. And, if you do a simple
calculation, and you estimate that there is a 10% decrease in depreciation
values of property that runs along those transmission lines, it is not hard
to come up with a dollar value of $2 million per mile -- that property
values have decreased due to the presence of transmission lines.

There has been a lot of discussion in the past about whether or not transmission lines affect residential property and in our neighborhood it is clear, through a number of recent cases, where it is now impacting property values. The people who have had their homes recently refinanced have found that they had to have two appraisals because the first appraisal was not believed when the presence of the transmission lines was found. There was one case in our neighborhood where a woman was trying to sell her home and it took her over a year. She had to drop the property value. She even had Puget Power come in to try and defend their case that there was no problem with the transmission lines. Clearly, in those cases, the presence of transmission lines has affected the property values.

Again, if you take this value and you simply calculate that when you put a transmission line in you drop the property value something like $2 million per mile -- I could run through that calculation for you. This loss is actually small compared with any capital cost that Puget may have to put up to either put in new or upgrade transmission lines. In reality, when you consider all the parties, cost is not a practical consideration -- in worrying about putting in transmission lines. I request that the city 8
include an additional transmission alternate in the EIS, and in this alternate, you consider the undergrounding of new and upgraded transmission lines.

I have a second issue with the EIS. The EIS technical appendix which appeared on page 12, item 2, as far as I am concerned, has to be corrected. The impression is given that the Lakeside to Sammamish transmission line 3
and upgrade is presently in permit review by the city. This is not true, according to city sources. Puget Power still has to apply for a permit and, from what I understand, it is not in permit review and I would appreciate that comment being corrected in the EIS. The final comment I have has to do with -- I don't understand the mechanisms of how the utility element comprehensive plan gets into the EIS, but clearly, the document that was addressed at last night's Planning Commission, I would like to see that document as part of the EIS. Right now there seems to be a disconnect and I'm not sure how that gets coordinated. That is the extent of my comments and thanks for your time.

SHERRARD: Thank you Mr. Nabor. Would you mind giving your address just so we have it on the record?

NABOR; 13600 NE 48th Place, Bellevue.

SHERRARD: In the absence of additional people signed up to testify, I'm going to turn off the recorder. It is approximately 7:00 p.m. and we will turn it on again when we have additional testimony.

CALMES: I'm Joseph Calmes. I reside at 13812 NE 40th, Bellevue. I'm President of an organization known as Neighborhood Utility Watch of Bellevue. We've reviewed the draft EIS and our criticism of the draft EIS primarily centers on what we consider to be a superficial treatment of the EMF issue. While it is true that there are over 150 pages in the 2 volumes devoted to EMF, the discussions are very generic. They could have been used in Baltimore as well as Bellevue. There is nothing concrete and specific which addresses the EMF levels in the present system nor in the proposed alternatives.

In the section dealing with the transmission alternatives, the draft EIS does say that T-3 would have the greatest increase in EMF while T-1, which is the alternative that Puget and the staff prefer, would have an EMF increase. T-3 would have a decrease and T-4 would have the lowest level of EMF. A similar ranking is given to the distribution alternatives. However, without some quantification, those ratings are not very meaningful.

First, we need to establish some baseline values for EMF in the present system -- both in the transmission and distribution portions of the system. We should know what the ranges and medians of the EMF levels are on the present transmission lines, on the major distribution feeders, and throughout typical neighborhood distribution systems. Computer modeling should be employed to give probable EMF levels throughout the system for each of the alternatives. Without that type of quantification, trying to compare the various alternatives from and EMF point of view, is almost meaningless. For instance, we do not know whether the anticipated increases in EMF associated with T-1 would be a 3% increase or a 300% increase. 16

The other aspect of EMF which should be detailed is the differing number of living units and businesses which would be affected by EMF in the various alternative configurations of the transmission and distribution systems. T-1 indicates that, due to the grid system, there would be more transmission lines and more people would be exposed to EMF. Again, without some quantification, it is difficult to make a value judgement as to the impact that T-1 may have on the citizens of Bellevue. We need to know if it would be 3% increase or 300% increase in the number of people affected. A supplemental study should be performed to complete the information.

Our other criticism is that in September 1992, which is apparently after the EMF portion of the draft EIS was completed, two major epi- 17 demiological studies were released in Sweden. As a result of those studies, Sweden became the first country to formally recognize and EMF-cancer link. Those studies found a solid statistical correlation between EMF at levels of 3 milligauss or greater and substantially increased incidence of leukemia, especially in children. In the wake of this new development, the draft EIS should be amended to address it.

Thank you.

SANCHEZ: Thank you for your comments. The time is now approximately 7:15 and I will turn off the tape until there is another speaker.

SANCHEZ: The time is now approximately 8:05 p.m. Please give us your name and address, to begin with. Thank you.

HANSEN: My name is Norm Hansen. I live at 3851 136th Ave. NE in Bellevue. I live near Bridle Trails State Park and on my property there is the easement for the transmission line from Sammamish to Lakeside. Currently there are 215 volt lines there and there is a project which Puget Power has to change the configuration of those two lines which would locate both transmission lines on a single monopole steel pole, which would be good, at approximately the mid point of the easement which is now 100 ft. On one side would be 230, on the west side, and 115 would remain on the east side until such time as the loads were great enough that they would include that also as a 230. This would probably go on at least until 2000 -- that configuration. And, with that configuration the discussions I've had with Arnold Tomac and Jim Kearnes from Puget Power, is that the edge of the easement, by continuing with the 230/115 situation that the EMF at the edge of the easement, would actually go up. We have some charts that show that. I think they were given to the city in 1991. It's based on the average yearly load of the power requirements and is projected out through the year 2000.

I'm particularly concerned about the EMF, even though there is no proven case. Puget Power did come out and measure it in my home about 25 ft. from the edge of the easement. There are other homes in that area that are similarly placed. In the upstairs, which is closer to the line, it was 11 when they measured it. Downstairs in the kitchen it was 8 and as you go to the living room it goes down to 4. So there is a dropoff and by the time you get out into the street it's about 2.

Particularly what I'm interested in is how the city will view this new

project in terms of the comprehensive plan in applying any principal of
prudent avoidance. I would hope that the city would require the new 1
combined installation of have lower, not higher, EMF, even if it's only
incremental. I know there is going to be another planning process to do
this, but I'm interested in how the city would view that.

The other issue that I want to talk about is undergrounding. I've been
told by the same Puget Power people that if these two lines were under-
grounded there would be virtually no EMF. They would be able to cancel
it by placing it 4 or 5 feet underground with oil field cable. It seems to
me from listening to the discussions of the Planning Commission, that
there has been an extreme -- I think that cost has been used as an excuse
for not undergrounding. I think that actual costs should really be obtained 14
from other projects that have been successful, especially recent ones. I've
heard that they're done a lot of undergrounding in Boston, and I've heard
that they're done 100 miles of undergrounding of transmission lines -- high
voltage transmission lines --. Maybe they've done some in Seattle. I'd like
to see the city address or develop a plan or have something in their 8
comprehensive plan so that over the next 10 to 25 years there will be a
process where you can begin undergrounding this stuff. In my discussions
with Jim Kearnes, the state of the art of this stuff is pretty good. It's not
bad at all and it is feasible.

So, I would encourage the city to look at the cost of undergrounding, not 1
only the actual cost, but to compare those to the other utilities and the
other services that the city provides. For instance, to put sewers in our
area, it's going to cost $12,000 to $20,000 and that's probably going to
come at some point in time. Even though the cost of undergrounding may
be high in relation to putting sewers in our area -- maybe it's even less
than that. The other service that the city provides that you could compare
it with is roads. At some point in time 140th from NE 24th up to 60th will
be improved. And we've been told that the costs of improvement -- just
redoing the two lane road and sidewalks and all the amenities -- will
probably cost $2.5 million to $3 million a mile. When you consider the
costs that were in the book for undergrounding high voltage lines, they
were looking at five times. To go overhead, you are looking at around
$300,000 to $400,000 a mile, and for the undergrounding, you are looking
at maybe $1.5 million to underground. So, when you look at those costs
in terms of the road costs, in terms of utilities, sewer costs, you can't
overlook the cost that people are paying for cable now -- that's even an
optional cost and they're paying a lot of money for that kind of thing. So,
I think if you look at that in the context of the cost of the other things of

doing business, that maybe it becomes more reasonable to do that. The benefits certainly are here with reliability, with the aesthetics. Why should some citizens of Bellevue have to bear the burden of the aesthetics? Why not put everybody on an equal basis?

Then you have the other unknown factor of EMF, which is up for a lot of debate. But those three benefits definitely would have some payback. I think that anytime a utility -- I think they would be receptive to community interest of doing some things like this -- especially on some projects. Maybe they need to get some more experience before they would feel totally confident with maybe undergrounding all of Bellevue.

The other aspect of this is that I've seen a lot of people move out of Bellevue. I don't think it's entirely appropriate, but when you look at the reasons why they move --. One of the most likely things is that they want to get away from the traffic and gridlock when they go to work. But the other things they're getting out on the Sammamish plateau is that most of the housing developments have underground power and some of the other amenities that maybe people want. So maybe the city of Bellevue -- if we're going to compete as a living environment with some of the newer communities that do offer these kinds of things -- maybe that's the thing to consider. That's all I have to say. Thanks very much.

SANCHEZ: Thank you for your comments. The time is now 8:15 p.m. and I will turn off the recorder until there is another speaker.

SHERRARD: This is David Sherrard. It is approximately 8:50 p.m. and I am reopening the public hearing on the draft EIS to accept additional comments. This is a public hearing on the draft environmental impact statement. The intent of the hearing is to get comments which allow us to correct deficiencies in the EIS. In addition to testimony on the EIS, there will be opportunities for testimony on the proposed utilities element of the comprehensive plan before the Planning Commission. At this point there is a public hearing scheduled for February 17. I would appreciate it if you would give us your name and address for the record before you begin your testimony.

BRICKEN: My name is William Bricken. I live at 3832 140th in Bellevue. I'm a research professor at the University of Washington. I've been following the development of the draft EIS and the utilities element report for nearly two years. I've studied some issues about EMF and siting pressures for utilities.

I have one general and a couple of specific comments to make. The general comment is that there seems to be an incredible difficulty for citizens to get involved with local government decisions. In my own personal case, this comes basically as the issue of having to give up my rare and cherished personal time in order to get involved with public policy. Whereas representatives from the utilities and even from the City of Bellevue are at least compensated at some level to have interest in these issues. The net result of this difficulty of public involvement is basically that it seems as though a lot of the policies are being developed with consonance for abstract concepts such as public good, and only reluctantly considering the individual needs of citizens and neighborhoods. We're just under-represented. I don't have a clear recommendation on this point other than to observe that the City Council and the public representatives must underlie their commitment and continually reassert their commitment to represent citizens and neighborhoods as opposed to institutions and abstract concepts such as the public good. That is to say that, decisions made in the name of the public good like providing greater services to the public can only be made with total respect for the individual rights of citizens.

My specific points following from this are that it has been established very 14
clearly in California, Florida, and the state of Washington, that non-aesthetic siting of public utilities impose approximately 10% to 15% property devaluation. In other words, there is a significant adverse effect on property values of indiscriminate siting of utilities elements. In that sense, I was absolutely horrified to see that the staff policies -- at least on Policy No. P-19 -- could even consider eliminating the statement that schools and residential neighborhoods should be avoided in the location of new transmission lines and substations. I was also very disappointed to see that the evaluation and analysis of undergrounding utilities elements was taken at a very casual level as far as cost estimates and at a very biased level in the sense that Puget Power seems to be the only one asked to evaluate the cost impact of undergrounding electric utilities. It seems that, although 1
the policies of the commission are good-hearted and right spirited, they did not take into account the deeper needs and the long-term costs that a neighborhood must pay in order to support the general good of providing basically utilities for a growing city.

In particular, my second point in reference to the EMF issue, regardless 1
of the scientific evidence, fear of electromagnetic radiation exposure is real. The fear alone is detrimental. When we have children and old people waiting at the bus depot right next to an electromagnetic radiation

source, there is an element of discomfort there, regardless of whether or not it is rational. That is to say, undergrounding achieves a psychological benefit of being able to put the issue out of sight and out of mind. It also achieves the prudent avoidance benefit of being able to minimize exposure.

So, my comments in summary again are just to observe that the governmental process, particularly at the local level, must pay particular attention to the needs of citizens and neighborhoods, and that policies must almost bias themselves in favor of those of us who are forming the stable core of the residential neighborhoods of the City of Bellevue.

SHERRARD: Thank you very much. Well now, according to my watch, it is 8:57. What time do you have Susan?

SANCHEZ: I have 8:57.

SHERRARD: Well, in that case, we'll wait until 9:00.

SHERRARD: This is David Sherrard. It is 9:00 and I am closing the public hearing. Thank you all for coming.

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Appendix E: EMF Calculations for Alternatives

February 24, 1993

Mr. David Sherrard
Design and Development Department
City of Bellevue
P.O. Box 90012
Bellevue, WA 98009-9012

FEB 25 '93

Re: Bellevue Utilities Element DEIS--Request for EMF Calculations for Alternatives

Dear David:

Per your request, Puget Power developed two tables of anticipated levels of electromagnetic fields (EMF) that could be expected to be associated with typical power lines under normal loading for each of the transmission and distribution system alternatives discussed in the Utilities Element DEIS (see attached). Presented below are the assumptions used in the calculation of these EMF levels as well as the levels. We suggest the City review the assumptions and calculations with its consultant.

BACKGROUND INFORMATION

The EMF levels for the alternatives were derived from predicted field levels published in "Electric and Magnetic Field Reduction: Research Needs" (State of Washington Electric Transmission Research Needs Task Force, January 1992). A copy of this report was previously delivered to the City of Bellevue. Pertinent pages used by Puget Power to develop the tables of EMF levels for typical power lines for each of the alternatives are attached.

The Task Force report reviews how different line designs affect magnetic fields for a given load. Varying factors among the examples include different pole structures, decreased/increased voltage, and double circuit configuration. These factors represent typical lines under normal conditions, not emergency conditions such as storm outages. The EMF levels in the report are theoretical, and do not represent the magnetic fields of any specific line. In this fashion, the EMF levels in the Task Force report are useful for comparing typical lines of alternative system designs. The EMF levels for the examples are therefore not related to system loads, but rather line loads.

CALCULATION ASSUMPTIONS

The assumptions for operating conditions for the transmission and distribution system examples in the Task Force report are within the normal range for Puget Power's system. In addition, one or more of the examples represent Puget Power's typical line designs. Choice of a particular example to represent an alternative transmission or distribution system was primarily based on pole configuration and whether or not the typical line would be installed overhead or underground.

Two transmission examples (cases B and I, see p. 26-27) and two distribution examples (cases A and F, see p. 30-31) were chosen as base cases for the overhead and underground lines of the alternative systems. As the transmission system examples in the Task Force report are for 230 kV systems, T-2 (230 kV radial) was identified as the base case overhead transmission system example.

Specific loads on particular lines could result in current flows and EMF levels which could vary significantly from normal operating conditions. Normal operating conditions do not address hourly, daily, and seasonal fluctuations in electric load or significant increases in electric load in the future. In addition, system current flows would alter as improvements are made to the various facilities of the system. The relative EMF levels between alternative systems under such conditions, however, would remain comparable as long as other assumptions remained constant.

EMF level, however, is directly related to current which varies along a power line. For radial transmission lines, the current decreases from the maximum load as it flows from the transmission substation to the terminal of the line. This decrease is not gradual, but rather drops in steps as power is supplied to the distribution substations. For grid systems, current also varies between transmission line segments between the distribution substations. The amount of current within any particular segment depends on the direction power is flowing in the line and the load demands of the substations. A similar analogy can be made for distribution lines of radial and grid systems, respectively, where customer loads replace substation loads. For the EMF levels calculated for the alternatives, they are representative of the initial segment of radial system lines from the transmission substation, though levels on grid system lines would be the segment with the highest current flow along the line.

EMF levels for the non-base case system alternatives were then calculated by modifying the EMF levels in the Task Force report. Modifications addressed variations in voltage, substation capacity, or placement of power lines from the base case system characteristics. The estimated number of lines for alternatives is another factor used to modify base case EMF levels as similar load distributed on more lines reduces current flow on the lines.

As information to the reader, the approximate mileage of power lines serving Bellevue load for each of the alternatives is included (see Attachment A). These figures are not just the new or rebuilt lines. One mile of double-circuit power line was counted as one mile of line, not two. The number of miles of lines and/or feeders for the alternatives also may be useful to evaluate public exposure of EMF from power lines.

EMF LEVELS FOR THE ALTERNATIVES

The following lists the specifics of how the EMF levels for the examples in the Task Force report were used to derive representative EMF levels for the system alternatives in the DEIS. The first of the transmission and distribution system alternatives is T-2 and D-1, respectively. These alternatives were identified as the base cases. To facilitate the readers' understanding of the logic involved in the calculations, the order in which the following alternatives are discussed builds upon the explanations given for previous alternatives.

Transmission System Alternatives

T-2: 230 kV Radial

A typical transmission line configuration in the T-2 system alteRnative is represented by the "B. Vertical Delta" example in the Task Force report (see p. 26). The published EMF levels for this example are the same as those anticipated for a typical line under this alternative.

T-3: 115 kV Radial

A typical transmission line configuration in the T-3 system alternative is similar to the "B. Vertical Delta" example except that the voltage of the system is 115 kV and not 230 kV. With system voltage one half, the current must double for the same load. (This alternative requires rebuilding the existing lines to allow for increased current flow.) As current and EMF levels are directly related, the estimated EMF levels for a typical transmission line of T-3 are two times the EMF levels of T-2.

T-1: 115 kV Grid
A typical transmission line configuration in the T-1 system alternative is similar to the T-3 alternative except the system is a grid and not a radial system. The described T-1 system alternative has approximately 2.5 electric lines more than the T-3 radial system for the same load. With more supply lines (not miles), the same current flow is dispersed on more lines which reduces current flow on each individual line.

Since EMF is proportional to the current flow, the EMF levels of a typical line for the T-1 alternative would be less than EMF levels of T-3. We assume that Alternative T-1 includes 8 lines scerving the Bellevue load, whereas alternatives T-3 includes the equivalent of 5.5 lines. Due to this 45% increase in the number of lines, the current flow is reduced by the inverse of this amount, or 69% of the original value. With EMF levels directly related to current flow, the EMF levels for a typical transmission line of this alternative are similarly reduced.

Eventually, Puget Power's 115 kV transmission lines serving Bellevue are planned to operate at 230 kV. With voltage on lines increasing from 115 kV to 230 kV and assuming the same amount of power, current on a typical line of the ultimate 230 kV grid system would be reduced by half. Therefore, EMF levels on a typical transmission line on such a system would be half of the estimated EMF levels presented for the T-1 115 kV grid system alternative.

T-4: Underground Transmission System
A typical transmission line in the T-4 alternative is similar to the "I. Underground Line - Fluid Filled Steel Pipe" example. Two sets of assumptions have been used to calculate the EMF levels for this conceptual alternative--one for an underground alternative similar to the T-1 grid and another for an underground alternative with a tighter grid (more lines).

The first variation of the alternative, we have assumed would have 8 lines verses 5.5 lines as in Alternative T-2. Thus, current per individual line is reduced by the inverse of this 45% increase in number of lines. The EMF levels of the the example for the typical line of this alternative variation therefore would be reduced to 69% of this value.

For the second variation of the alternative, even more lines would be needed to operate a tighter grid system for the same load. For comparison, we assumed 12 lines would be needed. The current and EMF levels would similarly be reduced by the inverse of this 118% increase in the number of lines in the base case of 5.5 lines.

Distribution System Alternatives

D-1: 12 kV Lines and 25 MVA Substations
Two types of typical feeders exist in this distribution system alternative--overhead and underground lines. The typical overhead feeders would be similar to the example "A. Base Case" in the Task Force report (see p. 30). The typical underground feeders are similarly represented by the example "F. random lay underground" in the report (see p. 31).

D-3: 12 KV Lines and 50 MVA Substations
As described in the DEIS, this alternative is similar to the D-1 alternative except the capacity of the substations would be 50 MVA, not 25 MVA. To distribute the increased amount of power from the substation, approximately twice as many new feeders would be needed for each substation. The current flow on each of these feeders would be the same as under the D-1 alternative--300 amps. The additional feeder construction has been assumed to be underground. As the current flow in the feeders for this alternative is approximately the same as for D-1, the EMF levels would be similar.

D-2: 34 kV Lines and 50 MVA Substations
This alternative would be similar to D-3 except that the feeder voltage is increased from 12 kV to 34 kV. With the higher voltage, fewer feeders would be needed from each substation than for Alternative D-3. The current flow on each of these longer feeders is, as in D-1 and D-3, 300 amps. The higher voltage and similar current flow would be used to distribute the power from the fewer number of substations. As the current is similar, EMF levels would also be similar to the D-3 alternative.

SUMMARY

The table on Attachment A summarizes the EMF levels for a typical line in each of the alternatives discussed in the DEIS. Attachment B summarizes EMF levels under or over the line for peak, average, and minimum current flows under normal operating conditions. I hope this information assists you in the formulation of your responses to comments on the DEIS. Please contact me if you need additional explanation of this technical information.

Sincerely,

Betsy

Betsy J. Minden, AICP
Environmental Scientist

ATTACHMENT A

EMF LEVELS OF THE DEIS ALTERNATIVES

(Assuming normal operating peak conditions)

DEIS Alternative	EMF Field Levels (milligauss) under/over	@40'	@200'	Line-miles
Transmission:				
T-1 (115 kV Grid)	37.3	15.2	0.83	44
(Ult. 230 kV Grid)	18.7	7.6	0.41	44
T-2 (230 kV Radial)	27.0	11.0	0.6	31
T-3 (115 kV Radial)	54.0	22.0	1.2	31
T-4 (T-1 Grid)	3.4	0.14	0.007	44
(w/ Tighter Grid)	2.3	0.09	0.005	73
Distribution:				
D-1 (12 kV 25 MVA Subs)				
overhead	22.4	7.7	2.2	287
underground	56.3	4.7	1.9	680
D-2 (34 kV 50 MVA Subs)				
overhead	22.4	7.7	2.2	287
underground	56.3	4.7	1.9	680
D-3 (12 kV 50 MVA Subs)				
overhead	22.4	7.7	2.2	287
underground	56.3	4.7	1.9	1047

ATTACHMENT B

EMF LEVEL RANGES FOR THE DEIS ALTERNATIVES

(For Peak, Average, and Minimum Normal Operating Conditions)

DEIS Alternative	EMF Field Levels (milligauss under/over line)		
	Peak	Average	Minimum
Transmission:			
T-1 (115 kV Grid)	37.3	20.5	9.3
(Ult. 230 kV Grid)	18.7	10.3	4.7
T-2 (230 kV Radial)	27.0	14.9	6.8
T-3 (115 kV Radial)	54.0	29.7	13.5
T-4 (T-1 Grid)	3.4	1.9	0.9
(w/ Tighter Grid)	2.4	1.3	0.6
Distribution:			
D-1 (12 kV 25 MVA Subs)			
overhead	22.4	12.3	5.6
underground	56.3	31.0	14.1
D-2 (34 kV 50 MVA Subs)			
overhead	22.4	12.3	5.6
underground	56.3	31.0	14.1
D-3 (12 kV 50 MVA Subs)			
overhead	22.4	12.3	5.6
underground	56.3	31.0	14.1

NOTE:

Normal operating average conditions would be approximately 55% of peak values and normal operating minimum conditions would be 25% of this value.

Chapter 4

Comparisons of Power Line Design and Resulting Electric and Magnetic Fields

This section compares how different power line designs affect electric and magnetic fields. Data for making these comparisons were generated by the Electric Transmission Research Needs Task Force with the assistance of the Technical Committee. The Task Force and Technical Committee identified a range of parameters which would affect electric and magnetic field strength, then prepared field projections based upon altering these parameters.

First, "base case" designs for both transmission and for distribution were defined. Next, several transmission and distribution alternatives were identified and compared to the base cases. Alternatives were developed within the separate categories of transmission, distribution three-phase, and distribution single-phase. Alternatives within each category were structured to be capable of delivering equal amounts of power. Electric and magnetic field projections were made using computer software developed by Vernon Chartier of the Bonneville Power Administration and Dr. Robert Olsen from Washington State University. These programs are in common use and provide accurate results provided line current and geometry are known. The results of this exercise are presented in the following pages, including a discussion of assumptions, description of alternatives, comparative field projections and observations from these comparisons. Cost estimates for each alternative are also provided.

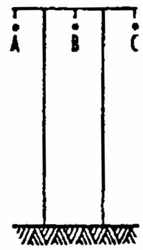
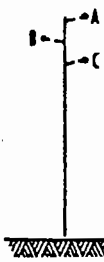
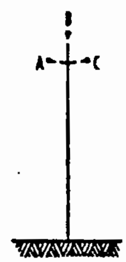
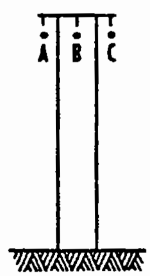
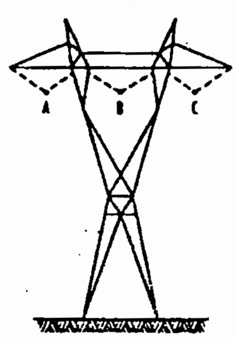
Transmission Line Design

Numerous conductor and support (pole or tower) configurations are used for high voltage transmission systems. It has long been known that different conductor configurations create substantially different electric and magnetic fields in both magnitude and shape (Moore). To demonstrate these differences, ten alternatives capable of delivering 125 megawatts (MW) of electrical power are described on the following pages. (This amount of power is about one-tenth the average power used by Seattle.) These alternatives are not all inclusive, but represent a range of available techniques for reducing EMF, relative to one another. Comparison of the general magnitude of these differences, when weighed against other considerations such as cost, maintenance factors and reliability, gives one insight into the relative value (in field reduction) of incorporating certain measures into line design.

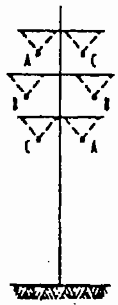
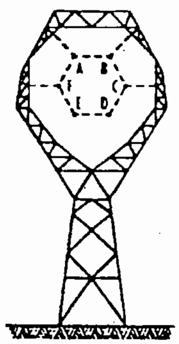
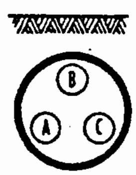
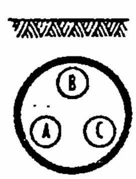
Unbalance on transmission systems is typically much lower than on distribution systems. It has been found that the range of unbalance on transmission lines generally does not contribute significantly to the magnetic fields produced. For the purpose of this analysis, it is assumed that there is around 5% current amplitude variation, and a two degree phase angle variation of unbalance on transmission systems.

Table 2 compares the electric and magnetic fields associated with each alternative design at various distances and provides a graphic of each design considered. Specifics concerning transmission conductor geometry (i.e., conductor positioning) and phasing for each alternative are contained in Appendix 3.

Table 2 - Transmission Line Designs: "Base Case" and Alternatives

Description	Graphic of Configuration	Cost/Mile (thousands)	Magnetic Fields (milligauss)			Electric Fields (kilovolts/meter)		
			under	40'	200'	under	40'	200'
A. "Base Case" - 230 kV - 300 amps, - 125 MegaWatts - Wooden H-frame - 19 foot spacing		230-260	59.6	29.7	1.6	2.6	1.9	0.04
B. Vertical Delta*		220-250	27.0	11.0	0.6	1.9	0.7	0.04
C. Horizontal Delta		220-250	28.9	9.8	0.5	1.6	0.7	0.03
D. Decreased Voltage - 115 kV - 600 amps, - 11 1/2 foot spacing		200-230	91.5	34.4	1.9	1.0	0.6	0.01
E. Increased Voltage - 500 kV - 138 amps, - 30 foot spacing - Steel lattice tower		400-500	24.4	18.9	1.2	5.5	5.3	0.1

* Differences between base case and alternatives to base case are described beneath alternative title.

Description	Graphic of Configuration	Cost/Mile (thousands)	Magnetic Fields (milligauss)			Electric Fields (kilovolts/meter)		
			under	40'	200'	under	40'	200'
F. Double Circuit/Split Phase - 150 amps per conductor - Steel pole		350-400	14.5	4.8	0.1	1.7	0.6	0.02
G. Multiphase - 6 phase line - 132 kV - 150 amps per conductor - Steel structure		380-450	16.7	6.7	0.4	2.5	0.9	0.05
H. Single Circuit Steel Pole - vertical configuration		275-350	36.2	22.1	1.5	2.7	0.8	0.1
I. Underground Line - Fluid Filled Steel Pipe - buried 5 feet below the earth's surface		1500-2000	4.9	0.2	0.01	0	0	0
J. Underground Line - Dry Type Cable, Non-Magnetic Pipe - buried 5 feet below the earth's surface		1500-2000	14.7	0.6	0.03	0	0	0

In brief, the ten different alternatives are as follows.

Base Case

A conventional flat, horizontal conductor arrangement operated at 230 kilovolts (kV) with 300 amperes (amps) current for 125 megawatts (MW) of power, supported by wooden H-frame poles.

Vertical Delta

A triangular conductor arrangement in which the triangle formed by the three conductors has a vertical side; operated at 230 kV with 300 amps for 125 MW power delivery.

Horizontal Delta

A triangular conductor arrangement which raises the height of the center phase conductor above the outside two so that the triangle has a horizontal side; operated at 230 kV, with 300 amps current for 125 MW power, placed slightly higher above ground than the base case and supported on wood poles.

Decreased Voltage

Use of the flat, horizontal line configuration as in base case; operated at a lesser voltage of 115 kV with 600 amps current to derive 125 MW power.

Increased Voltage

Use of the flat, horizontal configuration as in the base case; operated at a higher voltage of 500 kV and only 138 amps to deliver 125 MW; supported by steel lattice towers.

Double Circuit/Split Phase

A vertical arrangement of two circuits, one circuit on either side of the supporting structures, where the phases on one circuit are running in the reverse of the opposite circuit; operation at 230 kV and 150 amps per conductor to deliver 125 MW.

Multiphase

Also called "high phase order" transmission; use of six rather than three-phase conductors in a circular arrangement; operated at 132 kV with 150 amps current per conductor to deliver 125 MW; supported on steel structures.

Single Circuit/Vertical/Steel Pole

Stacked arrangement of conductors one above the other, supported by tall steel poles; single circuit line with 230 kV at 300 amps to deliver 125 MW.

Underground Line/Fluid Filled Steel Pipe

An underground cable contained in a fluid filled steel pipe; operated at 230 kV with 300 amps for 125 MW.

Underground Line/Dry Type Cable/Non-Magnetic Pipe

An underground cable encased in non-magnetic pipe operated at 230 kV with 300 amps to deliver 125 megawatts.

From Table 2, we draw the following conclusions.

1. There is a large variation in the fields resulting from different alternatives. Magnetic fields directly under (or above, if underground) transmission lines range from 91.5 mG (decreased voltage) to 4.9 mG (underground fluidfilled steel pipe). A typical flat, horizontal configuration, the "base case" is estimated to generate a 59.6 mG field directly below the line.

2. When comparing overhead alternatives, the highest magnetic and lowest electric fields result when voltage is reduced, the amount of power delivery remaining constant.

3. Conversely, of all the overhead alternatives, increasing the voltage results in the highest electric fields, and lower magnetic fields, *assuming equal power delivery*.

4. The greatest field reductions are accomplished by undergrounding transmission lines in a steel pipe filled with fluid. Electric fields are eliminated and magnetic fields are reduced from 29.7 mG (base case) to 0.2 mG, calculated at forty feet away from the centerline in each case. This particular underground alternative also results in reduced magnetic fields when comparing field strengths immediately under the base case line (59.6 mG) and above the underground line (4.9 mG). The magnetic field reduction is due to cancellation from the phase spacing and not shielding. The cost of this type of construction is estimated to be six to seven and one-half times more than the base case depending on the particular circumstance.

5. Next to undergrounding, the greatest magnetic field reductions are achieved using either a double circuit/split phase or multiphase arrangement. The double circuit/split phase arrangement achieves magnetic field reductions of around 4 to 16 times, by comparison to the base case, depending on the point of measurement. The multiphase design achieves magnetic field reductions of around 3.6 to 4.4 times, by comparison to the base case, depending on the point of measurement. The costs of these alternatives are estimated to be 53% greater than the base case for the split phase alternative and 69% greater for the multiphase alternative.

6. The two delta type configurations examined achieve very similar magnetic field reductions when compared to the base case, that is, a magnetic field reduction on the order of approximately 2 to 3 times in either case, depending on the point of measurement. These alternatives are comparable in cost to the base case.

Distribution Line Design

Magnetic fields from distribution systems can be more complicated than those around high-voltage transmission lines because there are sometimes two circuits, a higher voltage primary and a lower voltage secondary which connects to customer equipment. The net current flow (the non-zero vector sum of all currents flowing on all the conductors) results in an uncancelled (or net) magnetic field component (Moore). Net current results when not all of the return current flows on the lines but instead, a portion flows in the earth. Net current can also result when low-voltage return currents from customer loads disperse through ground connections and do not return on the neutral wires from the house to the distribution transformers (Moore). The magnetic field from net currents falls off less rapidly with distance from the lines than magnetic fields from a set of conductors carrying no net current.[1]

For the purpose of comparing the field characteristics of various distribution designs, and for the sake of simplification realizing the multitude of alternatives and assumptions that can be made about the amount of unbalance and earth return current, distribution alternatives were defined within the following parameters. First, each alternative includes only primary circuits. Second, all cases assume 20% current amplitude variation and 5 degree phase angle variation of unbalance on the system and, for lack of being able to quantify an arguably better assumption, 50% return current in the earth at a depth of 1000 meters. The assumption regarding the amount of earth return is probably very conservative (i.e., high).

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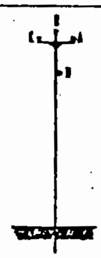
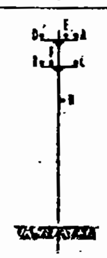
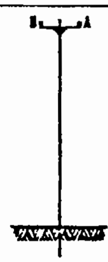
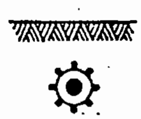
[1]Independent of its impact on EMF from distribution lines, net current can sometimes be the dominant source of background magnetic fields inside a house or building (Johnson). Because the scope of ESSB 6771 is limited to electric and magnetic fields from distribution and transmission lines, the Task Force did not explicitly address the issue of reducing magnetic fileds associated with net current inside homes and other buildings.

Seven three-phase alternatives and three single-phase alternatives were studied for delivery of 6.5 and .72 MW respectively. These power levels result from practical current levels for these configurations. Brief descriptions of each alternative follow, with more detailed descriptions contained in Appendix 4. Graphic representations and field levels are found in Table 3.

Table 3 - Distribution Line Designs: "Base Case" and Alternatives*

Description	Graphic of Configuration	Cost/Mile (thousands)	Magnetic Fields (milligauss)				Electric Fields (kilovolts/meter)			
			under	20'	40'	200'	under	20'	40'	200'
A. "Base Case" - 12.5 kV - 6.5 MegaWatts - 40 ft. pole - 10 ft. crossarm - 4 foot sag		50-70	22.4	14.9	7.7	2.2	0.05	0.05	0.03	.003
B. Increased Pole Height** - 55 ft. pole		60-80	10.1	8.1	5.3	2.1	0.02	0.02	0.02	.004
C. Increased Voltage - 25 kV - 47.5 foot pole		60-80	6.9	5.1	3.1	1.0	0.07	0.06	0.04	.007
D. Compact Delta		55-75	13.1	8.8	4.9	1.9	0.03	0.03	0.01	.003
E. Double Circuit/ Split Phase - 47.5 foot pole		80-120	3.3	3.1	2.5	1.2	0.03	0.03	0.01	.003

* Assume 50% return current in the earth, ± 20% current amplitude variation and ± 5° phase angle variation.
** Differences between base case and alternatives to base case are described beneath alternative title.

Description	Graphic of Configuration	Cost/Mile (thousands)	Magnetic Fields (milligauss)				Electric Fields (kilovolts/meter)			
			under	20'	40'	200'	under	20'	40'	200'
F. Random Lay Underground - buried 3 feet deep - 7.5 inth phase spacing		120-600	56.3	9.8	4.7	1.9	0	0	0	0
G. Underground Line In Conduit - buried 3 feet deep - 2.5 inch phase spacing		120-600	31.2	8.4	4.4	1.8	0	0	0	0
H. Single Phase Crossarm - 7.2 kV - 0.72 MegaWatts		30-40	14.5	12.8	8.6	3.6	0.09	0.08	0.04	.010
I. Single Phase Headpin - 7.2 kV - 0.72 MegaWatts		30-40	8.5	8.3	6.4	3.2	0.08	0.06	0.03	.008
J. Single Phase Underground - 7.2 kV - 0.72 MegaWatts - buried 3 feet deep - concentric neutral		100-450	51.3	15.4	8.0	3.2	0	0	0	0

Base Case

Conventional horizontal arrangement strung on wooden poles, around thirty feet off the ground; voltage is 12.5 kV with 300 amps for delivery of 6.5 MegaWatts (MW).

Horizontal (Base Case)/Increased Pole Height

Same as base case except the conductors are around 45 feet off the ground rather than 30.

Increased Voltage

Utilize base case/horizontal arrangement and increase voltage from 12.5 kV to 25 kV with 150 amps for 6.5 MW.

Compact Delta

A triangular conductor arrangement, with conductors spaced 24 inches apart, around 2,731 feet above the ground.

Double Circuit/Split Phase

Placement of two three-phase circuits on either side of a single structure, with phase conductors stacked one above the other from 32 to 36 feet above the ground; use of 12.5 kV at 300 amps for delivery of 6.5 MW.

Underground/Random Lay

Placement of conductors three feet beneath the ground, randomly laid, with a phase spacing of 7.5 inches apart, directly in the ground; voltage is 12.5 kV with 300 amp current for power delivery of 6.5 MW.

Underground Line in Conduit

Placement of conductors in a non-magnetic conduit so they are constrained to approximately 2.5 inches apart, three feet deep, using 12.5 kV at 300 amps for 6.5 MW delivery.

Single Phase/Crossarm

Placement of a single phase on a pole, around 29.3 feet above the ground; a crossarm supports both the phase conductor and the neutral; use of 7.2 kV and 100 amps current for .72 MW power delivery. (When one phase of a 12.5 kV circuit and the circuit neutral are used, the voltage between them is 7.2 kV.)

Single Phase/Headpin

Placement of a single phase at the top of a pole, rather than off to the side on a crossarm, around 30.8 feet above the ground; the neutral is placed down the pole some distance. Use of 7.2 kV and 100 amps current for 0.72 MW power delivery.

Single Phase Underground

Placement of an insulated single-phase wire with concentric neutral, which is a neutral wrapped around insulated phase wire, buried three feet underground without encasement; use of 7.2 kV and 100 amps for .75 MW.

Table 3 shows electric and magnetic fields resulting from these alternatives. Comparing the alternatives we can conclude the following.

1. Other things remaining the same, a double circuit/split phase results in the greatest magnetic field reduction. This is true even when comparing to the underground distribution alternatives studied. Also, magnetic fields from this design are much less than magnetic fields for the single phase alternative studied, even though the power delivered is nine times

greater for the three-phase (6.5 MW versus 0.72 MW). This design could have application where an express feeder is run from a substation to a load area. It would become unbalanced and be less effective for general distribution lines where connections are made along its length to serve customers.

2. Single-phase distribution generally produces greater magnetic fields for the amount of power delivered. For example, a three-phase compact delta line designed to deliver 6.5 MW produces a 4.9 mG field 40 feet away versus a 6.4 mG field from the single-phase headpin alternative, delivering only .72 MW.

3. The second most effective means by which to reduce magnetic fields from distribution lines appears to be doubling the primary distribution voltage (see Alternative "C", Horizontal Delta) which reduces the fields to about 40% of the base case magnetic field at 40 feet.

4. The compact delta design reduces the magnetic field to about 63% of the base case at 40 feet.

5. Undergrounding a three-phase distribution line reduces the magnetic field to between 57% to 61% of the base case at 40 feet (see Alternatives "F", Double Circuit/Split Phase and Alternative "G", Multiphase, respectively). In other words, undergrounding is no more effective than use of the compact delta (see above) and is more costly. Undergrounding also results in higher fields than other alternatives directly over/under the line. Table 3 shows a range of 31.2 mG to 56.3 mG for underground versus 3.3 mG to 22.4 mG for overhead at 0 feet from the center line.

6. Magnetic fields from distribution lines can be relatively greater for the amount of power delivered than transmission lines due to the amount of unbalance in the distribution system, the close proximity to ground level where the fields are measured, and the amount of earth return current. If we assume 20% current amplitude variation, and 50% earth return on the distribution system, a 12.5 kV, 300 amp double circuit/split phase distribution line produces an estimated mean value magnetic field of 2.5 mG 40 feet away, by comparison to a 230 kV, 300 amp circuit/split phase transmission line field of 4.8 mG at the same distance; when the transmission line is delivering 19 times as much power.

Additional Observations

General Observations

- Electric and magnetic fields are a function of voltage and net current on a line, geometry of the line, and distance from a line.

- The most common single circuit transmission structure in the United States is the flat, horizontal configuration. This design results in the highest electric and magnetic fields.

Phase Spacing

- The closer the phase spacing, the lower the external electric and magnetic fields produced. If all three phases of a transmission line could be placed at the same point in space, there would be no electric or magnetic field assuming no net current and voltages on all three phases are equal.

- The higher the voltage, the farther the conductors must be apart to provide satisfactory operation of the line in the areas of safety, reliability, radio and TV interference and audible noise.

- The State and National electrical codes determine the minimum allowable distances between phase conductors based upon safety considerations. The Washington State code includes provisions that may affect field reduction potential.

- Engineers have sought to tighten phase spacing for reasons other than field reduction, including cost of towers and width of right-of-way.

- Single-circuit, three-phase transmission is now often designed to maximize field reduction by placing the phases closer together.

- Single-circuit, multiphase lines, which are now under experimentation, offer reduced magnetic fields for the same amount of power because there are additional phases to share current.

- Double-circuit, three-phase lines can achieve lower EMF than when the two circuits are on separate structures.

- Increasing the height of phase conductors reduces fields on the right-of-way but at some distances close to the line can actually increase fields off the right-of-way.

Electric Fields

- Electric fields can be reduced by shielding. Electric field shield wires can be strung between energized conductors and the ground, resulting in a significant reduction in electric fields at certain locations. Also, most houses and other buildings are very good shields.

- Lines using single conductors can yield significantly lower electric fields (as much as 25%) than lines using bundled conductors, but they produce higher audible and radio noise.

Magnetic Fields

- Magnetic fields are directly related to the customers' use of electricity and varies hourly and seasonally with living patterns.

- The use of two or more transmission or distribution lines, where one transmission or distribution line would normally be used, results in lower magnetic fields near each line, given the same total power delivery.

- The use of more substations with lower current distribution lines would result in lower magnetic fields near each line, for the same amount of power delivered.

- Magnetic fields from distribution lines may decrease more rapidly with distance than magnetic fields from transmission lines because of their close conductor spacing.

- Much of the magnetic field attributed to distribution lines comes from unbalanced currents between phase conductors and from split currents from neutral-ground bonds to other grounding systems, such as water piping systems.

- Degaussing loops along the right-of-way have been proposed for reducing magnetic fields, but so far, practical methods for their use have not been developed or tested.

- Certain types of underground construction can reduce magnetic fields from transmission lines except at distances very close to the line. The lines can be placed very close together and some attenuation is also produced by the heavy steel pipe used in high pressure fluid filled underground transmission systems. This type of system is not currently being used for distribution because, among other things, the net current produces fields, whether the pipe is present or not.

- The multiphase line and double-circuit/split phase transmission line alternatives can reduce magnetic fields to about around 50% that of the two delta configured lines. These are lines with more than three phases that transmit the same amount of power as normal single-circuit three-phase lines.