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NUREG-75/025
Supplement No. 1

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DRAFT SUPPLEMENT

TO THE

FINAL ENVIRONMENTAL STATEMENT

RELATED TO THE CONSTRUCTION OF

PEBBLE SPRINGS NUCLEAR PLANT

UNITS 1 AND 2

DOCKET NOS. 50-514 AND 50-515

Proposed By
Portland General Electric

November 1979

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U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, DC

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SUMMARY AND CONCLUSIONS

This draft supplement to the Final Environmental Statement was prepared by the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation.

1. This action is administrative.

2. The proposed action is the issuance of construction permits to the Portland General Electric Company for the construction of the Pebble Springs Nuclear Plant, Units 1 and 2 (Docket Nos. 50-514 and 50-515), located near the Columbia River in Gill' n County, Oregon, and scheduled for commercial service in 1986 and 1989, respectively.

   The Pebble Springs Nuclear Plant, Units 1 and 2, will employ two pressurized water reactors to produce up to 3670 MWt per unit. Two steam turbine generators could use this heat to provide up to 1311 MWe per unit. The exhaust steam will be cooled by a once-through flow of water obtained from a 1900-acre man-made reservoir. Makeup (up to 45,000 gpm or 72,450 acre-ft/yr) will be drawn from the Columbia River. No blowdown will be discharged to the Columbia River.

3. Principal alternatives considered.

   a. Alternative sites.

4. Summary of alternative sites review.

   In its alternative sites review, the staff reviewed the applicant's alternative site methodology, identified alternative sites, and compared those sites with Pebble Springs. Having made this comparison, the staff failed to find any of the potentially licensable sites to be environmentally preferable to Pebble Springs.

   The staff agrees with the conclusion reached in the FES that the site is well chosen among the alternative sites available, and further concludes that none of these sites is obviously superior to the proposed site.

5. The following Federal, State, and local bodies have been asked to comment on this Draft Supplement to the Final Environmental Statement:

   - Advisory Council on Historic Preservation
   - Department of Agriculture
   - Department of the Army, Corps of Engineers
   - Department of Commerce
   - Department of Energy
   - Department of Health, Education an Welfare
   - Department of Housing and Urban Development
   - Department of the Interior
   - Department of Transportation
   - Environmental Protection Agency
   - Office of the Governor, State of Oregon
   - Nuclear and Thermal Energy Council of Oregon
   - Mayor of Arlington
   - County Judge, Gilliam County

6. The Final Environmental Statement was made available to the public, to the Council on Environmental Quality, and to the other specified agencies in April 1975.

7. On the basis of the analysis and evaluation set forth in this statement, after weighing the environmental, economic, technical, and other benefits of the Pebble Springs Nuclear Plant, Units 1 and 2, against environmental and other costs and considering available alternatives, it is concluded that the action called for under the National Environmental Policy Act of 1969 (NEPA) and 10 CFR Part 51 is the issuance of construction permits for the facilities.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

90001 31

FOREWORD

Recent Atomic Safety and Licensing and Appeal Boards decisions regarding alternative sites have placed greater emphasis on analysis by the staff of alternative site-selection procedures. On reviewing the Pebble Springs Final Environmental Statement, the staff found it inadequate in this respect and determined that reevaluation of the alternative sites was warranted. This supplement presents the results of that reevaluation.

The Summary and Conclusions section presented in this supplement was drawn both from the analyses presented herein and from the Pebble Springs Final Environmental Statement issued in April 1975. It summarizes the staff's analysis of the alternative sites in relation to the project and contains the staff's conclusions and conditions relative to the project as now constituted.

Single copies of this statement may be obtained by writing the:

Director, Division of Technical Information and Document Control
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Mr. Richard Froelich is the NRC Environmental Manager for this project. Should there be questions regarding the content of this statement, he may be contacted at the above address or at 301/492-8442.

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1. INTRODUCTION

In April 1975, the U.S. Nuclear Regulatory Commission, Office of Nuclear Regulation, issued a Final Environmental Statement (FES) for the Pebble Springs Nuclear Plant, Units 1 and 2. Hearings relative to the application f construction permits for Units 1 and 2 commenced in June 1975 and are still in progress before the Atomic S and Licensing Board (ASLB).

Since the issuance of the FES, the NRC staff has required that greater emphasis be plac on analysis of the methodology of site selection as well as data, and that the staff fully disclose its ow analytical process rather than just summarize the analysis of the applicant. This supplement presents the esults of this reevaluation of alternative sites by the staff.

The information used by the staff for its analysis was provided by the applicant in response to the staff's questions concerning alternative sites. The applicant also provided a number of siting studies commissioned by Portland General Electric Company (PGE) and other utilities in the Northwest. The staff used these in its evaluation of the applicant's methodology. These sources were supplemented by visits to the sites by the staff. The staff also met with officials of the State of Oregon to seek views of state and local agencies on power plant siting within the state and to exchange views and data on siting studies.

The staff has also retained the services of the Bonneville Power Administration (BPA) to identify and analyze the transmission systems facilities which would be needed to integrate power plant output with the Pacific Northwest bulk power transmission system. This analysis, for the Pebble Springs site and for those alternative sites selected by the staff for comparison with the Pebble Springs site, is presented in Appendix C of this supplemental environmental statement.

2. ALTERNATIVE SITE-SELECTION PROCESS

2.1 REGION OF INTEREST

2.1.1 Applicant's Selection

During preliminary investigations for the siting of nuclear power plants, potential sites outside Oregon were considered by Portland General Electric. These sites were on the Hanford Reservation and Patterson Ridge in the mid-Columbia region in the State of Washington and the Colstrip site in eastern Montana. However, the applicant decided early in 1971 to consider only sites in Oregon, unless no suitable sites could be found there. According to the utility, that decision was made because Portland General Electric was an Oregon company and its service area was within Oregon.[1,2]

In January 1976, the license application for the proposed Pebble Springs project was changed to reflect ownership by Portland General Electric (PGE), Pacific Power and Light (PP&L), and Puget Sound Power and Light (PSP&L). The latter two utilities have their corporate headquarters in Washington. It is the staff's understanding that a 17-member Oregon cooperative corporation, Pacific Northwest Generating Company (PNGC), proposes to obtain a 10% share of Unit 1. PGE remains the sponsor of the Pebble Springs project, and for the reasons stated above, still prefers to site its sponsored projects within Oregon.

2.1.2 Staff's Evaluation of Applicant's Selection

With the changes in project ownership that have occurred, the service area of the project has been extended. The PGE service area is in Oregon, and its principal load center is in the Portland and Willamette Valley areas. The PP&L service area is principally in south-central Oregon and northern California. Its service area also extends into parts of Washington, Idaho, Wyoming, and Montana PSP&L's service area is in western Washington, with a load center in the Seattle-Tacoma area. The PNGC consists of 17 cooperatives in Washington, Oregon, Idaho, Wyoming, Utah, and Nevada. There is no load center as such, but the main use of the electricity from these cooperatives is in Washington and Oregon.

Within this expanded service area, then, additional candidate areas and potential sites might be available for consideration as possible alternatives to the proposed Pebble Springs site. In fact, some of the new participants in the project already have conducted nuclear plant siting studies in other areas. For example, the PSP&L has investigated possible sites for nuclear plants in conjunction with its application for a license for a nuclear plant at Skagit, Washington, and PP&L has conducted studies to identify sites in Washington suitable for nuclear power plants. Another group of utilities, Washington Public Power Supply System (WPPSS), has two sites designated for nuclear power plants. This illustrates that there are areas outside of Oregon in which suitable sites may be found. Moreover, siting outside of Oregon may be practicable, because the transmission system in the Pacific Northwest is well integrated, and some of the other sites may be close to the load centers.

2.1.3 Staff's Independent Assessment of Region of Interest

Some potential siting areas within Washington are no farther from the load center than are the applicant's proposed or alternative sites in Oregon. Thus, with regard to the transmission of electricity, Washington areas could have advantages and offer a practical and feasible transmission distance. Moreover, nuclear power plant siting has been extensively studied in Washington; indeed, there are a number of nuclear generating facilities being built or undergoing licensing in that state that might be considered as alternative sites.*

The staff concludes that the addition of the State of Washington to the region of interest adds resource areas of sufficient diversity to provide an adequate range of environmental alternatives from which to choose a site location.

2.2 CANDIDATE AREAS

2.2.1 Applicant's Selection

Having defined its region of interest as being the State of Oregon, the applicant looked for potential sites in smaller geographic areas within Oregon by applying a screening process based on cooling water availability, seismicity, and general geographic considerations relative to transmission lines. The candidate areas thus identified by the applicant were near the Columbia River, the Willamette River Valley, and the Oregon coast.

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*An application has been filed for an operating license for WPPS 2 at Hanford. WPPS 1&4 are being constructed at Hanford, and WPPS 3&5 are being constructed at Satsop. Construction permits have been applied for by PSP&L for a two-unit station at Skagit.

The conclusions relative to availability of water were based in part on discussions between the applicant and the Oregon State Engineer regarding the general availability of surface water for power plant cooling.[3] It reportedly was indicated during these discussions that while quantities of water might be available in various locations throughout the state, the most likely sources of major additional appropriations were the Columbia River, the Willamette River, and the Pacific Ocean. The Snake River, where it borders Oregon, also was judged by the State Engineer to have an adequate water supply for a nuclear power plant. The remaining major surface water sources in Oregon generally were fully subscribed, or potential yields were uncertain relative to the large quantities required for condenser cooling. The other river systems that were considered but that did not have an adequate water supply were the Deschutes, John Day, Uattila, Malheur, Owyhee, Klamath, and the Crooked rivers.

The applicant was told by the State Geologist that the Cascade Range and large portions of central and southern Oregon, including the Klamath Falls-Lakeview area, should not be considered for siting because of seismic activity and soil instability.[4] Areas east of the High Cascades and along the coast were determined to be generally favorable in terms of seismic conditions, although the coast contained some potential slide areas.[4]

In terms of geographic considerations relative to transmission lines, the applicant concluded that siting of the plant in the northwestern quadrant of the state would be preferred because transmission costs and environmental costs would be reduced (Ref. 2, Attachment 1 to p. 4).

These various considerations favored selection of the Willamette River Valley, the lower and mid-Columbia River areas, and certain areas along the Oregon coast as candidate areas. The general geographic boundaries of each of these candidate areas are shown in Figure 2.1.

2.2.2 Staff's Evaluation of Applicant's Selection

The staff considers the screening factors used by the applicant as reasonable for identification of large areas for further study. However, after identifying these areas (Willamette, lower Columbia, mid-Columbia, and coast), the applicant eliminated all areas but the mid-Columbia from consideration essentially on nonenvironmental grounds.[1] Sites in these other areas were considered by the applicant to be difficult to license and gain public support and, therefore, plants could not be built there on a timely basis (the applicant was aiming for a 1980 startup).[1] A contributing factor in elimination of the coastal, Willamette Valley, and lower Columbia River areas from consideration was the uncertainty of the Nuclear and Thermal Energy Council site certification and review procedure pending the results of the Oregon Siting Task Force study.[5] That study has now been completed, and some areas in all three candidate areas mentioned above were found to have suitable locations for nuclear plants. Indeed, the applicant had investigated some sites in the areas that were considered by the Task Force to be suitable for nuclear power plants.

2.2.3 Staff's Independent Assessment of Candidate Areas

The staff has chosen to use drainage basins to delineate resource regions from which to identify candidate areas. Major river basins were used since they contain a number of potential sites, each having similar hydrological and aquatic characteristics but different land use, terrestrial ecology, socioeconomic structure, and geology.

The staff screened each river within Washington and Oregon by the application of arbitrary criteria that maximum pumping for a two-unit nuclear plant with cooling towers or ponds (2.8 m^3/s, or 100 cfs) should not exceed 25% of recorded low flows or 10% of predicted one-in-ten-years low flows (monthly). These criteria were selected to ensure that only those regions with the least expected aquatic impacts would be searched for alternative sites. The rivers meeting these criteria are listed by subregion in Table 2.1.

Saltwater is also a potential cooling source for power plants in Oregon and Washington. Coastal areas in which potential nuclear plant sites have been identified are the Pacific Ocean, Strait of Juan de Fuca, Strait of Georgia, and Puget Sound. Coastal sites in Washington have been reviewed as part of alternative-site testimony for the proposed Skagit Nuclear Power Plants and it was concluded that the Cherry Point site on the Strait of Georgia was the best the region had to offer.

The Snohomish River basin was eliminated because of its proximity to major population centers--the Seattle-Everett urban corridor--and because of the high quality of bordering agricultural land.[6]

Thus, for the purposes of this analysis, four inland regions were chosen by the staff for consideration as candidate areas--the Columbia River Valley (lower Columbia, mid-Columbia and upper Columbia) the Cowlitz River, the Willamette River, the Skagit River. The coastal area of Oregon and Washington also was chosen as a candidate area. Potential sites in the candidate areas are considered fully in the next section.

2.3 POTENTIAL SITES

2.3.1 Applicant's Selection

Although the applicant later eliminated all candidate areas but the mid-Columbia from consideration, the applicant or coapplicants originally performed siting studies in the Willamette Valley, lower Columbia, mid-Columbia, and coastal areas. These areas and sites are described below for the purpose of information.

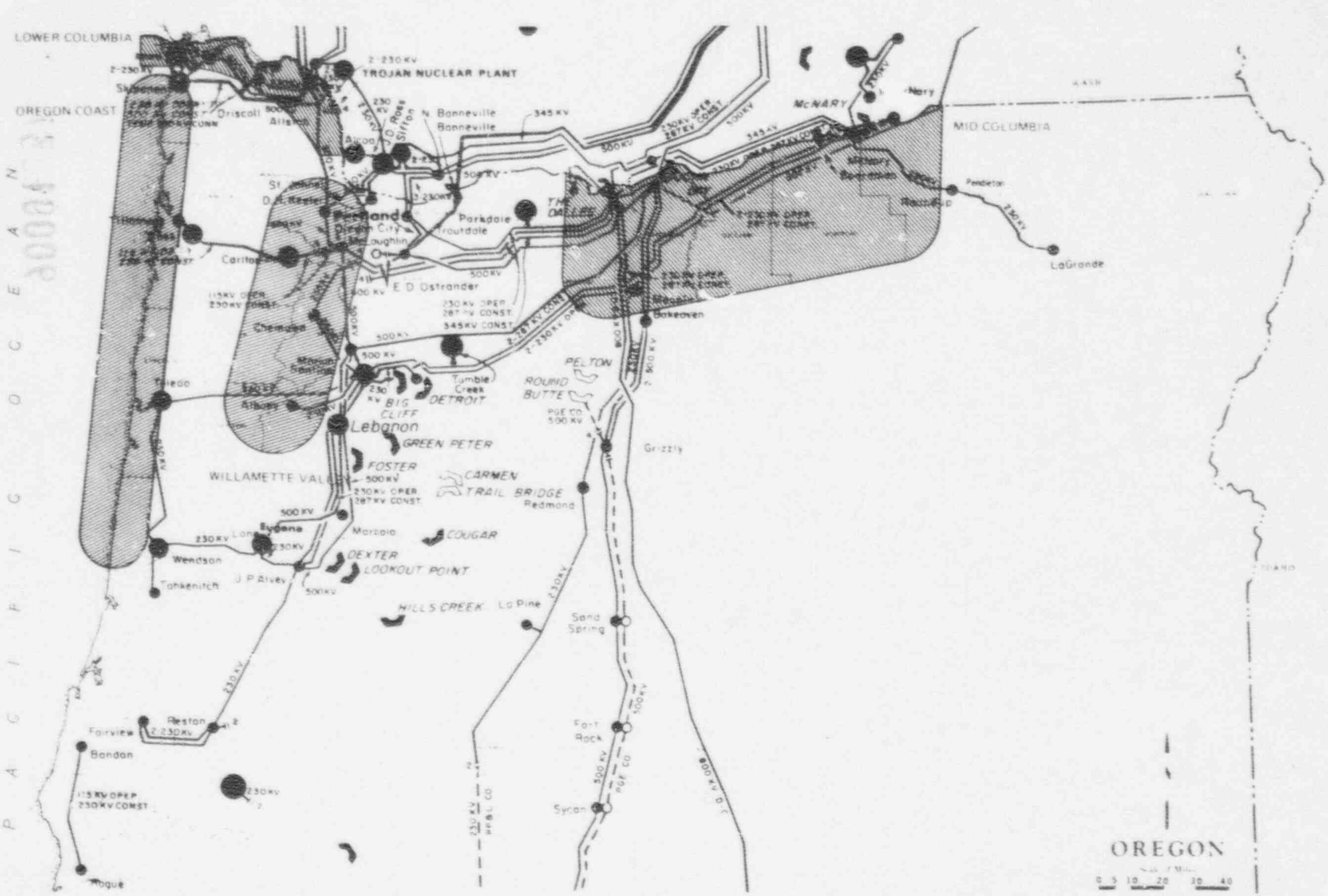

Figure 2.1. Applicant's Candidate Areas (shaded regions). [From Pebble Springs Environmental Report, Fig. 9.2-3.]

Table 2.1 Discharge Characteristics of Major Rivers within the Region of Interest, Listed by Resource Region

Resource Region/River	Minimum Flow of Record (m^3/s)	One-in-Ten Years Low Flow (monthly) (m^3/s)	Average Discharge of Record (m^3/s)
Pend Oreille River Basin			
Pend Oreille R. at Newport, WA	36	144	736
Columbia River Basin			
Columbia R. below Priest Rapids, WA	117	1841	3410
Columbia R. at The Dalles, OR	343	3000	5497
Snake River Basin			
Snake R. at Weiser, ID	266	238	515
Snake R. at Ice Harbour Dam, WA	0[a]	357	1599
Cowlitz River Basin			
Cowlitz R. at Castle Rock, WA	28	62	263
Willamette River Basin			
Willamette R. at Salem, OR	70	147	669
Snohomish River Basin			
Snohomish R. near Monroe, WA	32	b/	287
Skagit River Basin			
Skagit R. near Concrete, WA	74	144	430
Coastal Area (WA and OR)			
Not Applicable			

[a] Result of testing dam.

[b] Information not given.

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2.3.1.1 Willamette Valley

According to the applicant, among the reasons for its rejection of sites in the Willamette River Valley were that the area has a relatively high population density and contains several major urban areas. The meteorological conditions were considered to be poor because atmospheric inversions were frequent. There also is much agricultural land in that area, and the applicant was aware of the State Legislature's interest in protection of such land. The applicant reported strong public and political opposition to nuclear power plants in the area.[7] Another reason given by the applicant for rejection of the area was concern about availability of cooling water for a nuclear plant.[8]

The applicant has provided the staff with a copy of a report prepared for PP&L (one of the co-owners of the proposed Pebble Springs plant) in which three sites in the Willamette Valley are evaluated in terms of their suitability for nuclear power plants.[9] However, the Lebanon site, east of Lebanon in Linn County, Oregon, was the only one in the Willamette Valley considered by PGE (see Fig. 2.1). This site survived a screening of 23 potential sites in Oregon. The sites were evaluated in terms of environmental, socioeconomic, and geotechnical factors and engineering cost analysis. The environmental evaluation included assessment of expected impacts on the ecology, hydrology, esthetics, and archeology at the site. Some of the possible socioeconomic impacts of plant construction and operation were estimated, and cost factors related to construction and operation were evaluated.

It was concluded in the study that the Lebanon site was satisfactory both geotechnically and environmentally;[10] however, the Oregon Energy Facility Siting Council has designated as "unsuitable" for use as sites for thermal power plants, areas which consists of greater than 33% prime agricultural land.* A recently completed mapping of the Lebanon site by the Soil Conservation Service indicates that there is no Class I land, but that over 50% of the site is composed of Classes II and III farmland.[10]

2.3.1.2 Lower Columbia

The applicant made a site-selection survey of the lower Columbia River in 1966 and identified six major potential sites for nuclear power development.[11] That study was preliminary and involved a rough screening process that took into account site accessibility, transmission, flooding, seismology, and meteorology. The six locations judged by the applicant's consultant to be suitable for nuclear power development were the Warrenton, Bradwood, Beaver, Mayger, Trojan, and Deer Island sites. The site for the Trojan nuclear plant was selected from this preliminary survey. The location of these sites is shown in Figure 2.2, and the sites are described in Appendix A.

The applicant later excluded sites on the lower Columbia River from serious consideration for the current project, noting that studies first were needed to assess impacts from the thermal discharges and from cooling-tower operation of the Trojan nuclear plant before other plants could be built. One concern was the potential impact on anadromous fishery resources;[13-15] dissipation of the plume from the cooling towers was another.[16,17] Those impacts had been discussed in a 1970 statement about the Trojan site,[18] and the applicant wanted to be certain of the successful operation of the Trojan plant before constructing additional units nearby. The applicant also wanted to avoid impact interactions and adverse impacts on a proposed wildlife refuge downriver of the Trojan plant (Ref. 1, p. 9.2-16).

2.3.1.3 Mid-Columbia

The applicant preferred the mid-Columbia area for siting because of several indications that a site could be chosen, approved, developed, and put into operation for 1980 service as originally planned. Chief among these indications was a report by the State-Federal Mid-Columbia Nuclear Power Siting Task Force published in June 1971.[19] In the report the area was judged as favorable for nuclear plant development, and it was recommended that such development be combined with local interests in multipurpose irrigation development. Preliminary studies of the area had been done by the Ports of Morrow and Umatilla counties, Boeing Company, and the Bureau of Reclamation. The State Geologist declared the area favorable as well.[4]

Two other state reports also had been favorable to the mid-Columbia area. One report was a review of the Trojan site evaluation by the State Nuclear Plant Siting Task Force, published in November 1970. While approving the Trojan site, several members of the task force recommended multipurpose development of future nuclear plant cooling reservoirs, especially for irrigation in the mid-Columbia area. The report also recommended monitoring evaluations for the Trojan plant.[20]

The other report by the State Nuclear Plant Siting Task Force, published in late 1971, was an ad hoc report on siting in the mid-Columbia region.[21] It was noted in the report that the area was probably the only one in Oregon favorably disposed toward nuclear plant development, and the task force strongly supported such development with concurrent use of cooling-reservoir water for irrigation. The State Water Resources Board, from which the applicant would need a permit for a new station, was among the state agencies urging irrigation co-development. Two sites in particular were mentioned as being of interest to the state--Carty Reservoir and Cold Springs Reservoir.

*Defined by the Oregon Energy Facility Siting Council[12] as land identified by the U.S. Conservation Service as being Class I, II or III.

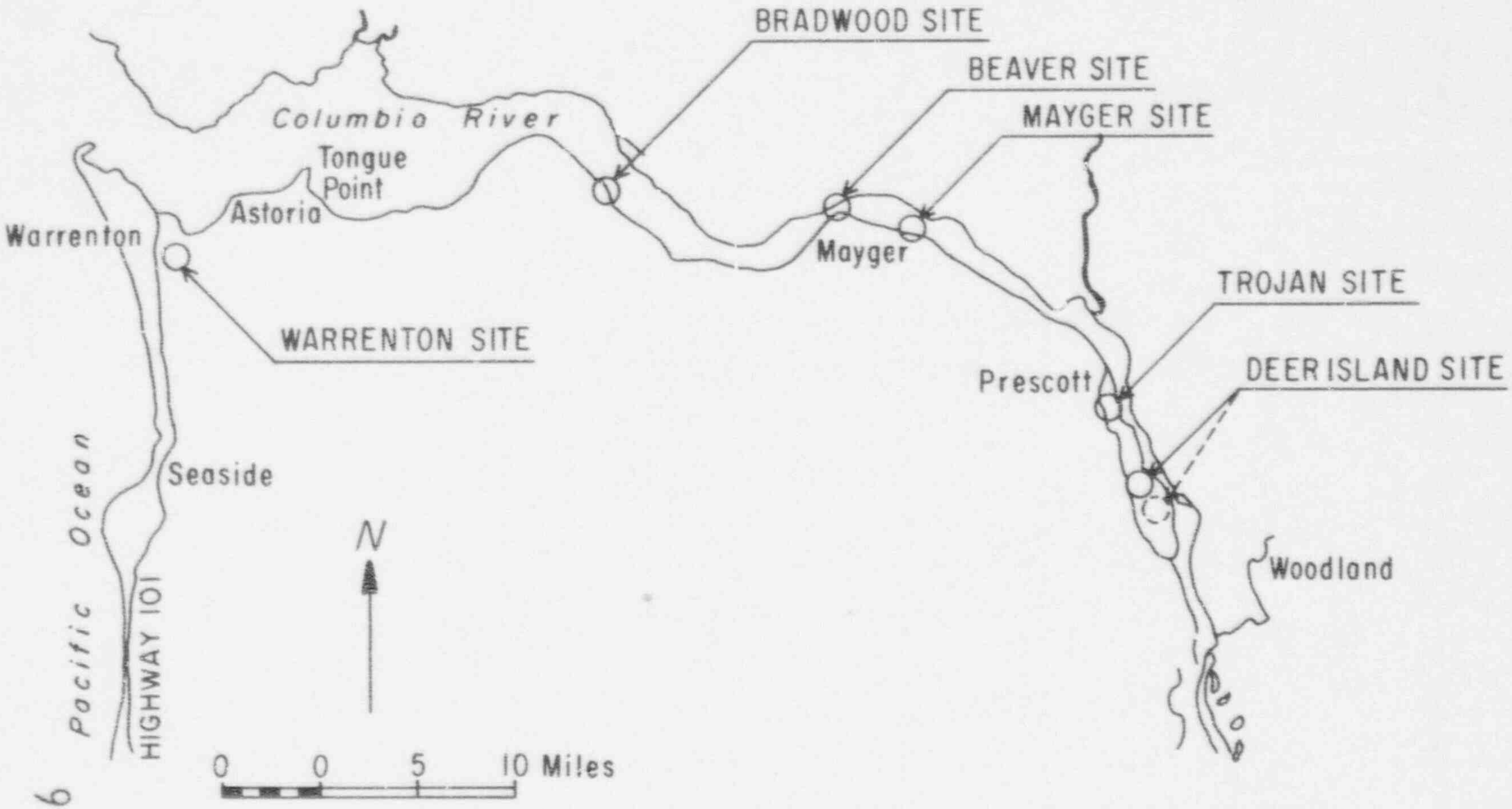

Figure 2.2. Locations of Lower Columbia River Sites.

The above considerations were seen by the applicant as factors that might be expected to "reduce the necessary lead time and the opportunities for opposition."[9] Thus, the applicant concentrated its siting efforts in the mid-Columbia area by late 1971.[22]

In identifying candidate sites in the mid-Columbia region, the applicant considered regional environmental factors (seismicity, population density, meteorology, and ecosystems) as roughly equivalent throughout the area. Therefore, criteria it used in identifying sites were: potential for multi-purpose reservoir development; population in the immediate site vicinity; water accessibility; access to transmission and transportation facilities; and site topography. Seven multi-purpose sites were identified--Cold Springs, Sand Hollow, Boardman, Juniper Canyon, Sixmile Canyon, Carty West, and Eightmile Canyon. When it became apparent that use of Boardman and possibly other multipurpose sites could be precluded because of the nearby Navy Weapons Systems Training Facility (see Fig. 2.3), the applicant identified additional sites between Willow Creek and The Dalles.[23]

Sites suitable for use of a single-purpose cooling pond or of cooling towers also were identified. The nine sites identified as suitable for cooling ponds were Pebble Springs, Alkali Canyon, Diamond Butte, Hay Canyon, China Hollow, Spanish Hollow, Mud Hollow, Fulton Canyon, and Fifteenmile Canyon. The three sites identified as suitable for use of cooling towers were West Arlington, John Day Arm, and Fulton Ridge. The sites are described in greater detail in Section 9.2.2 of Reference 1 and the locations of the sites are shown in Figure 2.3.

Later in its site-selection process, the applicant also adopted West Roosevelt,* a site in Washington just across the Columbia River from Pebble Springs, as a potential site. This site was first identified by PP&L and is described in a Woodward-Clyde report.[8]

2.3.1.4 Oregon Coastal Area

After identifying the mid-Columbia region as its primary candidate area, the applicant conducted several additional siting investigations along the northern coast of Oregon.[25-29] The Eugene (Oregon) Water and Electric Board (EWEB) had previously conducted a site-selection study for the southern coast of Oregon. Big Creek, the best site in the EWEB study, was included for consideration in the applicant's coastal siting study. Only once-through cooling was considered in these siting studies.

The applicant identified 29 potential coastal sites in a screening process that involved map evaluations, automobile and air reconnaissance, and consultation with State officials. The preliminary factors evaluated were population density; highway, rail, barge, and transmission facility access; cooling-water intake/outfall pipeline length; esthetics; land ownership; proximity to estuaries; plant foundations; public acceptance; site safety problems; topography; and proximity to kelp beds. After additional ground reconnaissance and geologic consultations, five sites were selected for more detailed investigation as potential nuclear plant sites.[30,31]

Four of the sites are in Tillamook County--Jetty Creek, on Nehalem Bay; Watseco Quarry, north of Barview (Tillamook Bay inlet); Miles Lake, north of Pacific City; and Daley Lake, north of Neskowin. The fifth site is on Big Creek (the EWEB site), north of Florence. The locations are shown in Figure 2.4.

The investigation covered site development, including circulating ocean water for cooling and potable water supply; site access, including rail, highway, and barge; and transmission considerations. Factors compared were presence of important game and fish species, population, land use, visual impact, and cost.

In order of decreasing desirability with respect to the major factors investigated, the rankings of the sites were as follows:[30]

Environmental Impact**	Access	Population Pressure	Visual Impact	Cost
Miles Lake	Daley Lake	Miles Lake	Miles Lake	Miles Lake
Daley Lake	Miles Lake	Jetty Creek	Watseco Quarry	Big Creek
Big Creek	Watseco Quarry	Big Creek	Big Creek	Watseco Quarry
Watseco Quarry	Jetty Creek	Daley Lake	Jetty Creek	Daley Lake
Jetty Creek	Big Creek	Watseco Quarry	Daley Lake	Jetty Creek

Applying equal weight to all four factors, the composite ranking in order of overall decreasing desirability was: (1) Miles Lake, (2) Big Creek, (3) Daley Lake, (4) Watseco Quarry, and (5) Jetty Creek. Although ranked as the most desirable site on the basis of the above factors, the Miles Lake site was later judged geologically unsuitable for a nuclear plant.[30]

2.3.2 Staff's Evaluation of Applicant's Selection

Although the applicant excluded sites from all but the mid-Columbia area from consideration as candidate sites primarily on nonenvironmental grounds (see Sec. 2.3.1), the applicant did identify potential sites in environmentally diverse areas. The applicant's site-selection process was neither consistent nor systematic, however.

*The staff had previously compared the West Roosevelt and Pebble Springs sites in terms of environmental impacts and concluded that the impacts of construction and operation would be somewhat greater at West Roosevelt.[24]
**Presence of important game and fish species.

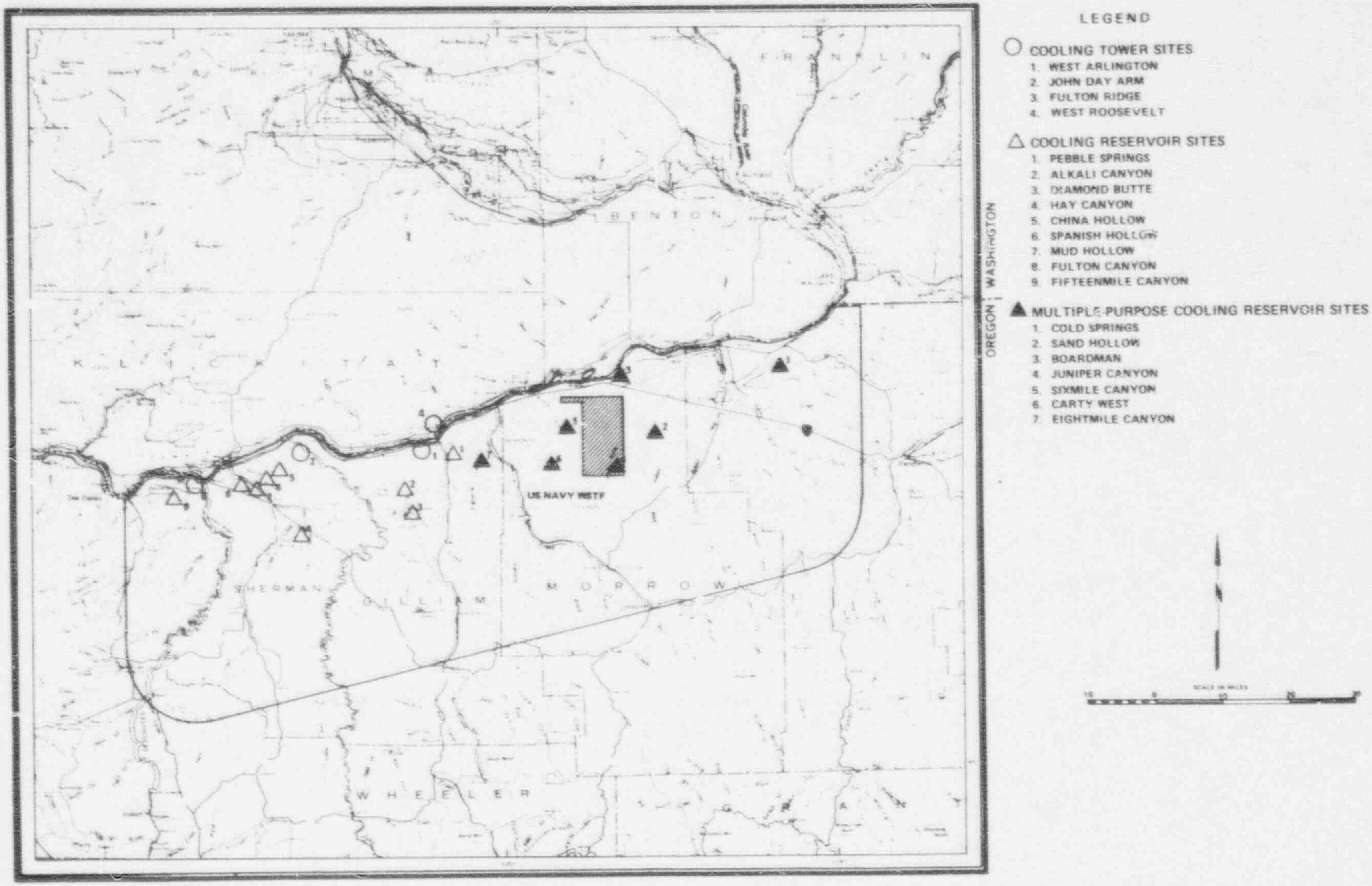

Figure 2.3. Locations of Mid-Columbia River Sites. [From Pebble Springs Environmental Report, Fig. 9.2-4.]

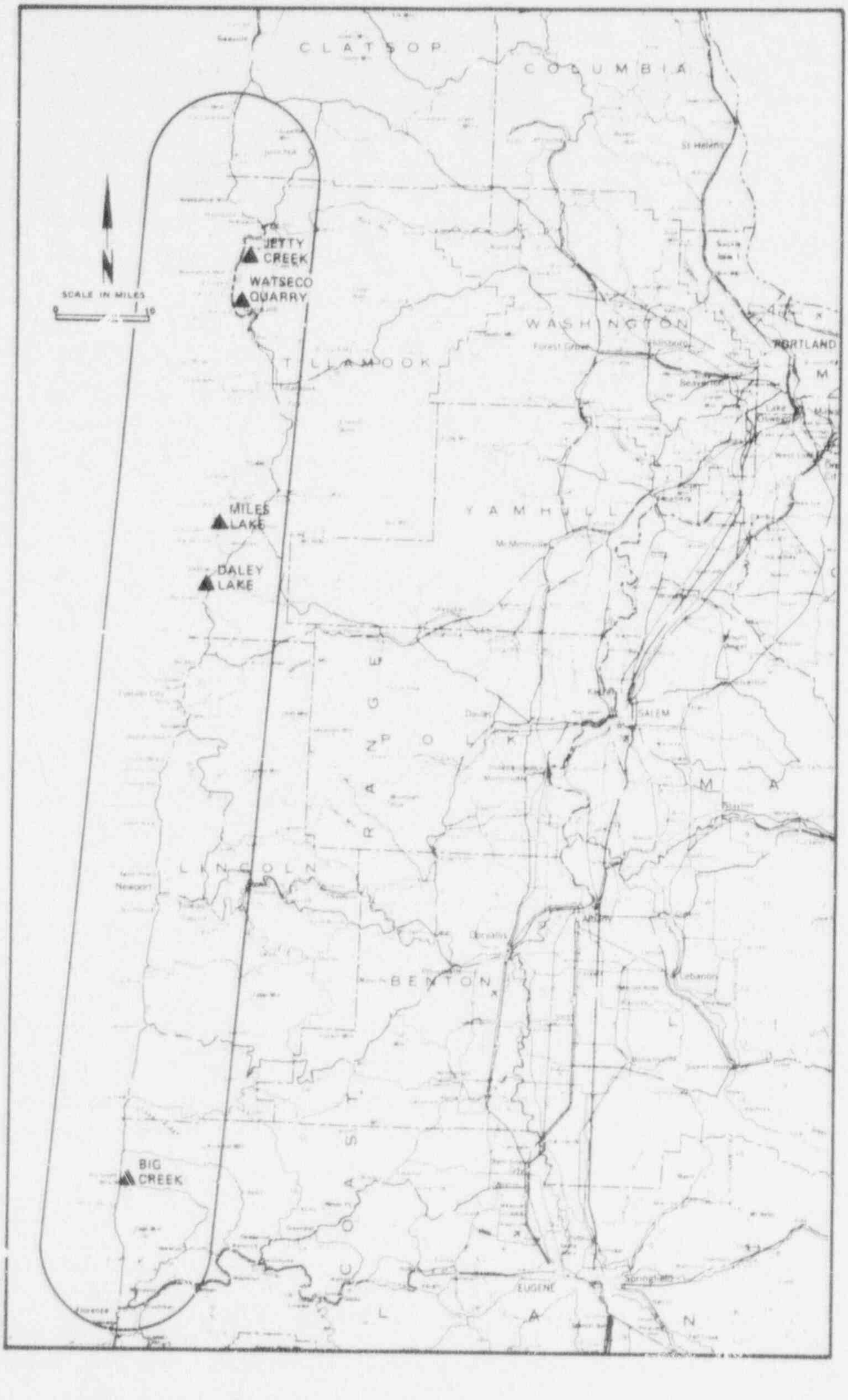

Figure 2.4. Locations of Oregon Coastal Sites. [From Pebble Springs Environmental Report, Fig. 9.2-6.]

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In some studies, the applicant's screening process involved a combination of engineering, economic, environmental, and socioeconomic factors. In other studies, fewer, or different, factors were considered. The environmental criteria used for siting varied, reflecting in part the fact that the studies were made over a period of 10 to 12 years when different regulations were in effect and when emphasis on environmental matters was changing.

On the basis of the information presented by the applicant, the staff concludes that the sites reasonably represent the variety of regional environmental factors. This conclusion is based on the information supplied by the applicant, consideration of other written material, and discussions with the applicant and state officials. Also, staff technical experts conducted ground reconnaissance of a number of potential sites considered in the applicant's analysis. Thus, the staff investigated the applicant's potential sites in different candidate areas to independently determine whether any environmentally preferable sites exist. Descriptions of the sites in terms of environmental characteristics and potential impacts for construction and operation of a two-unit nuclear plant are given in Appendices A and B.

2.3.2.1 Coastal Area

The following coastal sites previously identified by the applicant were screened by the staff for the purpose of identifying alternative sites: Jetty Creek, Watseco Quarry, Daley Lake, Miles Lake, and Big Creek. In order to include a coastal location from the Washington portion of the expanded region of interest, the staff added a sixth site--Cherry Point. The Cherry Point location has been considered as an alternative site to the proposed Skagit nuclear station.

Once-through cooling systems were assumed for these coastal sites.

2.3.2.2 Columbia River Area

For its analysis of potential sites in the Columbia River candidate area, the staff included six sites previously identified by the applicant (Warrenton, Bradwood, Mayger, Deer Island, Fulton Ridge, and Boardman) and added two more--West Roosevelt (the PP&L site) and Hanford Reservation. The Hanford Reservation is on the upper Columbia River and already has a number of nuclear installations.

The Trojan site, with one operating nuclear unit, was not considered as a suitable site because it does not have sufficient space for two more units with cooling towers.

Cooling towers were assumed for all Columbia River sites except Boardman, where use of a cooling pond was assumed.

2.3.2.3 Willamette River Area

Lebanon was the only potential site considered by the staff in the Willamette River area. It was identified as a possible nuclear plant site by a co-applicant, PP&L. Cooling towers were assumed for this site.

2.3.2.4 Cowlitz River Area

For this analysis, the staff extended the region of interest to include the Cowlitz River, and a location at Ryderwood was included for analysis as a potential site. This site was identified by PSP&L for consideration as an alternative to the Skagit site. Cooling towers were assumed for the Ryderwood site.

2.3.2.5 Skagit River

The Skagit site, identified by PSP&L and considered to be the prime site for another nuclear power plant, is the only potential site adopted by the staff for this resource area. PSP&L has a license application pending for a two-unit nuclear station at the Skagit site. Hearings concerning the application currently are being held before the Atomic Licensing and Safety Board. In considering Skagit as an alternative site, the staff assumed that two units would already exist at the site, and two new units would be added. The new units would use the same basic design of intake/discharge and cooling towers as the existing Skagit units.

2.4 ALTERNATIVE SITES

2.4.1 Applicant's Selection

2.4.1.1 Procedure

The applicant selected alternative sites after choosing the mid-Columbia area as the principal candidate area. Site-specific information on geology, seismology and meteorology was obtained to evaluate each site relative to specific alternative plant and cooling-system designs. Regional geologic studies and general economic evaluations were made of several sites. More detailed economic evaluations and preliminary ecological characterizations subsequently were performed for three locations which emerged as prime candidate sites--Boardman, Pebble Springs and Fulton Ridge.[2]

The multiple-unit potentials of Boardman (up to four units) and of Pebble Springs (up to two units) made them attractive to the applicant. The remaining 17 potential sites in the mid-Columbia area had been represented as one-unit sites.[1] As a result of its evaluations, the applicant first selected Boardman (1973) as the proposed site for its nuclear project. However, the U.S. Atomic Energy Commission determined that the presence of the

Navy's Weapons System Training Facility adjacent to the Boardman site (see Fig. 2.3) constituted a serious problem because the proposed nuclear facility was not designed to withstand the impact of an aircraft crash, and assurance was not available that the Navy would move its Weapons Training Facility. The applicant subsequently decided that the economic cost of "hardening" the proposed station would be too great, and decided instead to file an application for the Pebble Springs site for its two-unit nuclear power plant.

2.4.1.2 Staff's Evaluation of Applicant's Selection

A major defect in the applicant's site-selection process was that having investigated and identified environmentally diverse resource areas (and possible sites in those areas), the applicant excluded from consideration (primarily on nonenvironmental grounds) potential sites from all but the mid-Columbia candidate area. Thus, a number of sites possibly acceptable on environmental grounds were eliminated from consideration. The NRC staff was unable, on the basis of the applicant's analysis, to determine if environmentally preferable sites were available in the wider region of interest. Moreover, it is the opinion of the staff that the applicant, having elected to concentrate its efforts in the mid-Columbia area, should have conducted a more explicit environmental comparison to determine the best site within that area, even though differences among sites in the area may be small.

2.4.2 <u>Staff's Site Selection Process</u>

2.4.2.1 Introduction

The staff does not subscribe to any single site-selection process or methodology. Rather, applicants are given considerable latitude as long as their treatment of key issues is reasonable, logical, consistent, and results in identification of reasonable siting options. Because of the deficiencies in the applicant's site-selection process in this case, the staff has developed an independent site screening and analysis to ensure that sites with a wide range of environmental conditions are evaluated and compared to the Pebble Springs site.

The staff chose 17 sites located in five candidate areas in Oregon and Washington as potential sites. In each of three candidate areas, only one potential site was identified. These three sites were carried forward without further screening: Skagit (Skagit River candidate area), Ryderwood (Cowlitz River area), and Lebanon (Willamette River Valley area).

Several potential sites have been identified in each of the two remaining candidate areas--the coastal area has six sites, and the Columbia River area has eight. To identify one or more alternative sites from each of these two candidate areas, the staff developed a screening process by which the sites within each area were rated according to the potential for environmental impacts on terrestrial, aquatic, geologic/hydrologic, and socioeconomic resources. (These topics are hereafter referred to as "resource categories.") Although other resource categories also could have been considered, the staff felt that the four used were adequate to identify important environmental differences among the sites.

For each of the four resource categories, the sites considered within each of the two candidate areas were rated by the staff on the basis of reconnaissance-level information.* Based on these ratings, the sites within each area then were grouped into those with (1) low potential for adverse impact, (2) intermediate potential for adverse impact, and (3) high potential for adverse impact. This was done for each resource category, and alternative sites were selected from the two candidate areas on the basis of a combined rating of all the resource categories. The three sites thus identified were considered as alternative sites to be compared, along with the alternative sites in the three single-site candidate areas, with the proposed Pebble Springs site.

Results of this screening process for the coastal and Columbia River candidate areas and ranking methods and criteria used for each resource category are outlined in the following sections. The various sites are described in Appendices A and B.

2.4.2.2 Screening for Alternative Sites

2.4.2.2.1 Terrestrial Resources

<u>Criteria and Methods</u>

In general, major impacts to the terrestrial ecosystem from power plant construction and operation arise primarily from loss and alteration of terrestrial wildlife habitat and from loss of the soil resource. These impacts are considered major because they are long term (extend beyond the life of the power plant) and are essentially impossible to mitigate. Impacts such as those that arise from noise, dust, and drift from freshwater cooling towers are of less concern because they are short term and can be controlled with proper station design and/or mitigated without unreasonable economic cost.

For this resource category, the staff based its ranking of the sites on characteristics that have direct bearing on the potential for habitat loss and/or soil erosion--habitat type; water erosion hazard (primarily based on slope and rainfall); land use; habitat type traversed by, and length of, rights-of-way for access roads, railroad

*Reconnaissance-level information consists of information from open literature, published or unpublished reports, existing records, and authoritative sources, or information that can be obtained by brief field surveys performed by skilled investigators. It does not include information that can be obtained only by detailed onsite monitoring programs or studies.

spurs, pipelines, and transmission corridors; and any special problem. The land-use characteristic is important not only in terms of habitat evaluation and soil erosion, but also in terms of the human aspect of the terrestrial ecosystem.

Each characteristic was rated using the following scheme:

"+"--has little or no potential for long-term impacts;

"0"--any impacts to the terrestrial environment are likely to be short term, or more readily mitigated than at sites rated as "-";

"-"--has the potential for a long-term, adverse impact.

The rating system and criteria used in ranking sites with regard to impacts on terrestrial resources are explained below:

- Habitat--If the site consists of forest, a "-" rating has been given because forest habitats in Oregon and Washington, particularly those in the Coast Ranges and in the Cascades, are among the most productive in the world and support a variety of wildlife. The regeneration time for such forests ranges from decades to hundreds of years. Because these forests occur primarily on foothills and mountains, the potential is high for erosional loss of soil during construction. The soils of the forests in Oregon and Washington are among the finest forest soils in the world; they are deep, relatively rich, fine-textured, and high in organic matter and nitrogen.[32] Soil loss is essentially irretrievable. If the site consists of old field, pasture, or grasslands that have been overgrazed, revegetation of areas disturbed during construction is expected to be achieved within the lifetime of the station (short term), given a reasonable reclamation effort. Such sites have been rated "0". If a site already is devoted to industry and no additional offsite terrestrial habitat would be lost or altered, a "+" rating has been given.

- Erosion Hazard--If the site is relatively flat, the water erosion hazard is usually slight,[33] and a rating of "0" has been given. The erosion hazard on slopes will range from moderate to severe, depending on such factors as the magnitude of the slope;[34] a rating of "-" has been given to sites on sloping terrain. A "+" rating indicates essentially no potential for soil erosion.

- Land Use--For sites currently devoted to wildlife habitat, harvesting of forest products, or multipurpose use, such as recreation-wildlife habitat-residential, a "-" rating has been given. If the site is devoted to industrial use, such as for an existing power plant or manufacturing installation, a "+" rating has been given because little or no disturbance of terrestrial habitat is expected. (Exceptions might be sites where an adjacent industry may result in synergistic adverse effects on the terrestrial ecosystem; determination of the existence of this potential would require detailed site-specific data not available from a reconnaissance survey.) If the land is in range, crops, pasture, or old field, a "0" rating has been given (except for Class I or II farmland, in which case a "-" rating has been given because such land is at a premium and is essential for long-term production of food).

- Utility and Transportation Rights-of-Way--For any necessary transmission corridors, pipelines, access roads, and railroad spurs, both the type of habitat to be traversed and the length of rights-of-way were considered in rating the sites. Habitats along the rights-of-way were rated as discussed above for the site proper. If no new offsite corridors or roads would be required, a rating of "+" has been given. New rights-of-way up to 10 miles long or corridor widening have been rated as "0". New rights-of-way in excess of ten miles have been rated as "-". (The value of 10 miles is arbitrary and can be excluded from the evaluation unless all other factors are equal.)

- Unresolved Considerations--Any other characteristics of the site that have the potential for a significant adverse impact but that have not been investigated in any detail are listed under this category. No ratings are given since the severity of the potential impact has not been ascertained. If any locations with special problems were selected as alternative sites, these unresolved considerations would need to be examined in some detail. (Potential problems with rare, endangered, or protected plant and animal species are examples of site characteristics that cannot be determined without detailed species identification at the individual sites.) In the table summarizing the ratings relative to terrestrial impacts, a blank space under the heading "Unresolved Considerations" is not intended to imply that there are no such problems for a given site; rather, it simply means that no such problems were identified with the reconnaissance-level information used for this initial screening.

Results and Discussion

Ratings of the sites relative to terrestrial resources are shown in Table 2.2. Depending on the relative number of "-", "0", and "+" ratings assigned in the initial rating, the sites within each of the two candidate areas then were grouped (see Table 2.3) into (1) those with the low potential for a long-term, adverse impact, (2) those with intermediate potential, and (3) those with high potential.

Table 2.2 Evaluation of Potential Sites Relative to Terrestrial Resources[a]

Site	Habitat	Erosion Hazard	Land Use	Pipelines, Roads, R.R. Spurs	Transmission Corridors	Unresolved Considerations
Coast						
Big Creek	-	-	-	-	-	Proposed wilderness area immed. east
Cherry Point	0	-	0	-	0	Synergisms with aluminum plant?
Daley Lake	0	0	0	-	-	
Jetty Creek	-	-	-	-	-	Large spoil area required
Miles Lake	-	0	-	-	-	Fragile ecosystem (sand dune area)
Watseco Quarry	0	-	-	-	-	Severe erosion hazard
Columbia River						
Boardman	0	0	+	+	0	
Bradwood	-	-	*[b]	0	0	Proximity to proposed wildlife refuge
Deer Island	0	0	0	0	0	
Fulton Ridge	0	0	*	-	0	
Hanford	+	0	+	+	+	Pacific flyway
Mayger	-	0	+	0	0	Proximity to wildlife refuge
Warrenton	-	-	*	0	0	
West Roosevelt	0	0	-	-	0	

[a]See Section 2.4.2.2.1 for basis of rating system.

[b]*Assumes no new offsite transmission lines required.

Table 2.3 Grouping of Sites Relative to Potential for Adverse Terrestrial Impacts[a]

Potential for Adverse Impacts	Coastal Area	Columbia River Area
Low	Daley Lake	Boardman Hanford
Intermediate	Cherry Point[b]	Deer Island Fulton Ridge Mayger West Roosevelt
High	Big Creek Jetty Creek Miles Lake Watseco Quarry	Bradwood Warrenton

[a]Arrangement within each group is alphabetical.

[b]If uncertainties described in the text are removed, Cherry Point is expected to have low potential for adverse impact.

The staff's evaluation of the specific characteristics of the sites in the coastal and Columbia River candidate areas relative to terrestrial resources is discussed in detail below.

Coastal Area. Among the coastal sites the Daley Lake site was selected as having the least potential for long-term, adverse impact. The site is an open meadow on flat to gently sloping ground. With the exception of the Miles Lake site, the other coastal sites considered are on steeper slopes where the erosion hazard is greater. The Miles Lake site, however, consists of forest and brush in a sand dune area. Stable sand dune vegetation communities can develop only after hundreds of years. The communities usually are fragile, and if they were disturbed by plant construction, it is considered probable that reclamation could not be achieved within the lifetime of a power station. Since the length of transmission corridors and the type of habitat traversed would be similar for Miles Lake and Daley Lake, there would be no advantage in selecting the Miles Lake site over the Daley Lake site.

The Cherry Point site was rated intermediate in potential for adverse impact. The site has high bluffs, but portions are relatively flat, and construction could be limited to the flat areas. An advantage of the Cherry Point site is the industrial nature of adjacent areas, which include an oil refinery and an aluminum plant. Use of the Cherry Point site would involve no major change in land-use patterns of the area; also, there is the possibility that no new offsite transmission corridors would be required (although the corridors would need to be widened) if a tie-in could be made with existing corridors serving nearby industrial sites. However, the possibility of adverse synergistic effects, such as interaction of effluents, should be considered.

Along with the Miles Lake site, Big Creek, Jetty Creek, and Watseco Quarry have the highest potential for long-term, adverse impacts relative to erosion hazard and habitat loss, either on the site or in the rights-of-way.

Columbia River Area. The Hanford and Boardman locations are existing power plant sites, and therefore little or no terrestrial habitat would be lost or altered and no new offsite transmission corridors are expected to be required. The Boardman transmission corridors would, however, require widening. The Deer Island and Mayger sites are on unforested, flat ground, but are in the floodplain of the Columbia River; construction at these sites is expected to have adverse effects on riparian vegetation and wetlands that probably serve as resting areas for migratory waterfowl. The staff is of the opinion that development and construction on any floodplain is ill advised (Executive Order 11988, Floodplain Management). The Fulton Ridge and West Roosevelt sites are on relatively flat ground in unforested areas containing shrub-steppe vegetation. However, there is some evidence of the presence of critical wildlife habitat in these areas (see Appendix A). The Bradwood and Warrenton sites are hilly and mainly forested; soil erosion and loss of terrestrial habitat for diverse fauna are expected to be more severe at these sites than at the other Columbia River sites considered.

Summary

Relative to potential impacts on terrestrial resources, the preferred coastal site is Daley Lake (low potential for adverse impact), followed closely by Cherry Point (intermediate potential). Along the Columbia River, the Boardman and Hanford sites are preferred (both ranked as having low potential for adverse impact).

2.4.2.2.2 Aquatic Resources

Criteria and Methods

In general, potential impacts to aquatic environments from construction and operation of a nuclear generating facility include destruction of habitat, effects of sedimentation, impingement and entrainment of aquatic organisms in the cooling water intake system, thermal and chemical effects from plant discharges, and competition among water users. The magnitude of these impacts depends on plant design, on the hydrological characteristics of the water supply, and on the types and sensitivity of aquatic biota. The ranking of sites in this report is based on reconnaissance-level information, often without site-specific plant designs. Although this level of information introduces additional errors in predictions of the magnitudes of site-specific impacts, these impacts can still be assessed using general site descriptions and regional ecological information.

The use of reconnaissance-level data often precludes the use of absolute criteria in assessing ecological characteristics of the sites and potential impacts of plant construction and operation. Therefore, implicit in its assessment of aquatic impacts, the staff has evaluated the potential sites being considered within each candidate area on a comparative basis rather than in absolute terms. Each characteristic considered was given a "+", "0", or "-" rating. Characteristics were rated according to the following criteria:

"+"--Potential for impacts is less than for most other sites within the candidate area, magnitudes of impacts expected to be less than at most other sites within the area, or the characteristic has significantly less value or quality than for most other sites within the area--site has some overall environmental advantage;

"0"--Potential for impacts is similar to most other sites within the candidate area, magnitudes of impacts expected to be similar to most other sites within the area, or the quality or value of the characteristics is indistinguishable from most other sites within the area--site has no overall environmental advantage;

"-"--Potential for impacts is greater than for most other sites within the candidate area, magnitudes of impacts expected to be greater than at most other sites within the area, or the quality or value of the characteristics is significantly greater than for most other sites within the area--site has some environmental disadvantages.

The characteristics or factors used for the evaluation of the sites were:

- Fisheries--Evaluated on the basis of fish and shellfish species present and presence of important fish habitat and fisheries areas within the vicinity of the site. (Site-specific information on the presence of rare or endangered aquatic species was available only for the Hanford site; thus that factor has not been included in this evaluation.)

- Expected Disturbance of Aquatic Habitat--Evaluated on the basis of the quantity of habitat lost or altered and expected impacts of the disturbance.

- Sedimentation Impacts--Evaluated on the basis of erosion potential of the site, expected route of sediment discharge to aquatic habitats, ambient sediment loads, size of the area affected, and relative sensitivity of affected biota.

- Effluent Impacts--Evaluated on the basis of type and quantity of effluents, size of area impacted, species and important habitat potentially affected.

- Impingement and Entrainment--Evaluated on the basis of how many and what types of aquatic biota are expected to be impinged or entrained by operation of the cooling-water intake system.

Results and Discussion

The ratings of the sites in the two candidate areas are shown in Table 2.4. In Table 2.5 the sites in each area are grouped according to potential for impact on aquatic resources. The staff's evaluation of the sites relative to aquatic resources is given in more detail below.

Coastal Area. The coastal sites differ in regard to the presence of important fishery species and fish habitat within the expected influence of a once-through cooled nuclear power plant of 2000 MWe. On the basis of fish and shellfish species and habitat, the staff considers Miles Lake and Daley Lake to be the preferred sites for power plant development. In the vicinity of these sites, the only abundant salmonid fish are cutthroat trout. In addition, shellfish stocks have less fishing value at these two sites than at other sites. These sites are given a "+" rating. The staff has given Watseco Quarry and Cherry Point a "0" rating because some fishery resources are located nearby. Sites near estuaries, important fishing areas, or with populations of several different salmonid and shellfish species are rated "-" (Big Creek and Jetty Creek).

The staff expects that disturbance of aquatic habitat would be least at Watseco Quarry and at Cherry Point, where no barge basins would be necessary and where disturbance of the freshwater bodies on the sites would be minimal. These sites are given a "+" rating. Although no barge basin would be necessary at Jetty Creek, long makeup water lines would traverse the intertidal zone, and a creek would be rerouted around the plant. Thus, the staff gives the site a "-" rating. Development of the Big Creek site would require construction of a barge basin in the intertidal zone, extensive modification of the channel and floodplain of the creek, and impoundment of the upper reaches of the creek. Thus, Big Creek also has been given a "-" rating. All other sites are expected to experience intermediate impacts and are given a "0" rating.

Impacts from sedimentation during construction are expected to be less severe where no streams exist onsite (Cherry Point, "+" rating), and the greatest where larger streams will be highly disturbed, where barge basins will be constructed in the intertidal zone, and where significant runs of anadromous fish occur (Big Creek, "-" rating). Although the latter conditions are also present at Jetty Creek, aquatic communities adapted to tidal flows from the estuary are presumed to be adapted to withstand periods of high turbidity; therefore, Jetty Creek is rated "0", as are Daley Lake, Miles Lake, and Watseco Quarry.

Impacts of discharges of heated effluents and chemicals from once-through cooling are expected to be greatest at sites near shellfish areas, major sport fishing, or commercial fishing grounds, and sites that are near the mouths of estuaries (Jetty Creek). This site is given a "-" rating. Impacts of effluents are expected to be less at all other sites, and they are given "0" ratings (Big Creek, Cherry Point, Daley Lake, Miles Lake, and Watseco Quarry).

Impingement and entrainment of aquatic organisms are expected to be the greatest in protected areas, near major fish and shellfish nursery areas, and at the mouths of estuaries (Jetty Creek, "-" rating). All other sites are judged to be intermediate ("0") relative to impingement and entrainment.

Thus, on the basis of aquatic resources, the Cherry Point site is expected to experience the least impact due to power plant development, and Big Creek and Jetty Creek sites are expected to experience the greatest impacts. Daley Lake, Miles Lake, and Watseco Quarry sites are intermediate (Table 2.5).

Table 2.4 Evaluation of Potential Sites Relative to Aquatic Resources[a]

Site	Fisheries	Disturbance of Aquatic Habitat	Sedimentation Impacts	Impacts of Effluent Discharges	Impingement and Entrainment
<u>Coast</u>					
Big Creek	-	-	-	0	0
Cherry Point	0	+	+	0	0
Daley Lake	+	0	0	0	0
Jetty Creek	-	-	0	-	-
Miles Lake	+	0	0	0	0
Watseco Quarry	0	+	0	0	0
<u>Columbia River</u>					
Boardman	0	0	0	+	*[b]
Bradwood	0	0	0	0	*
Deer Island	0	0	0	0	*
Fulton Ridge	0	0	0	0	*
Hanford	-	0	0	-	*
Mayger	0	0	0	0	*
Warrenton	-	-	0	-	-
West Roosevelt	0	0	0	0	*

[a] See Section 2.4.2.2 for basis of rating system.

[b] * = Insufficient data available to rate this site for this factor.

Table 2.5 Grouping of Sites Relative to Potential for Adverse Aquatic Impacts[a]

Potential for Adverse Impacts	Coastal Area	Columbia River Area
Low	Cherry Point	Boardman
Intermediate	Daley Lake Miles Lake Watseco Quarry	Bradwood Deer Island Fulton Ridge Hanford Mayger West Roosevelt
High	Big Creek Jetty Creek	Warrenton

[a]Arrangement within each group is alphabetical.

Columbia River Area. Anadromous salmonids are important at all Columbia River sites, as are native and introduced warmwater fishes. Relative to fisheries, a "-" rating has been given to Warrenton because it is at the mouth of the Columbia, Oregon's major salmon fishing area and an important habitat for a variety of shellfish and bottomfish.[35] Hanford also has been given a "-" rating because the Priest Rapids spawning area of fall chinook salmon and steelhead trout is upstream from the site.[36] Based on the limited information available on biota, all other sites are ranked as similar to each other relative to fisheries and have been given "0" ratings.

Little aquatic habitat would be disturbed at any site except Warrenton, where intakes would be placed in an estuary and the outfall in the Pacific. Warrenton has been given a "-" rating, and all other sites have been rated "0" for this factor.

Sedimentation impacts to aquatic environments are indistinguishable without further site-specific design information. Thus, based on reconnaissance-level information, all sites are expected to have minor sedimentation impacts and have been given "0" ratings. Impacts of effluent discharges would be least at Boardman because no effluents would be released to the Columbia River, and this site has been given a "+" rating. Since three units already are under construction at Hanford, the siting of two more units there would mean that effluents would be discharged from a total of five units on the site. Therefore, the site has been given a "-" rating relative to impacts of effluent discharges. Warrenton, with once-through cooling, has been given a "-" rating relative to sites with cooling towers.

Since the location and design of cooling-water intakes is not known except for Warrenton and Hanford, the relative impingement and entrainment potential of the sites for the most part cannot be ranked. At Hanford, specially designed intakes for WPPSS 1, 2, and 4 are expected to result in insignificant impingement and entrainment, even though small salmonid juveniles are abundant.[37] However, no rating has been given for this factor for Hanford or any of the other sites where cooling towers would be used. This is because insufficient information on biota and intake placement is available to compare those sites. Warrenton has been given a "-" rating because impingement and entrainment rates in intakes located on an estuary are expected to be significantly greater than for sites nonestuarine.

Thus, on the basis of aquatic resources, the Boardman site is expected to experience the least impact from nuclear plant construction in the Columbia River candidate area and Warrenton is expected to experience the greatest impact (Table 2.5).

Summary. On the basis of impacts to aquatic resources, the Cherry Point site in the coastal candidate area is judged to have low potential for adverse impacts; in the Columbia River area, the Boardman site is ranked as having low potential for adverse impacts (Table 2.5).

2.4.2.2.3 Geologic and Hydrologic Resources

Criteria and Methods

Two general types of impacts are considered for this resource category--(1) impacts that construction or operation of a plant could impose on the resources (e.g., alteration of stream flows), and (2) potential influences of geology or hydrology that could impede operation of the plant or jeopardize the public health and safety (e.g., potential for a damaging earthquake at the site).

Potential impacts of construction or operation on geologic and hydrologic resources considered in this report include loss of mineral resources, alteration of streamflow, acceleration of slope failure and erosion (acceleration of mass wasting), and restrictions on utilization of surface water or groundwater (reduction of either availability or quality). Although neither long-term nor significant relative to geologic time, these impacts are, however, significant in terms of present use of the site vicinity by plant, animal, and human populations.

Potential impacts of geologic and hydrologic features on operation of a nuclear power plant and on public health and safety considered in this report include surface faulting, vibratory ground motion, volcanic hazards, foundation suitability, and flooding. Although such factors are basically more pertinent to a discussion of reactor safety than of environmental impacts, they nonetheless have been included here for initial screening purposes.

For each site, each potential impact considered was rated (if sufficient information was available) as follows:

"+"--adverse impact unlikely;

"0"--adverse impact may occur but either is not expected to be severe or mitigation is possible;

"-"--adverse impact may be unavoidable and may be severe.

The criteria used in the assignment of ratings for specific potential impacts were as follows:

Loss of Mineral Resources:

"+"--No mineral resources of economic significance are within the exclusion area;

"0"--Mineral resources within the exclusion area are marginally economic, or economically recoverable resources are so close to the site that the power plant will influence mining operations;

"-"--The site contains economically recoverable and valuable mineral resources.

Alteration of Stream Flow:

"+"--No stream flows through the site, the site is not on a floodplain, the plant will not restrict natural stream channel migration, the plant will not require a dam, streamflow will not be affected;

"0"--A stream crosses the site, the watershed is small and the topography lends itself to rerouting or enclosing the stream in a culvert (if necessary), the plant will require an impoundment on the stream;

"-"--The site is on a floodplain, an actively cutting stream crosses the site, surface gradation of the site dams a stream, probability of siltation and flooding is high.

Acceleration of Mass Wasting:

"+"--There is no evidence that a plant or its reservoir might trigger landslides, no ancient slides in the vicinity, possible slide surfaces are not saturated, water table is low, water table will not be significantly affected by plant construction or operation, little excavation so the disturbance of the ground's surface would be minimized;

"0"--Moderate slopes, some excavation required but backslopes will be gentle, groundwater can be controlled, no local slides in materials similar to those that will be affected by excavation, more surface disturbance due to slopes of excavation walls;

"-"--Steep terrain, nearby slide scars, excavation will remove the toes of slopes, excavation will produce high backwalls, water table is high, artesian conditions that could cause heave in floor of excavations, soil and groundwater conditions that could cause piping, large area of ground disturbed.

Potential for Surface Water Utilization:

"+"--Surface water is abundant and the consumption of water by the plant will have no adverse effect on water quantity or use of the water by others;

"0"--Water is available but storage will be required to augment low flows, quality may be impaired but not below applicable standards;

"-"--Water is unavailable, water has been previously allocated, water consumption by the plant will decrease overall water quality.

Potential for Groundwater Utilization:

"+"--Quality and quantity of groundwater available to other users will be unaffected or improved;

"0"--Plant site will require dewatering during construction but the effects will be temporary and local users can be supplied from other sources during that time;

"-"--Plant dewatering will dewater local streams, ponds or lakes, or plant site will require permanent dewatering, groundwater available to other users reduced.

Surface Faulting:

"+"--There are no capable faults that fall into the distance/length categories described in 10 CFR Part 100, Appendix A;

"0"--Capable faults exist near the site but the site is outside the zone requiring detailed fault investigation as defined in 10 CFR Part 100, Appendix A;

"-"--The site is located within the fault zone of a capable fault, or the site is located in a cavernous area that may be subject to surface faulting at a later date.

Vibratory Ground Motion:

"+"--The site is in seismic risk zone 1 or 2 and its foundation is bedrock;

"0"--The site is in seismic risk zone 3 and its foundation is bedrock, or the site is in seismic risk zone 1 or 2 and there are tens of feet of unconsolidated sediments above the bedrock;

"-"--The site is in seismic risk zone 2 or 3 and has a deep, unconsolidated foundation.

Volcanic Hazards:

"+"--No volcanic activity could affect plant operation;

"0"--Ashfall possible, but not impairing safe plant operation or shutdown;

"-"--Site could be affected by mud flow, tephra, or lava flow.

Foundation Suitability:

"+"--Solid rock, not subject to fault displacement or dissolution, deep water table;

"0"--Unconsolidated sediments above bedrock, settlement, pore pressures, etc., can be controlled, deep piles or excavation required for the heavier structures;

"-"--Deep, unconsolidated sediments (especially if saturated), potential for liquefaction, karst topography, regional subsidence.

Flooding:

"+"--The site is well above the level of the probable maximum flood, including the combined effects of rainfall, upstream dam failure, seiche, and tsunami;

"0"--The plant site is at about the same level as the probable maximum flood;

"-"--The plant site is likely to be flooded.

Results and Discussion

Results of the staff's evaluation of the potential impacts considered are shown in Table 2.6. The ratings shown have been used to group the sites according to the potential for adverse impacts (Table 2.7). Geologic and hydrologic conditions at the sites are summarized in the following paragraphs; however, because of the number and complexity of impacts considered, not all impacts and ratings have been explicitly mentioned in the discussion for each site.

Coastal Area. The Daley Lake site is the only site in the coastal candidate area that has been assigned no "-" ratings. This site has a relatively shallow sandstone formation for a foundation, and unlike the other coastal sites, does not straddle a narrow, stream-carved valley. The topography is more gentle and rolling. Cut slopes would be smaller here than at other sites in this candidate area.

The Big Creek site received only one "-" rating (flooding potential). It is downstream of the proposed Big Creek dam in the floodplain of Big Creek and is at about the same elevation as the maximum elevation for tsunamis (seismicly induced tidal waves). More excavation would be required and slopes would be steeper than at Daley Lake.

The Watseco Quarry site has a relatively high potential for landslides, and the Garibaldi fault system may extend onto the site.

Cherry Point is on a deep deposit of unconsolidated till, and foundations could not be put on solid bedrock. Structures there would be more susceptible to such conditions as settlement and amplification of ground motion.

The Jetty Creek site is in steep, densely vegetated terrain. Construction there would require the most excavation of any of the sites considered in the coastal area and would result in the placement of the most fill in a stream valley. The impact on the creek could be significant. The area is also susceptible to landslides.

The staff considers the Miles Lake site to be poor for the siting of a nuclear plant because (1) it is located on a tilted fault block (which makes stability less than certain), and (2) the site would require dewatering for construction, and that could result in the dewatering of Miles Lake.

On balance, then, within the coastal candidate area the Big Creek and Daley Lake sites are rated as having low potential for adverse impacts in terms of geologic and hydrologic resources, Cherry Point, Jetty Creek, and Miles Lake sites have high potential for adverse impact, and the Watseco Quarry site is intermediate.

Table 2.6 Evaluation of Potential Sites Relative to Geologic and Hydrologic Resources[a]

Site	Loss of Mineral Resources	Alteration of Stream Flow	Acceleration of Mass Wasting	Potential for Surface Water Utilization	Potential for Groundwater Utilization	Surface Faulting	Vibratory Ground Motion	Volcanic Hazards	Foundation Suitability	Flooding
Coast										
Big Creek	+	0	0	0	+	0	0	0	0	-
Cherry Point	0	+	-	*[b]	+	0	-	+	-	+
Daley Lake	*[b]	0	0	+	0	0	0	0	0	+
Jetty Creek	*	-	-	+	+	0	0	0	-	-
Miles Lake	*	0	+	-	-	-	-	0	-	+
Watseco Quarry	0	0	-	+	0	-	0	0	0	+
Columbia River										
Boardman	+	+	+	+	+	0	0	0	0	+
Bradwood	*	0	*	+	0	0	0	0	*	0
Deer Island	+	-	+	+	0	0	-	0	-	-
Fulton Ridge	*	+	0	+	+	-	0	0	0	+
Hanford	+	+	*	+	+	0	0	0	0	0
Mayger	*	+	0	+	0	0	-	0	*	-
Warrenton	+	0	+	+	0	0	+	+	+	-
West Roosevelt	+	+	-	+	[illegible]	0	+	0	+	0

[a]See Section 2.4.2.2.3 for basis of rating system.

[b]* = Insufficient data available to rate this site for this factor.

Table 2.7 Grouping of Sites Relative to Potential for Adverse Geologic and Hydrologic Impacts[a]

Potential for Adverse Impacts	Coastal Area	Columbia River Area
Low	Big Creek Daley Lake	Boardman Hanford
Intermediate	Watseco Quarry	Bradwood Fulton Ridge Mayger Warrenton West Roosevelt
High	Cherry Point Jetty Creek Miles Lake	Deer Island

[a]Arrangement within each group is alphabetical.

Columbia River Area. The sites considered in the Columbia River candidate area are located either in the floodplain of the lower Columbia River or on the plateaus above the mid-Columbia. Little geologic or hydrologic information was available to the staff for any of the sites on the floodplain; however, because of their location, extensive flood protection would be needed. On the other hand, several geotechnical investigations have been performed on the sites as the plateaus.

Neither the Boardman site nor the Hanford site was given any "-" ratings relative to geologic and hydrologic impacts. The Boardman site received the most positive ratings of any site in the candidate area. The advantages of the Boardman site include increased availability of water for irrigation as a result of cooling-system operation and the fact that the cooling reservoir required is already partially completed. The foundations for the plant and dams would be in preconsolidated sediments. The Hanford site is not near any floodplains or stream channels, and construction and operation of the plant would not affect availability of water. Foundations would be in the sediments of the Ringold formation.

The Bradwood, Mayger, and Warrenton sites are on the floodplain of the lower Columbia River, but the Warrenton site is farther from the water than either Bradwood or Mayger. The foundation at Warrenton is shallow bedrock. Sufficient information was not available to the staff to rate the foundation suitability at Bradwood and Mayger.

The Fulton Ridge site has been given an intermediate rating (Table 2.7) because of the possibility that the Warwick Fault passes through the site. All of the other geologic/hydrologic characteristics of Fulton Ridge would make it suitable as a nuclear plant site.

The West Roosevelt site is along the mid-Columbia River, but it is well above flood levels. The site is less suitable than Boardman or Hanford because of instability of soil and the enhanced potential for acceleration of mass wasting.

The Deer Island site is ranked as having high potential for adverse impact because of its location on a former island in a braided stretch of the Columbia River. Flooding, dewatering, and settlement would be major problems.

In the Columbia River candidate area, then, the Boardman and Hanford sites have been ranked as having low potential for adverse impact, and Deer Island has been ranked as having high potential for such impacts. Potential for impacts at all the other sites is considered intermediate by the staff.

Summary. In terms of geologic and hydrologic resources and potential impacts in the coastal candidate area, the Big Creek and Daley Lake sites have been judged to have low potential for adverse impacts; in the Columbia River candidate area, the Boardman and Hanford sites have been ranked as having low potential for adverse impacts.

2.4.2.2.4 Socioecomic Resources

Criteria and Methods

To fully assess the potential socioeconomic impacts that would result from the construction and operation of a nuclear power plant (or any facility) in a given location requires the examination of numerous factors and conditions, many of which can, of course, be evaluated only after detailed, site-specific studies. However, evaluation of a few key factors often can provide an indication of the severity of impacts that might occur.

For this study, six factors have been examined for each site: (1) demography of the site vicinity; (2) the potential impacts from construction or upgrading of access and transmission facilities; (3) potential impacts on cultural, historic, and recreational sites; (4) potential impacts on esthetics; (5) the local availability of a labor force; and (6) the adequacy of the community infrastructure to accommodate the population influx expected.

While information for these six factors is generally more accessible than information for other indicators, the staff was unable to collect all the necessary information for each factor for each site. Missing data for some indicators, in particular community infrastructure and labor force, could not be supplemented by data gathered during the site visit or by reconnaissance investigation. Therefore, in such cases, no rating was given for certain factors for some sites.

Other factors, such as political turmoil and decline of mor. alues, often have serious impacts on a community, but cannot be assessed in the absence of detailed examination of the impacted communities

The criteria used to rate the sites for each of the six factors considered were as follows:*

Demography--Population data were analyzed for the areas within the vicinity of each site to determine the number of people that might be adversely impacted by construction or operation of the plant. The rating system for this factor was:

*No rating of "0" has been used for three factors: demography, labor supply, and community infrastructure. These indicators require more detailed, site-specific information than was available to determine if an impact was something other than minor or serious.

"+"--Impacts can be absorbed or mitigated with planning.

"-"--Disruption, dislocation, and other adverse social conditions will result and will have long-term adverse impacts.

. Access and Transmission Facility Impacts--Evaluation of the potential for disruption of people by construction or upgrading of access and transmission systems was based on the following factors: number and quality of highways near the site, vehicular congestion on these highways (if data were available), rail spurs to the site, dock access to the site, onsite roads and new road construction required, and the need for construction of new transmission lines and upgrading of existing lines. The degree of adverse socioeconomic impacts from construction of such facilities depends upon the disruption of people living on or near the rights-of-way and of individuals using nearby facilities (e.g., parks). Upgrading of existing access facilities is considered to be less disruptive. Ratings were based on the following system:

"+"--Sufficient highways, railroads, waterways, and transmission lines are within the general vicinity of the plant and little or no disruption to people's lives would result from any upgrading of facilities;

"0"--Some upgrading or minor construction of highways, railroad spurs, barge facilities, and transmission lines would be necessary and a limited number of people would be impacted;

"-"--Major construction involving roads, railroad lines and spurs, transmission lines, docks, or other facilities would severely disrupt residents and/or people using nearby facilities.

. Cultural, Historical, and Recreational Sites--The construction of the plant and related facilities (including access and transmission systems) can cause disruption and displacement of historic, archeological, scenic, cultural, and recreational resources and natural features. Consideration was given to archeological surveys already conducted; National Register notices of national landmarks, scenic areas, and monuments; locations of any national, state, and local parks and recreation areas, or any significant cultural or religious shrines that would be affected. Such resources were considered to be affected by the project if it appeared to the staff that they might have to be relocated (if possible), if attendance might decline because of construction traffic or noise, or if the use, enjoyment, or purpose of the site might be restricted as a result of the power plant project. The following system was used to rate sites relative to potential impacts on cultural, historical and recreational resources:

"+"--An archeological survey found no prominent sites, and no cultural, historical, or recreational sites would be affected by the project;

"0"--No recreational or historical sites would be affected by the facility;

"-"--An archeological survey found prominent sites, or a recreational or historical site would be affected by the plant or facilities.

. Esthetics--The esthetic quality of any particular environment differs markedly according to social attitudes and values of the observer. In order to avoid criteria based upon an individual judgement, evaluation of this factor was based on expected visibility of plant structures and the potential number of observers:

"+"--Structures and facilities will be totally or mostly blocked from view;

"0"--Structures and facilities, although visible, will be seen by few people;

"-"--Structures and facilities will be totally or partially visible to many people.

. Labor Supply--Construction and operation of a nuclear facility require many employees, but these plants are often sited in areas of low population density. This combination often necessitates the in-migration of a number of workers and their families. For the most part, an influx of a large number of people is the greatest source of socioeconomic impact for such projects. The labor supply ranking for a site was determined by the following criteria:

"+"--Sufficient workers reside in or will commute to the area to necessitate few in-movers;

"-"--Majority of employees will have to move to the communities near the site.

. Community Infrastructure--To judge this factor, communities were assessed to determine if they could accommodate the expected influx of new workers resulting from construction (and to a lesser degree, operation) of the plant. Such variables as availability and development of housing, school facilities, water and sewage treatment facilities, and police and fire protection were taken into consideration (when data were available) in ranking the sites. This factor is closely linked to the previous one (labor supply), and in general, areas least likely to have an existing labor supply sufficient to meet

the needs at the plant are also the areas least likely to be able to accommodate a large influx of new workers. The infrastructure ratings were based on the following criteria:

"+"--Impacts can be absorbed or mitigated with planning;

"-"--Disruption, dislocation, and other severe negative conditions will result and will have long-term adverse impacts.

Results and Discussion

The ratings of the sites relative to socioeconomic impacts are given in Table 2.8. In Table 2.9, the sites within each candidate area are grouped relative to the overall potential for adverse socioeconomic impacts.

The staff was restricted in its assessment by the amount of reconnaissance-level socioeconomic data available for the individual sites. This lack of data caused the staff to remove one factor and certain sites from the socioeconomic assessment. This is discussed in more detail in the following analysis.

Coastal Area. The five coastal sites in Oregon (Jerry Creek, Watseco Quarry, Miles Lake, Daley Lake, and Big Creek) are located in a scenic and highly valued part of the state. The sites have several characteristics in common: sparse population and small communities, large transient populations (vacationers), poor access facilities, and many recreational areas. Construction of an electric-generating facility or any other large plant would disrupt the communities around these sites and would adversely affect tourism. These coastal areas have developed into specialized communities providing services to tourists and are adapted to seasonal fluctuations in population. These services are not designed for long-term demands such as those associated with a construction force for a major project of this kind. These towns do not have sufficient year-round housing or public services to cope with a large, year-round increase in population.

U.S. Highway 101 is the major artery for the coastal area and would be the primary access to all the sites; thus construction at any of the sites could cause severe traffic problems on that highway. Also, construction and operation of the plant would cause increased noise and traffic congestion. To varying degrees, visibility of the plant facilities would adversely affect esthetics for people in surrounding parks and beaches. Finally, the relatively long transmission lines that would have to be built from any of the sites would have potential impact to parks, forests, and homes.

The Cherry Point site, the only coastal site in Washington State, has many of the same problems associated with the Oregon coastal sites, but it does have a low permanent and transient population around the site and a large labor supply is within commuting distance of the site. (Since information about the availability of labor near the Oregon coastal sites can not be readily determined, this factor was not considered in the evaluation of the coastal sites.)

All the Oregon coastal sites have been ranked as having equally high potentials for adverse impacts. The Cherry Point site also has some disadvantages that could cause adverse impacts, but is judged by the staff to be somewhat more preferable as a nuclear plant site and has been ranked by the staff as having intermediate potential for adverse impact.

Columbia River Area. The information available for the eight sites varied considerably. Since the Hanford and Boardman sites have existing generating facilities, detailed data has been gathered about the site environs. Data for the Bradwood, Deer Island, Fulton Ridge, Mayger, and Warrenton sites were too limited in terms of socioeconomic impacts and were eliminated from consideration for this resource category.* Information about the West Roosevelt site was deficient only concerning labor supply.

The West Roosevelt and Warrenton sites have features that make them poor sites for a nuclear plant project. The proximity of the Warrenton site to the City of Warrenton and the county airport is considered by the staff to be a negative characteristic for demographic reasons. The area around the West Roosevelt site has many small communities that probably could not absorb the number of construction workers who might move to the area. Also, the West Roosevelt plant would be highly visible from the Columbia River and from Interstate 80.

The Fulton Ridge, Mayger, Deer Island, and Bradwood sites have the advantages of having some form of transportation or transmission facilities near them and of having low population densities around the sites. Deer Island has the added positive factor of being located near Portland, Oregon, and thus being within commuting distance of the Portland labor force.

Because of their present generating plants, the Hanford and Boardman sites already have the access facilities needed for a nuclear plant. Also, the local communities have already experienced an influx of construction workers. The Boardman site was selected by the applicant for a coal-fired facility since it had positive qualities in terms of demography, low potential for esthetic impacts, and lack of cultural, historical, and recreational sites. The Hanford Reservation was dedicated over 30 years ago to the development of energy resources. The siting of more nuclear power plants at the reservation would continue this purpose.

*For those factors for which information was available, none of these five sites had ratings equal to or better than the Boardman, Hanford, or West Roosevelt sites. Even though these five sites are not ranked, there is nothing to suggest that they would be better sites than the three ranked sites.

Table 2.8 Evaluation of Potential Sites Relative to Socioeconomic Resources[a]

Site	Demography	Access and Transmission Facility Impacts	Cultural and Historical Sites	Esthetics	Labor Supply	Community Infrastructure
Coast						
Big Creek	-	-	-	0	*[b]	-
Cherry Point	+	0	-	-	+	-
Daley Lake	-	-	-	-	+	-
Jetty Creek	-	-	-	0	*	-
Miles Lake	-	-	-	-	*	-
Watseco Quarry	-	-	-	0	*	-
Columbia River						
Boardman	+	0	+	+	+	+
Bradwood	0	0	*	*	+	*
Deer Island	0	0	*	*	+	*
Fulton Ridge	0	0	*	*	*	*
Hanford	+	+	+	+	+	+
Mayger	0	0	*	*	*	*
Warrenton	0	*	*	*	*	*
West Roosevelt	0	-	-	-	*	-

[a]See Section 2.4.2.2.4 for basis of rating system.

[b]* = Insufficient data available to rate this site for this factor.

Table 2.9 Grouping of Sites Relative to Potential for Adverse Socioeconomic Impacts[a]

Potential for Adverse Impacts	Coastal Area	Columbia River Area[b]
Low		Boardman Hanford
Intermediate	Cherry Point	
High	Big Creek Daley Lake Jetty Creek Miles Lake Watseco Quarry	West Roosevelt

[a]Arrangement within each group is alphabetical.

[b]Insufficient information was available to rank the Bradwood, Deer Island, Fulton Ridge, Mayger, and Warrenton sites in the Columbia River candidate area.

Thus, for the Columbia River area, the Boardman and Hanford sites have been judged by the staff to have low potential for adverse socioeconomic impacts. Since both sites already have generating facilities, many of the problems associated with power plant construction have been experienced and would not have to be repeated for another plant (e.g., construction of new roads and transmission lines). The West Roosevelt site has been ranked by the staff as having high potential for adverse socioeconomic impacts. Because of the limited information available, the other sites in the Columbia River candidate area were not ranked.

Summary

In terms of the socioeconomic factors considered, in the coastal area the Cherry Point site was judged as having intermediate potential for adverse impact. In the Columbia River resource area, the Boardman and Hanford sites were rated as having low potential for adverse impacts, and West Roosevelt was rated as having high potential for adverse impacts. The five other sites were not ranked.

2.4.2.3 Combined Ranking of Sites

Following the ranking of sites for each of the four resource categories, the next step in the staff's alternative-site-selection procedure was to choose one (or more) site for each candidate area based on the ratings for all the resource categories combined. The sites so selected are the ones considered (along with the three locations in the single-site candidate areas) as the alternative sites to Pebble Springs. The staff's rankings are summarized in Table 2.10 for the coastal candidate area and in Table 2.11 for the Columbia River candidate area.

Coastal Area

All sites in the coastal candidate area except Daley Lake are ranked as having high potential for adverse impact in at least two of the resource categories. Daley Lake is ranked as having low potential in two of four resource categories, as having intermediate potential in another category, and in the fourth, socioeconomics, it is not distinguishably worse than all other coastal sites. Therefore, the staff has selected the Daley Lake site as the preferable alternative site in the coastal candidate area for comparison with Pebble Springs.

Columbia River Area

The Boardman site ranks as having low potent[illegible]r adverse impact for all resource categories. Hanford ranks as having low potential in three of the four resource categories. All other sites rank as having high potential for adverse impacts in at least one resource category. Therefore, both the Boardman and Hanford sites have been selected by the staff as alternatives for comparison to the Pebble Springs site; thus, in the staff's judgment, increasing the number of environmental alternatives in the analysis. Hanford and Boardman are on different parts of the Columbia River and at one (Hanford) cooling towers would be used, while at the other (Boardman) a cooling pond would be used.

Single-Site Candidate Areas

Sites to be considered as alternatives from single-site candidate areas are Lebanon (Willamette River area), Ryderwood (Cowlitz River area) and Skagit (Skagit River area).

Summary

Through the process described above, the staff has selected the following six sites as alternative sites for comparison with the proposed Pebble Springs site:

Site	Candidate Area
Daley Lake, Oregon	Coastal
Boardman, Oregon	Columbia River
Hanford, Washington	Columbia River
Lebanon, Oregon	Willamette River
Ryderwood, Washington	Cowlitz River
Skagit, Washington	Skagit River

2.5 COMPARISON OF ALTERNATIVE SITE[illegible] PEBBLE SPRINGS

The next step in the staff's indepen[illegible] site analysis was an environmental comparison of the alternative sites with Pebble Springs to determine whe[illegible] any of the alternatives were environmentally preferable. For this comparison, the same resource categories were used as for the screening of potential sites: terrestrial, aquatic, geologic and hydrologic, and socioeconomic resources. In general, for each resource category, the same site characteristics, indicators, or potential impacts that were used for rating potential sites were also used to compare the alternative sites with Pebble Springs.

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Table 2.10 Multidisciplinary Evaluation of the Siting Characteristics of the Sites within the Coastal Candidate Area

Potential for Adverse Impact	Terrestrial Resources	Aquatic Resources	Geologic and Hydrologic Resources	Socioeconomic Resources
Low	Daley Lake	Cherry Point	Big Creek Daley Lake	
Intermediate	Cherry Point	Daley Lake Miles Lake Watseco Quarry	Watseco Quarry	Cherry Point
High	Big Creek Jetty Creek Miles Lake Watseco Quarry	Big Creek Jetty Creek	Cherry Point Jetty Creek Miles Lake	Big Creek Daley Lake Jetty Creek Miles Lake Watseco Quarry

Table 2.11 Multidisciplinary Evaluation of the Siting Characteristics of the Sites within the Columbia River Candidate Area

Potential for Adverse Impact	Terrestrial Resources	Aquatic Resources	Geologic and Hydrologic Resources	Socioeconomic Resources
Low	Boardman Hanford	Boardman	Boardman Hanford	Boardman Hanford
Intermediate	Deer Island Fulton Ridge Mayger West Roosevelt	Bradwood Deer Island Fulton Ridge Hanford Mayger West Roosevelt	Bradwood Fulton Ridge Mayger Warrenton West Roosevelt	
High	Bradwood Warrenton	Warrenton	Deer Island	West Roosevelt Watseco Quarry

[a]Insufficient data was available to rank five of the Columbia River sites (Deer Island, Bradwood, Mayger, Fulton Ridge, and Warrenton) in terms of potential for adverse socioeconomic impacts.

For all the resource categories, the six alternative sites (Boardman, Daley Lake, Hanford, Lebanon, Ryderwood, and Skagit) were compared with Pebble Springs using the following rating scheme for each site characteristic:

"+"--The potential for adverse impacts expected to be less than that for Pebble Springs (superior);

"0"--the potential for adverse impact expected to be similar to that for Pebble Springs (equal);

"-"--the potential for adverse impact expected to be greater than that for Pebble Springs (inferior).

Sites with two or more "+" ratings and no "-" ratings were judged to be superior to Pebble Springs. Sites with ratings consisting only of "-" and "0" were judged to be inferior. Sites with all "0" ratings or an equal number of "+" and "-" ratings were judged to be equal to Pebble Springs.

After all the alternative sites had been compared to Pebble Springs within each resource category, the rankings were combined to determine if overall, any of the alternative sites were clearly environmentally preferable to the Pebble Springs site.

In this comparison of the various alternative sites, the staff placed no particular emphasis on the assessment of one resource category relative to another in the overall assessment. That is, each resource category evaluation was judged to be of equal importance as the other categories.

Detailed descriptions of the alternative sites and their comparison to Pebble Springs are given in Appendix B.

2.5.1 Terrestrial Resources

The characteristics selected as the basis for comparison of terrestrial resources were habitat type, area to be disturbed for construction of the power station, the water erosion hazard (based primarily on slope), length and habitat type traversed by new rights-of-way for pipelines and transmission corridors, land use, and the possible presence of terrestrial wildlife species classified as rare, endangered, or protected, or whose status has been undetermined. For purposes of this comparison, these species have been grouped under the heading of "sensitive." Results of the comparisons are given in Table 2.12 and are discussed in some detail below.

The Pebble Springs site is located within the steppe vegetation zone of the Columbia basin. Although vegetation and wildlife in this zone are different from those of the coastal and forest zones of Oregon and Washington, they are no less valuable from an ecological point of view. On the basis of reconnaissance-level information, each alternative site can be compared with Pebble Springs on the basis of the potential for a major adverse impact to the terrestrial ecosystem from power-plant construction and operation. Comparison of the alternative sites on the basis of "habitat value", as described by the U.S. Fish and Wildlife Service,[38] while a useful technique, cannot be accomplished by use of only reconnaissance-level information.

In general, removal of forest, with the resultant loss of habitat for large and small mammals of the coast and Cascade mountains and foothills, is expected to be a long-term, essentially irretrievable loss. On the other hand, given reasonable reclamation efforts (e.g., supplemental irrigation, seeding, fertilization, and restriction of grazing) regeneration of shrub and grassland habitat is expected to be faster than regeneration of forest habitat in areas disturbed by construction. The Daley Lake, Lebanon, Ryderwood, and Skagit sites are thus inferior to the Pebble Springs site in this respect and have been given "-" ratings. The Boardman site, where vegetation and topography are similar to Pebble Springs, has been given a "0" rating.

It is assumed that the new units at the Hanford Reservation would be sited near the existing units. Most of the wildlife is found near the river and in the ecological preserve, which is not expected to be disturbed by the new units (see Appendix B). This site is thus rated superior ("+") to the Pebble Springs site in terms of impacts to wildlife due to habitat lost. This rating is further reinforced by the fact that an additional 800 ha (2000 acres) of steppe habitat would be lost at Pebble Springs for construction of the cooling reservoir, while no such loss would occur at the Hanford site. The Boardman site already has a cooling lake constructed for a coal-fired power plant, and thus no additional habitat would be lost for the new power units placed on the site.

Because of lower rainfall and relatively flat topography, construction of a power plant in the steppe region of Oregon or Washington is expected to result in less severe soil erosion (due to water) than would be the case along the coast, in the coastal ranges, or along the lower Columbia River. Thus, the Daley Lake, Lebanon, Ryderwood, and Skagit sites have been ranked inferior ("-") to the Pebble Springs site in this respect. The Boardman and Hanford sites have been given "0" ratings because soil erosion and resultant effects are expected to be similar to those at the Pebble Springs site. It is important, however, to consider that soil erosion by wind can be severe in semi-arid, flat areas such as the sites in the steppe region of Oregon and Washington. Wind speeds greater than 20 kilometers per hour (12 mph) are considered to be erosive, with the magnitude of the erosion force increasing as the cube of the wind speed.[39]

For all months of the year except January, the relative magnitude of wind erosion forces at Pendleton in eastern Oregon was greater than at Astoria in western Oregon.[39] It thus can be estimated that the erosion hazard due to wind would be greater at sites in the steppe region than at sites in the Cascades or Coast Ranges. However, without site-specific data, such as soil erodibility, water and wind erosivity, slope-length, and soil ridge roughness, total erosion rates (water plus wind) during construction of a power plant at the alternative sites

Table 2.12 Comparison of Alternative Sites with Pebble Springs for Terrestrial Resources[a]

Site	Habitat	Land Use	Construction Area	Erosion Hazard	Sensitive Species	New Rights-of-Way	Summary
Boardman	0	+	+	0	0	0	Superior
Daley Lake	-	-	+	-	0	-	Inferior
Hanford	+	+	+	0	0	+	Superior
Lebanon	-	-	0	-	0	-	Inferior
Ryderwood	-	-	+	-	0	-	Inferior
Skagit	-	-	+	-	0	+[b]	Inferior

[a]See introduction to Section 2.5 for basis of rating system.

[b]Assumes no new pipeline on transmission corridors will be required.

cannot be quantitatively compared. The staff elected to use slope as a measure of the relative erosion hazard from water and ignored the wind erosion component. A detailed, site-specific analysis of erosion could indicate that the relative rankings of the alternative sites would be different from those given in Table 2.12 if total erosion rates were calculated.

The Pebble Springs site is currently used for dry range and agriculture. The Daley Lake, Lebanon, Ryderwood, and Skagit sites are used for forest products, residences, and partly as pasture and range; however, because of the higher rainfall, these latter sites are expected to have higher productivity than the Pebble Springs site. Thus, in terms of land use, these sites are rated as inferior to ("-") Pebble Springs as nuclear plant sites. Boardman and Hanford are primarily industrial sites; adding two more power-generation units at either site would cause no drastic changes in land-use patterns. These two sites thus are rated as superior ("+") to Pebble Springs. (One important additional factor is the need for irrigation water in the shrub-steppe region of Oregon. Effluent from the power station at Pebble Springs is intended to be used for irrigation, converting dry range to irrigated cropland. Pebble Springs thus may be the preferred site if irrigated land is preferred to rangeland and dryland crops.)

As indicated in Table 2.12, each of the alternative sites is similar to Pebble Springs relative to the potential for "sensitive" wildlife species to reside or forage on the site. As far as is known to the staff, none of the sites contains "critical habitat." However, this assessment can be verified and potential for impacts to various protected species can be determined only with detailed site investigations. Reconnaissance-level information indicates no differences among the alternative sites, and therefore a "0" rating has been given to each.

Segments of the new transmission line rights-of-way for the Daley Lake, Lebanon, and Ryderwood sites would traverse forests, necessitating extensive removal of trees and subsequent application of herbicides to prevent their regrowth. Transmission rights-of-way for the Pebble Springs site would traverse low-growing steppe vegetation that would not have to be disturbed except for small areas occupied by the tower bases. Application of herbicide is expected to be unnecessary for the Pebble Springs rights-of-way. Thus, the three sites in forest habitat would be inferior to Pebble Springs as plant sites and have been given "-" ratings. Transmission facilities already exist at the Boardman and Hanford sites, and the staff expects that no new offsite rights-of-way would be required, although right-of-way widening for Boardman would be required. Boardman and Hanford thus have been given "0" and "+" ratings, respectively, in this regard. It is assumed that the Skagit site will have existing transmission corridors, and thus also has been rated "+" in this respect.

A pipeline about 8 km (5 miles) long would be required to convey water from the Columbia River to the Pebble Springs site for the proposed plant. All alternative sites except Skagit are closer to their sources of cooling water, and each would require less than 1.5 km (1 mile) of pipeline corridor. The Skagit site is assumed to have an existing pipeline. Ratings given to each site as a result of impacts from the pipeline corridor have been incorporated into Table 2.12 under the heading "New Rights-of-Way."

Thus, of the six sites considered, only the Hanford and Boardman sites are judged as superior to the Pebble Springs site on the basis of overall impacts to the terrestrial ecosystem (Table 2.12). This conclusion results mainly from the fact that there are existing power-generating units on the Hanford and Boardman sites, and the new units will not necessitate drastic changes in land use, wildlife habitat, or new transmission rights-of-way. Even though two other nuclear units and transmission facilities also are assumed to exist at Skagit, impacts at Skagit due to habitat removal and soil erosion are expected to be greater than at Pebble Springs. Habitat removal and soil erosion impacts at Daley Lake, Lebanon and Ryderwood are also expected to be greater than at Pebble Springs. Therefore, these four sites have been judged as inferior to Pebble Springs.

2.5.2 Aquatic Resources

The aquatic factors selected to compare the alternative sites with the Pebble Springs site were sedimentation; rare, endangered and protected species; fisheries resources; impingement and entrainment; water quality; impact from effluents; and competing water use. The results of the ratings are given in Table 2.13.

Impacts of sedimentation and turbidity on aquatic resources during construction are expected to be trivial at all sites. Areas affected will be small and reduction in biological productivity of short duration. The staff can find no basis for distinguishing between the sites on the basis of these impacts.

Site-specific data are required to establish the presence of threatened or endangered species; this information was available only for Boardman and Hanford. However, on the basis of the reconnaissance-level data reviewed, the staff is aware of no information indicating the presence of threatened or endangered aquatic species at any of the sites; therefore, a "0" rating has been given each site.

Daley Lake has been rated "+" for fisheries resources because there are no important fisheries in the vicinity of the site. On the other hand, makeup water for the Pebble Springs site would be taken from a salmon migration route. Because of the proximity of salmon spawning and rearing areas, there is a greater potential for adverse impact to fisheries resources at the Hanford and Skagit sites than at Pebble Springs. Hanford and Skagit thus have been rated "-" for this factor. All other sites are located on rivers with salmonid fish runs. Although the commercial and sport values of these runs differ, the staff concludes that these other sites are comparable to the Pebble Springs site, and therefore have been given "0" ratings.

Table 2.13 Comparison of Alternative Sites with Pebble Springs for Aquatic Resources[a]

Site	Sedimentation Impacts	Rare, Endangered, Protected Species	Fishery Resources	Impingement and Entrainment	Water Quality	Impact from Effluents	Competing Water Use	Conclusion
Boardman	0	0	0	0	0	0	0	Equal
Daley Lake	0	0	+	-	0	-	0	Inferior
Hanford	0	0	-	0	0	-	0	Inferior
Lebanon	0	0	0	-	-	-	-	Inferior
Ryderwood	0	0	0	0	0	-	0	Inferior
Skagit	0	0	-	+	0	-	0	Inferior

[a]See introduction to Section 2.5 for basis of rating system.

Potential impacts from impingement and entrainment are greater at sites where once-through cooling would be used (Daley Lake), where river discharge is low (Lebanon), and where intakes would be located in embayments or areas of slack water (Lebanon). Thus, Daley Lake and Lebanon have been given "-" ratings. The Boardman, Ryderwood, and Hanford sites are expected to be similar to the Pebble Springs site in potential impingement and entrainment impacts and have been given "0" ratings. Although nearby salmon spawning increases the potential for impingement and entrainment at the Hanford and Skagit sites, perforated pipe intake designs currently proposed for Hanford should reduce such impacts to acceptably low levels. If Ranney collectors were used at the Skagit site (as currently proposed), they would be expected to have nearly zero impingement or entrainment rates; thus the Skagit site has been rated "+".

Boardman, Daley Lake, Hanford, and Ryderwood are similar to Pebble Springs with respect to water quality and have been given "0" ratings for this factor. The Lebanon site is judged by the staff to be inferior ("-") to Pebble Springs in this respect. This evaluation is based on the fact that extended periods of low dissolved oxygen concentrations and high temperatures occur in the South Santiam River at the Lebanon site. Although the Skagit site is located on a Class AA (Extraordinary) river with exceptionally high water quality and stringent water quality standards, current plans to dispose of effluents at a downstream location within a Class A (Excellent) section of the river would not cause any undue impacts to water quality.[40] Skagit therefore has been given a "0" rating.

No impacts on natural aquatic environments from effluent releases are expected at either the Pebble Springs or the Boardman sites since discharges would be confined to cooling ponds at both sites. The staff considers all other sites to be inferior with respect to effluent release since heated effluents and chemical effluents would be discharged to a river or the ocean. Thus, the Boardman site has been given a "0" rating, and all others have been given "-" ratings.

Since no measurable impacts on competing water use are expected at the Pebble Springs, Boardman, Daley Lake, Hanford, Ryderwood, or Skagit sites, the staff considers them to be equal ("0") for this characteristic. Potential impacts on water use may be greater at the Lebanon site than at the Pebble Springs site since the South Santiam River has relatively low discharges; a two-unit nuclear plant at Lebanon would be a major water user. Therefore, Lebanon has been given a "-" rating.

In summary, on the basis of potential impacts on aquatic resources, the Hanford, Lebanon, Daley Lake, Ryderwood, and Skagit sites are judged by the staff to be inferior to Pebble Springs. The Boardman site is considered equal to Pebble Springs.

2.5.3 Geologic and Hydrologic Resources

Impacts considered for this comparison include ground response, loss of mineral resources, acceleration of mass wasting, potential for surface water utilization, and potential for groundwater utilization. The results of the comparison are given in Table 2.14.

For the most part, little ground response is expected at the alternative sites or at Pebble Springs; thus "0" ratings have been given all of the alternatives except Lebanon, where this factor could not be judged. Foundations either would be on rock or preconsolidated sediments, or would be designed to prevent excessive settlement.

No important mineral resources have been identified at any of the sites except Skagit, where coal deposits exist. Even though the coal at Skagit is not being mined, the site has been given a "-" rating on the basis of lost potential. All other sites have been rated as equal ("0") to Pebble Springs.

Hanford and Boardman have been rated as equal ("0") to Pebble Springs in terms of alteration of stream patterns. There are no streams on the Pebble Springs or Hanford sites, and Boardman has been given the equal rating because most of Carty Reservoir (which dams the upper reaches of Sixmile Creek) was constructed for another use prior to this assessment. Because creeks will be rerouted at Skagit and Daley Lake, dammed at Lebanon, and restricted at Ryderwood, all these sites were given "-" ratings relative to Pebble Springs.

The mass wasting expected at Pebble Springs includes wind and water erosion of disturbed ground, slumping in excavations, and possibly slumping of the Selah formation in Alkalai and Eightmile canyons. Slumping or erosion is expected at all of the alternative sites, and thus they all have been rated as equal to Pebble Springs for this factor.

Pebble Springs and Boardman sites would have a beneficial impact with respect to potential for surface water utilization in that blowdown from the cooling ponds may be used for irrigation. There would be no increased water availability at Hanford, but there are no potential users anyway. As a result, Boardman and Hanford have been given "0" ratings, all other sites have been rated inferior ("-").

There is no change in the potential for groundwater utilization at Pebble Springs or any of the alternative sites except Daley Lake, where dewatering for construction would be necessary. Daley Lake therefore has been rated as inferior ("-") to Pebble Springs. The other sites have been rated equal ("0") to Pebble Springs.

In conclusion, none of the six alternative sites is considered to be superior to Pebble Springs on the basis of geologic and hydrologic resources. The Boardman and Hanford sites are considered to be equal to Pebble Springs;

Table 2.14 Comparison of Alternatives with Pebble Springs for Geologic and Hydrologic Resources[a]

Site	Ground Response	Loss of Mineral Resources	Alteration of Stream Patterns	Acceleration of Mass Wasting	Potential for Surface Water Utilization	Potential for Groundwater Utilization	Summary
Boardman	0	0	0	0	0	0	Equal
Daley Lake	0	0	-	0	-	-	Inferior
Hanford	0	0	0	0	0	0	Equal
Lebanon	*[b]	0	-	0	-	0	Inferior
Ryderwood	0	0	-	0	-	0	Inferior
Skagit	0	-	-	0	-	0	Inferior

[a]See introduction to Section 2.5 for basis of rating system.

[b]* = Sufficient data not available for comparison.

the other alternative sites have some offsetting disadvantages and are considered for the purpose of this comparison to be inferior.

2.5.4 Socioeconomics

The six socioeconomic indicators used in this comparison are access and transmission facility impacts; esthetics; community infrastructure; cultural, historical and recreational sites; demography; and labor supply. The results of the staff's comparison are given in Table 2.15.

The Pebble Springs site is relatively near a major highway, railroad spurs, the Columbia River, and a transmission corridor. However, an access road, a barge facility, and connecting transmission line and railroad spur would have to be built. This construction will cause some disruption to people living and visiting in the area. Since the Boardman and Hanford sites have existing generating plants and Skagit is assumed to have two nuclear units at the site, some (although not all) of the necessary connecting facilities will have been constructed. These three sites have been rated by the staff as superior ("+") to the Pebble Springs site in this respect. Since access facilities at the Ryderwood site are comparable to those at Pebble Springs, Ryderwood has been given an equal ("0") rating. The Lebanon and Daley Lake sites are not as close to railroad lines and major highways as the Pebble Springs site is; thus, they have been given "-" ratings. With the possible exception of Ryderwood, the staff has not identified any potential traffic problems that would make any site significantly better or worse than Pebble Springs.

In terms of esthetics, all the sites except Daley Lake have been given "0" ratings. This is because esthetic impacts would either be similar to the case of Pebble Springs (i.e., plant facilities would be only partially visible to a limited number of people) or the plants would be located near existing generating facilities. A power plant built at the Daley Lake site, however, would be more readily visible to a greater number of people. This site therefore has been given a "-" rating.

The Lebanon, Skagit, and Hanford sites have urban areas within commuting distance. The communities of Albany, Lebanon, and Sweet Home are near the Lebanon site, and the cities of Salem, Eugene, and Springfield are within a one-hour commuting distance. Thus, relatively sufficient community services and housing would be available to accommodate the construction workers who would move to the area of the Lebanon site. The Skagit site is within commuting distance of towns with populations of 10,000 or more. As projected,[40] these communities will have experienced the growth attributed to the construction of two units and will be better able than those communities around the Pebble Springs site to cope with the building of two additional units. The Hanford site is within 16 km (10 miles) of the Tri-Cities Area of Pasco, Richland, and Kennewick, and all the basic service and housing needs are available sufficiently near to the site. In the area of Pebble Springs, on the other hand, there are only small communities that do not have the necessary infrastructure to accommodate an influx of a large number of workers and their families. However, it can be assumed that some construction workers would elect to commute to the Pebble Springs site from the Tri-Cities Area. Thus Lebanon, Skagit, and Hanford have been rated as superior ("+") to Pebble Springs. The situations at Boardman and Ryderwood are similar to Pebble Springs, and thus these two sites have been given as equal ("0") ratings.

Since explicit site-specific archeological surveys have not been conducted at the Daley Lake, Lebanon, and Ryderwood sites, the presence of archeological artifacts at these sites is uncertain. Regarding historical and recreational sites, all the sites except Daley Lake and Skagit have been assessed by the staff and found to be equal ("0") to Pebble Springs. Daley Lake is located near the Pacific Ocean and a national forest, both of which have a large number of visitors. Construction at the Daley Lake site would adversely impact the tourist business, and for this reason, the site has been rated "-" relative to Pebble Springs. Investigations of the Skagit site have found numerous archeological sites within in the site vicinity. Because of this, the staff has ranked the Skagit site as inferior ("-") to the Pebble Springs site in this category.

In assessing demographic considerations, the Hanford site has been rated as superior ("+") to Pebble Springs because Hanford is a restricted reservation already dedicated to nuclear facilities. The other sites were compared to Pebble Springs with respect to population densities in the vicinity of the sites, and the extent by which power plant siting would displace human activities. On the basis of population density, Boardman and Ryderwood were rated as equal to Pebble Springs, and Daley Lake, Lebanon, and Skagit were rated as inferior. None of the sites would require significant displacement of human activities, although siting at Daley Lake, Lebanon or Ryderwood would displace some residences. On balance, the staff rates Hanford as superior ("+"), Boardmand and Ryderwood equal ("0"), and Daley Lake, Lebanon and Skagit as inferior ("-") to Pebble Springs for demographic considerations.

The communities within commuting distance of the Hanford, Lebanon, and Skagit sites contain large labor forces. Ryderwood and Daley Lake are within commuting distance of a number of towns, but are not as well located with respect to large urban areas as are Skagit and Hanford. In contrast, the communities, as well as the labor force, around Pebble Springs are small. A majority of construction workers for a plant at Pebble Springs would have to be recruited from outside the local area, and many would be expected to relocate near the Pebble Springs site. Therefore, the Hanford, Lebanon, and Skagit sites are superior to the Pebble Springs site and have been given "+" ratings. The Boardman site (near the Pebble Springs site) and the Ryderwood site would have the same problems as Pebble Springs with respect to the availability of workers, and the situation at Daley Lake is probably the same; therefore, they have been given "0" ratings.

Table 2.15 Comparison of Alternative Sites with Pebble Springs for Socioeconomic Resources[a]

Site	Access and Transmission Facility Impacts	Esthetics	Community Infrastructure	Cultural, Historical, and Recreational Sites	Demography	Labor Supply	Conclusion
Boardman	+	0	0	0	0	0	Equal
Daley Lake	-	-	+	-	-	0	Inferior
Hanford	+	0	+	0	+	+	Superior
Lebanon	-	0	+	0	-	+	Equal
Ryderwood	0	0	0	0	0	0	Equal
Skagit	+	0	+	-	-	+	Equal

[a]See introduction to Section 2.5 for basis of rating system.

In conclusion, in terms of the socioeconomic factors considered, the Hanford site has been judged by the staff to be superior to the Pebble Springs site. The other sites have been judged to be equal to (Skagit, Lebanon, Boardman, and Ryderwood) or inferior to (Daley Lake) Pebble Springs.

2.6 CONCLUSIONS

The staff's final ratings for the resource categories considered in comparing the alternative sites, based on reconnaissance-level information as discussed above, are summarized in Table 2.16.

Daley Lake was given inferior ratings for all resource categories considered. Therefore, the staff judges that overall, this site is environmentally inferior to Pebble Springs. Skagit, Ryderwood, and Lebanon had inferior ratings in all but socioeconomics, where they had equal ratings. Thus, the staff also rates these three sites as environmentally inferior to Pebble Springs.

The only alternative sites having superior ratings in any resource category were the Boardman and Hanford sites in the Columbia River candidate area. Both sites were judged to be superior in terms of impacts to terrestrial resources, and Hanford was judged superior in terms of socioeconomic resources. Both sites are already dedicated to power generation, and many of the associated construction and land-use impacts already have occurred.

As noted in Section 2.3.1.3, the Boardman site is in proximity to the Navy Weapons Systems Training Facility (see Fig. 2.3). Construction of a nuclear power plant at this site, while not inconceivable, would nevertheless require extraordinary measures to provide plant protection from possible hazards (e.g., aircraft impact) resulting from Training Facility operation. The staff believes that this proximity to the Training Facility represents a definite impediment to licensability of the Boardman site. For this reason, the staff concludes that the Boardman site, although judged environmentally preferable to the Pebble Springs site, could not be shown to be obviously superior to Pebble Springs.

The Hanford site, while judged to be superior to the Pebble Springs site in terms of terrestrial resources and socioeconomic resources, was judged inferior with respect to aquatic resources. The staff is concerned that the impacts to aquatic resources, as summarized in Section 2.5.2, could be significant because of the presence of three other nuclear power plants on this same stretch of the Columbia River. This concern would be especially important for plant effluents discharged to the river. After adjusting the environmental rankings to account for this factor, the staff finds the Hanford site on balance to be equal to Pebble Springs from the standpoint of overall environmental concerns.

Taking the above factors into consideration, together with the ratings for the other resource categories, the staff judges that the Boardman site, while environmentally preferable to Pebble Springs, fails to meet the staff criterion of being a potentially licensable site. The Hanford site is judged to be environmentally equal to Pebble Springs, and all other sites are judged to be environmentally inferior.

Based on the information received by the staff, the Pebble Springs site has no significant environmental disadvantages other than those socioeconomic impacts characteristically associated with major construction activities in remote areas.

Thus, the staff concludes that there are no overriding reasons to select any of the six alternative sites over Pebble Springs as a nuclear plant site. Having failed to find any of the potentially licensable sites to be environmentally preferable, the staff concludes that none of these sites is obviously superior to Pebble Springs.

Table 2.16 Staff Evaluation of the Suitability of Alternative Sites Relative to Pebble Springs

Site	Terrestrial Resources	Aquatic Resources	Geological and Hydrological Resources	Socioeconomic Resources	Environmental Conclusion
Boardman	Superior	Equal	Equal	Equal	Preferable
Daley Lake	Inferior	Inferior	Inferior	Inferior	Inferior
Hanford	Superior	Inferior	Equal	Superior	Equal
Lebanon	Inferior	Inferior	Inferior	Equal	Inferior
Ryderwood	Inferior	Inferior	Inferior	Equal	Inferior
Skagit	Inferior	Inferior	Inferior	Equal	Inferior

[a] Not rated obviously superior because site not licensable (see text).

REFERENCES FOR SECTION 2

1. "Pebble Springs Nuclear Plant Environmental Report, Construction Permit Stage," Portland General Electric Company, July 1974.

2. "Portland General Electric Responses to NRC Staff Questions," December 1, 1978.

3. Ibid., attachment 1A: Letter from State Engineer, Water Resources Department, State of Oregon.

4. Op. cit., Ref. 2, attachment 1B: GRIT memo to File Regarding Meeting with State Geologist, June 18, 1971.

5. "State-Wide Siting Task Force Report," Oregon Nuclear and Thermal Energy Council, July 1974.

6. "Irrigation," Appendix VII, in: "Comprehensive Study of Water and Related Land Resources, Puget Sound and Adjacent Waters," Puget Sound Task Force--Pacific Basins Commission, March 1970.

7. Op. cit., Ref. 2, attachment 1, p. 5.

8. Op. cit., Ref. 2, attachment 1D: Memo from GRIT to PGE Senior Officers, June 24, 1971.

9. "Power Plant Evaluation for Pacific Power and Light Company," Woodward-Clyde Consultants, March 1, 1975.

10. "Supplement to Power Plant Site Evaluation for Pacific Power and Light Company," Woodward-Clyde Counsultants, March 1, 1975.

11. "Site Location Study," Prepared by Bechtel Corporation for Portland General Electric, October 1966.

12. "Energy Facility Siting Council," Oregon Administrative Rules, Chapter 345-40-040, p. 43, 1978.

13. "Information on Timing and Abundance of Fishes near Prescott, Oregon, Important to the Commercial or Sport Fisheries of the Columbia River," Prepared by Battelle Pacific Northwest Laboratories for Portland General Electric, February 1968.

14. "Information on Responses to Elevated Temperature of Fishes Near Prescott, Oregon, Important to the Commercial or Sport Fisheries of the Columbia River," Prepared by Battelle Pacific Northwest Laboratories for Portland General Electric, May 1968.

15. "Research Related to the Development of a Power Reactor Site on the Lower Columbia River," Battelle Pacific Northwest Laboratories, June 15, 1968.

16. "Evaluation of Environmental Effects of Cooling Tower Operation at the Trojan Site," NUS Corporation, May 1972.

17. J. R. Coleman, et al., "Environmental Effects of Cooling Tower Operation at the Trojan Site," NUS Corporation, NUS-510, January 1969.

18. "PGE Statement on NEPA Information for Trojan Nuclear Plant," Portland General Electric, May 29, 1970.

19. "Environmental Aspects of Nuclear Power Plant Development, Mid-Columbia Area of Oregon," State-Federal Mid-Columbia Nuclear Power Siting Task Force, June 1971.

20. "A Review of the Trojan Nuclear Power Plant Site Evaluation," Oregon Nuclear Plant Siting Task Force, November 10, 1970.

21. "Ad Hoc Report on Nuclear Plant Siting in the Mid-Columbia Region," Oregon Nuclear Plant Siting Task Force, 1971.

22. Op. cit., Ref. 2, attachment 1E: Memo with Notes from July 19 Meeting, GRIT and PGE Senior Officers, July 20, 1971.

23. Op. cit., Ref. 2, attachment 1J: Memo from GRIT to PGE Senior Officers Regarding April 20 Meeting on Progress Report, April 28, 1972.

24. "Pebble Springs, Supplemental Testimony of John Gill, Analysis of West Roosevelt as an Alternative Site," U.S. Nuclear Regulatory Commission, Docket Nos. 50-514 and 50-515, January 18, 1977.

25. Op. cit., Ref. 2, attachment 1G: GRIT Memo Regarding Coast Reconnaissance November 16-17, dated November 29, 1971.

26. Op. cit., Ref. 2, attachment 1H: GRIT Memo Regarding Preliminary Coastal Siting Evaluation, December 28, 1971.

27. Op. cit., Ref. 2, attachment 1I: GRIT Memo Regarding Coastal Geology Reconnaissance and Meeting, March 27-28, dated March 31, 1972.

28. "Site Selection Study for Nuclear Electric Generating Station," prepared by Stone & Webster Engineering Company for Eugene Water and Electric Board, August 24, 1970.

29. Op. cit., Ref. 2, attachment 1K: GRIT Guidelines for Comparison Study of Coastal Sites, July 11, 1972.

30. "Site Comparison Study--Oregon Coastal Nuclear Power Plant Sites," prepared by Stevens, Thompson & Runyan, Inc., for Portland General Electric, February 16, 1973.

31. "Highway Access Restrictions: Big Creek, Jetty Creek, Watseco Quarry, Miles Lake Daley Lake" (author and date unknown).

32. J. F. Franklin and C. T. Dyrness, "Natural Vegetation of Oregon and Washington," U.S. Department of Agriculture, Forest Service General Technical Report PNW-8, 1973.

33. "Soil Survey Manual," U.S. Department of Agriculture, Handbook No. 18, 1951.

34. N. Hudson, "Soil Conservation," Cornell University Press, Ithaca, NY, 1971.

35. J. L. Squire, Jr., and S. E. Smith, "Angler's Guide to the United States Pacific Coast," National Marine Fisheries Service, U.S. Department of Commerce, November 1977.

36. "Final Environmental Statement Related to the Construction of Washington Public Power Supply System Nuclear Projects 1 and 4," U.S. Nuclear Regulatory Commission, NUREG-____, Docket Nos. 50-460 and 50-513, March 1975.

37. Op. cit., Ref. 20, Appendix 3, "Statement of the Fish Commission of Oregon Concerning the Proposed Trojan Nuclear Power Plant Near Prescott, Oregon."

38. B. S. Flood, M. E. Sangster, R. D. Sparrowe, and T. S. Baskett, "A Handbook for Habitat Evaluation Procedures," U.S. Department of the Interior, Fish and Wildlife Service, Resource Publication 132, 1977.

39. E. L. Skidmore and N. P. Woodruff, "Wind Erosion Forces in the United States and Their Use in Predicting Soil Loss," U.S. Department of Agriculture, Agricultural Research Service in cooperation with Kansas Agricultural Experiment Station, Agricultural Handbook 346, April 1968.

40. "Final Environmental Statement, Skagit Nuclear Power Project Units 1 and 2," U.S. Nuclear Regulatory Commission, NUREG-75/055, Docket Nos. 50-522 and 50-523, May 1975.

APPENDIX A. SITE DESCRIPTIONS AND IMPACT SUMMARIES FOR POTENTIAL SITES

Site descriptions and summaries of potential impacts of construction and operation of a two-unit nuclear plant are presented in this appendix for the 11 potential sites rejected in this study as alternative sites. Descriptions of the Pebble Springs site and the six alternative sites are presented in Appendix B.

1. BIG CREEK

1.1 Socioeconomics

The Big Creek site is east of Oregon Coast Highway 101 and about 400 m (¼ mile) from the coast. The site is in Kane County, Oregon, which contains the metropolitan area of Eugene-Springfield, Oregon. The county had a 1976 estimated population of 246,000, an increase of about 15% from 1970.[1] In 1975, nearly 238,000 people resided in the metropolitan area.[2]

There are a number of recreational facilities in the vicinity of the Big Creek site--the Pacific Ocean; a National Forest Service recreational site on Big Creek east of the site; Siuslaw National Forest to the east and south; Devil's Elbow State Park 3.2 km (2 miles) to the south; and Ponsler State Park, Rock Creek Forest Camp, and Roosevelt Beach, all less than 2 km from the site. Because of the presence of these facilities, the population within about 1 mile, or 1.5 km, of the site increases markedly during the warmer months; in 1972 the population increased from 6 year-round residents to 910 people during peak vacation period. This pattern is expected to continue; it is projected that in the year 2020 there will be only 16 year-round residents, but 3300 transients during peak vacation periods.[3]

Access to the site has been rated as poor.[4] The nearest harbor and railroad are at Florence, Oregon, about 16 km (10 miles) south of the site. Highway 101 is a winding two-lane road with steep grades near the site, connecting with the nearest Interstate about 125 km (75 miles) south of the site.[5] An access road would have to be built from Highway 101 to the site. In addition, a minimum of 77 km (48 miles) of transmission lines would have to be built.[3]

From a limited area, the plant would be fully visible to people traveling on Highway 101. Also, people to the northwest on the beach and in the ocean would be able to see part of the plant.[3]

1.2 Geologic and Hydrologic Resources and Seismicity

The Big Creek site is 12 m (40 ft) above mean sea level on a marine terrace along Big Creek. The foundation material consists of 6 m (20 ft) of clay and sandy silt underlain first by gravel and cobbles and ultimately by basalt and basalt porphyry.[3] Some excavation would be required for a nuclear plant. The heavier structures would be founded on rock. Landslide potential exists, but there is no evidence of local, ancient slides.

Big Creek would have to be stabilized in the present channel and a small dam would have to be constructed upstream to provide operating water for the plant.

The 16- to 19-km (10- to 12-mile) Cape Creek fault is 2.4 km (1.5 miles) to the southwest. It is considered inactive.[4] The site is 44 km (27 miles) from a probable offshore fault and 48 km (30 miles) from the Corvallis fault.

1.3 Aquatic Resources

Ocean bottom contours near the Big Creek site are such that it would be necessary to place plant cooling water discharge ports 820 m (2700 ft) offshore. Average ocean temperatures range from 9.5°C to 14.5°C (49°F to 58°F).

Marine game fish and shellfish in the area include salmon and surf smelt and dungeness crabs and razor clams.[4] Salmonid fishes found in Big Creek include a good quality run of steelhead, sea-run cutthroat trout, and coho salmon.

Construction of a nuclear plant at this site would have major impacts on the habitat and biota of Big Creek. Cooling water lines would be constructed through the floodplain of the creek, the site would be excavated in part of the streambed, the stream would be rerouted, and a service water impoundment would be constructed upstream. Although the magnitude of the impacts of these activities on the stream cannot be accurately determined with the limited data available, the staff believes these activities would significantly affect trout and salmon. Because of the lack of detailed information available concerning adjacent marine environments, the staff cannot determine the magnitude of any impacts from plant effluents on such environments, or determine

whether such impacts at this site would be any different from impacts of other plants of similar design in similar environments.

1.4 Terrestrial Resources

The Big Creek site is heavily timbered and provides habitat for an elk herd that winters on Big Creek.[3] Immediately east of the site is a proposed wilderness area.[3] The staff is aware of no terrestrial studies of the Big Creek site, but expects that plant and animal communities are similar to those of second-growth forest in the sitka-spruce vegetation zone described for the Daley Lake site (Sec. 3.4 of Appendix B).

The staff expects that impacts to the terrestrial ecosystem from construction of a power station at the Big Creek site would be greater than from construction of a similar plant at the Daley Lake site; the latter site is a fairly level, open meadow, while the Big Creek site is a sloping bench under forest. Habitat lost at Big Creek for large mammals, such as elk and bear, cannot be replaced as readily as grass and shrub vegetation of the meadow at Daley Lake. Also, access to Big Creek for animals of the adjacent wilderness area may be restricted; however, the impacts of such restrictions on animal populations cannot be predicted without site-specific studies.

2. BRADWOOD SITE

2.1 Socioeconomics

The Bradwood site, located in Clatsop County, Oregon, consists of an abandoned lumber mill site in the community of Bradwood. The community consists of fewer than 20 homes. A number of other small communities (Clifton, Brownsmead, Blind Slough, Wauna, and Taylorville) are within 16 km (10 miles) of the site, but less than 2000 people live within that area.[6] In 1976, Clatsop County had an estimated population of 29,500 people, a 3.1% increase from 1970.[1]

The Burlington Northern Railroad extends through the site, and a railroad spur exists there. A two-lane paved road connects the site with Highway 30. There is a small roadside park about 3 km (2 miles) south of the site.[7]

2.2 Geologic and Hydrologic Resources and Seismicity

The Bradwood site is adjacent to the Columbia River on a delta formed by Hunt Creek. Tidal flow affects the height of the Columbia River as it passes the Bradwood site. The terrain in the site vicinity is steep and mountainous, but the site itself is low lying. No borings or seismic studies have been made of the site. Bedrock in the area includes arkoses, siltstones, and some basalts.[6]

2.3 Aquatic Resources

No specific information is available to the staff on aquatic habitats and biota at the Bradwood, Deer Island, or Mayger sites, all on the lower Columbia River. However, aquatic ecology of the lower Columbia can be treated in a generic manner.

Major fishery species in the lower Columbia River include chinook, sockeye, coho, and chum salmon, steelhead and cutthroat trout, American shad, white sturgeon, and the Columbia River smelt. The lower Columbia serves as a migration route for salmonids from four major rivers: the Willamette River, the mid- and upper Columbia River, the Snake River, and the Yakima River. Salmon stocks in the Columbia River are augmented by hatchery releases.[8] Other biota of the lower Columbia River have been described in detail as part of the licensing application for the Trojan Nuclear Plant.[9]

Flow rates in the lower Columbia River are controlled by discharges from upstream dams, as well as by discharges from tributaries, such as the Cowlitz, Kalama, Lewis, and Willamette rivers. Average annual flow at The Dalles is 5497 m^3/s (194,100 cfs).[10] For at least the first 120 km (75 miles), water levels in the lower Columbia also are influenced by tides. At times of low river flows and strong tides, flow reversal occurs at river mile 75; however, the saltwater wedge is confined to the first 80 km (50 miles) of the river channel. Temperatures in the lower Columbia, as recorded at Bonneville Dam, range from winter lows of less than 5°C (41°F) to summer maximums of greater than 20°C (68°F).[9]

The staff would expect impacts on aquatic resources from a plant at the Bradwood site and other lower Columbia River sites to be similar to those impacts expected for the Trojan Nuclear Plant, except that at the Bradwood site, the sandy streambank with low slope might necessitate a different intake design. Impingement and entrainment effects would depend upon the specific design of the intake structures.

2.4 Terrestrial Resources

The Bradwood site is in the western hemlock vegetation zone, and terrestrial characteristics are expected to be similar to those described for the Ryderwood site (Sec. 6.4 of Appendix B). There have been no terrestrial studies conducted at the Bradwood site, but extensive logging in the area and the presence of an abandoned lumber mill on the site indicate to the staff that the forest is likely to be dominated by second-growth Douglas

fir. Topography of the site is flat to hilly. Impacts from habitat loss and soil erosion are expected to be greater in such forested areas than at Pebble Springs.

3. CHERRY POINT

3.1 Socioeconomics

The Cherry Point site is in Whatcom County, Washington, 19 km (12 miles) north of Bellingham. The 1975 population of the county was 89,842, with nearly half (41,789) living in Bellingham.[2] The communities of Birch Bay and Ferndale (each with less than 5000 residents) are within 16 km (10 miles) of the site. The largest metropolitan area is Vancouver, British Columbia, 37 km (23 miles) to the northwest. The population was 426,000 people in 1970.

There are several light-duty paved roads in the vicinity of the site, and Interstate 5 is within 32 km (20 miles). Barge facilities, an 8-km (5-mile) railroad spur, and 10 km (6 miles) of transmission lines would have to be built.[11] A number of recreational facilities are within 16 km (10 miles) of the site, and the plant would be partially visible to people using those facilities.[11]

3.2 Geologic and Hydrologic Resources and Seismicity

The Cherry Point site is in the Puget Sound drainage on a coastal plain overlooking the Straits of Georgia. The elevation is 30 m (100 ft) MSL. The site is underlain by more than 76 m (250 ft) of glacial till consisting of unsorted and unstratified pebbly silts and clays.[12] The sediments are very susceptible to sliding when saturated. Dewatering would permit the use of spread foundations for lighter buildings; deep piles would be required for the heavy structures. The liquefaction potential has not been determined. Flooding should not be a problem at Cherry Point because no stream channels cross the site. A fault which deforms the Lower Miocene sediments passes within 8 km (5 miles) south of the site;[2] however, it has not been determined if the fault is capable.

3.3 Aquatic Resources

Oceanographic and ecological characteristics of an unidentified site for a once-through-cooled nuclear plant of 2000 MWe located between Point Whitehorn and Neptune Beach (the Cherry Point location) have been summarized by Battelle Pacific Northwest Laboratories.[13]

Intake and outfall structures could be located within 457 m (1500 ft) of shore on a sedimentary substrate at a depth of 18.2 m (60 ft). Tidal mixing at the site is reported to be good.[13,14] Maximum tidal range in the area is 3.5 m (17.5 ft), and tides are of a irregular, semidiurnal type. Currents move north along the shore during flood tide and south away from the shore during ebb tide. It is estimated that the maximum length of shoreline potentially affected by the thermal plume from a 2000-MWe plant near the Cherry Point site would extend from Point Whitehorn on the north to Lummi Point on the south.

Battelle used reconnaissance-level information to predict that the impacted coastline is habitat for five important species of shellfish.[13] The presence of a state park north of Point Whitehorn probably encourages the sport fishery in the area, including a good fishery in Brick Bay, north of Point Whitehorn.

Impacts from the construction of a once-through-cooled nuclear plant would include short-term sedimentation during placement of the intake and discharge lines. Erosion potential of the site is moderate; however, sedimentation impacts are expected to be less than those produced by runoff from nearby agricultural activities. Impingement and entrainment of plankton, larval fish, and larval shellfish can be expected in a once-through cooling system at this location. Effluent effects permitted at the site would be regulated in part by stipulations associated with the Class AA (Extraordinary) water quality classification assigned by the State.[15] That classification limits temperature increases due to human activities. In the staff's opinion, the thermal criteria specified by the State of Washington would be difficult to meet with once-through cooling unless appropriate diffusers were installed to limit temperature increases to 0.3°C across the dilution zone.

3.4 Terrestrial Resources

The Cherry Point site is primarily pasture, with smaller areas planted to vegetable crops. The site is within the sitka-spruce vegetation zone (see Sec. 3.4 of Appendix B), but aside from isolated patches of "woodland", most of the site is no longer forest. There have been no terrestrial studies of the site, but the fact that it is adjacent to industrial sites (oil refinery and aluminum smelter) would indicate a low diversity of wildlife, particularly large mammals. There may be, however, diverse species of birdlife.

Terrestrial impacts of power plant construction at this site are expected to be less severe than at any of the other coastal sites except for the Daley Lake site; under certain circumstances, the Cherry Point site might be preferable to the Daley Lake site. However, there is a potential for adverse synergistics effects of the adjacent industry at the Cherry Point, e.g., interaction of thermal and chemical plumes in discharges to the ocean, and interaction of stack effluents with cooling tower vapor plumes if cooling towers are used.

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4. DEER ISLAND

4.1 Socioeconomics

The Deer Island site is on the Columbia River in Columbia County, Oregon. The population of the county increased 12% from 28,900 in 1970 to 32,400 in 1976. In 1976, the unemployment rate was relatively high--11.9%.[1] The closest communities to the site are Deer Island, Columbia City, St. Helens (6566 people in 1975), and Goble. Portland, Oregon, 35 km (22 miles) south of the site, is the closest metropolitan area. The population of the metropolitan area was estimated at about 1,080,000 in 1975.[2]

The Burlington Northern Railroad and Highway 30 follow the western shore of Deer Island. A maximum of 5 km (3 miles) of track and about 3 km (2 miles) of access road would be required to connect the existing transportation systems with the site.[7]

4.2 Geologic and Hydrologic Resources and Seismicity

The Deer Island site is on the river edge of what once was a bar in a braided section of the Columbia River. The site consists of deep deposits of saturated, unconsolidated river sediments. If a nuclear plant were to be built there, deep foundations would be necessary, and the site would have to be built up to prevent flooding. To the staff's knowledge, nc borings or seismic studies have been performed at this site.

4.3 Aquatic Resources

Aquatic ecology of the lowe~ Columbia has been treated briefly in a generic manner for the Bradwood site (Sec. 2.3 of this appendix).

4.4 Terrestrial Resources

The Deer Island site is an unforested area of the Columbia River floodplain. To the staff's knowledge, no terrestrial studies of the site have been conducted. Because of the lack of forest cover, fauna probably consist primarily of small mammals and birds. The staff also expects that the site is a resting area for migratory waterfowl; construction of a power station on this site would likely preclude such use. In any case, construction and development on any floodplain is usually ill-advised and should be avoided.

5. FULTON RIDGE SITE

5.1 Socioeconomics

The Fulton Ridge site is in Wasco County, Oregon, an area with a small population (20,300 people in 1976) and low population density (3.5 people/km² or 9/mi²).[1,2] The closest incorporated city, The Dalles, Oregon, is about 16 km (10 miles) west of the site; in 1975 The Dalles had 10,533 residents.[2] The economy of The Dalles is based largely on food and timber processing, with manufacturing becoming increasingly important in recent years. The Dalles can be considered the most important commercial center of the mid-Columbia region.[16]

Dry farming is the predominate land use around the site. During the summer months, migrant farm workers come to the area to work in the fields. A study conducted by the applicant indicates that within 80 km (50 miles) of the site, the transient population approaches 8000 people during the peak season.[16] Because of the extensive farming in the area, the population near the site is expected to remain low. In 1970, 619 people lived within 16 km (10 miles) of the site; this is expected to increase only to 820 people by the year 2020.[16]

Although Oregon State Highway 206 borders the northern side of the site, additional transportation facilities would have to be constructed to make the site accessible. A railroad spur would have to be constructed from the Burlington Northern Oregon Truck Railroad branch line, and a barge slip would have to be built about 1.5 km (1 mile) downstream from the site.[17]

5.2 Geologic and Hydrologic Resources and Seismicity

The Fulton Ridge site is on a bench about 210 m (700 ft) above the Deschutes River. The site is underlain by 8 m (27 ft) of siltstone of The Dalles Formation and about 900 m (3000 ft) of Columbia River basalts. Beds are nearly horizontal since the site is near the axis of the broad Dalles-Umatilla syncline. The site is directly in line with the Warwick fault, which can be traced through the Columbia Hills anticline on the north side of the Columbia River, about 5 km (3 miles) north of the site.[18] Intensive investigation would be needed to prove that this fault does not cross the site and is not capable. The Warwick fault extends northwest into Washington for about 40 km (25 miles). A minor fault extends across the Columbia River at nearly right angles to the Columbia Hills anticline and comes within 8 km (4 miles) of the site.

5.3 Aquatic Resources

The staff is aware of no site-specific information on the aquatic ecology of the Fulton Ridge site, but the Columbia River adjacent to the site probably is similar to the stretch of the river at the Pebble Springs site.[19,20] Impacts of construction and operation would probably be similar to those the Pebble Springs site,

except for minor or negligible impacts from cooling tower blowdown discharged into the Columbia River at the Fulton Ridge location.

5.4 Terrestrial Resources

There are no terrestrial studies of the Fulton Ridge site, but since it is in the shrub-steppe region of the Columbia basin, the staff expects that vegetation and animal life are similar to those at Pebble Springs and Hanford (see Secs. 1.4 and 4.4 of Appendix B). One exception might be greater numbers and species of migratory waterfowl at Fulton Ridge, due to the proximity of the site to the Columbia River. The power station design for the Fulton Ridge site includes two cooling towers, while cooling at Pebble Springs would require an 800-ha (2000-acre) lake. Losses of terrestrial habitat by construction of the station at Fulton Ridge thus would be less than at Pebble Springs, but additional impacts due to the cooling towers, such as cooling tower drift and bird collisions, are predicted. The staff expects that impacts at the Fulton Ridge site would be greater than at the Hanford site because the latter already is an industrial site, and vegetation has been severely burned.

6. JETTY CREEK SITE

6.1 Socioeconomics

The Jetty Creek site is the northernmost of four sites considered in Tillamook County, Oregon. The site is about 8 km (5 miles) north of the Watseco Quarry site (see Sec. 10 of this appendix). The resident and transient populations, nearby communities, and recreational facilities in the area are discussed in the site descriptions of Daley Lake (Appendix B) and Watseco Quarry. The communities of Wheeler, Wheeler Heights, Brighton, Nedonna Beach, and Manhattan Beach are within 5 km (3 miles) of the site. The intake and outfall lines for a plant constructed at Jetty Creek would cross the community of Nedonna Beach, which includes year-round and summer homes. Part of Nehalem State Park is west and northwest of the site across Nehalem Bay.

Although the site is only 300 m (1000 ft) from U.S. Highway 101, the nearest Interstate is 145 km (90 miles) away. The Southern Pacific Railroad runs parallel to Highway 101 in this area. Barge facilities could be built at Barview, 27 km (17 miles) south of the site, or at Nehalem Bay, 600 m (2000 feet) west of the site. About 80 km (50 miles) of new transmission line would have to be constructed.[3] Some of the transmission lines, but not the plant, could be seen from Highway 101. People at Nedonna Beach and farther out to sea would be able to see parts of the plant.[3]

6.2 Geologic and Hydrologic Resources and Seismicity

The Jetty Creek site is about 30 m (100 ft) above mean sea level in very steep and heavily vegetated terrain that would require extensive excavation. Excavated materials would be used as fill in the Jetty Creek Valley. Jetty Creek would have to be rerouted or enclosed. Flooding from Jetty Creek could result from restricting of the channel. The City of Rockaway is using Jetty Creek as a source of municipal water, and potable water for a Jetty Creek plant could be obtained there. Present surface lithology consists of approximately 5 m (17 ft) clay silt that is prone to sliding. This is underlain by about 6 m (20 ft) of weathered and disturbed siltstone, which also contains a horizon of slickensides.* Deeper siltstone is less weathered, but joints are common, and slickensides are evident in some zones.[21] Jetty Creek is about 10 km (6 miles) from the Garibaldi fault trace and 22 km (14 miles) from a possible offshore fault.

6.3 Aquatic Resources

Jetty Creek, on which the site is located, is a small, first order stream discharging near the mouth of Nehalem Bay. Freshwater, estuarine, and marine habitats are adjacent to the site. Jetty Creek is the habitat of two game fish species, coho salmon and sea-run cutthroat trout.[3] Nehalem Bay is a major estuarine resource in Oregon and sustains a recreational fishery for clams, crabs, and fish.[3] The bay is fished for both bottom fish and salmon, and coho and chinook salmon are fished off the mouth of the bay.[22] Parts of Nehalem Bay also are considered important areas for waterfowl and other wildlife.[23,24]

The Oregon Nuclear and Thermal Energy Council has designated Nehalem Bay as "unsuitable" for the siting for a thermal power plant; the area from Nehalem Bay south to Barview has been classified as "suitable."[25] Since the site is located on a tributary to the bay, but the intake and outfall would traverse the intertidal zone south of the mouth of the estuary, the status of the plant location is uncertain.

If a plant were built at the site, increased sediment dispersion and turbidity could be expected in Jetty Creek from site preparation, stream channelization, cooling-water line construction, and barge basin construction. However, the staff concludes that impacts from such sources would be negligible because estuarine processes continually produce large quantities of sediment to which estuarine fauna are well adapted. Impingement and entrainment rates are expected to be moderately high at this location because it is a biologically rich area. Once-through cooling would dispose of large quantities of heat offshore, and the staff considers the probability of important effluent impacts to be greater than at other ocean sites because of the biological richness of the area.

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*A slickenslide is a polished and smoothly striated surface that results from friction across a fault plant.

6.4 Terrestrial Resources

The site is in steep terrain with heavy brush characteristic of sitka-spruce vegetation that has been logged. The site is part of a tree farm.[3] No terrestrial studies of the site have been conducted, but the staff expects that the vegetation and fauna are similar to that described for logged areas of this vegetation zone at the Daley Lake site (see Sec. 3.4 of Appendix B). Impacts will be more severe than at the Daley Lake site because of the large spoil area that will be required and because of the steep topography at the Jetty Creek site.

7. MAYGER SITE

7.1 Socioeconomics

The Mayger site would be on property that currently includes an abandoned fish cannery and the village of Mayger. All Mayger residents would have to be relocated prior to construction of the site. The communities of Locoda, Quincy, Alston, and Rainier are near the site. This site is in Columbia County, Oregon, which is discussed in more detail in the description of Deer Island (Sec. 4.1 of this appendix).

The Burlington Northern railroad and a highway traverse the Mayger site and a railroad spur already exists at the site.[7]

7.2 Geologic and Hydrologic Resources and Seismicity

The site is adjacent to the Columbia River at the upstream end of a point bar. The lower areas of the site flood frequently. No borings or seismic studies have been done at the site. Local geology consists of marine sedimentary rocks and volcanic material.

7.3 Aquatic Resources

Although no site-specific information is available for the Mayger site, aquatic characteristics of the lower Columbia River have been described in a generic fashion for the Bradwood site (see Sec. 2.4 of this appendix).

7.4 Terrestrial Resources

Similar to the Deer Island site, the Mayger site is on the floodplain of the Columbia River. It consists of flat, open space. There have been no terrestrial studies of the site, but the staff expects that aside from riparian vegetation, there is little forest cover. Fauna are likely to consist mainly of small mammals and birds. The site is also expected to serve as a resting area for migratory waterfowl of the Pacific Flyway; it is in proximity to an area proposed as a wildlife refuge. Construction of a power station on this site would be expected to have adverse impacts on the riparian vegetation and associated wetlands; however, the magnitude and severity of such effects, particularly on migratory waterfowl and the proposed wildlife refuge, can not be evaluated without site-specific terrestrial studies. In any case, the staff is of the opinion that construction and development on any floodplain should be avoided if more suitable alternatives exist.

8. MILES LAKE

8.1 Socioeconomics

The Miles Lake site is north of Cape Kiwanda and Pacific City in Tillamook County, Oregon. Since the site is about 16 km (10 miles) north of Daley Lake, the information on permanent and transient populations, local communities, and recreational facilities would be about the same for Miles Lake as for the Daley Lake site (Sec. 3.1 of Appendix B).

There is no developed harbor near the site and a barge basin would have to be constructed. There is no railroad access beyond Tillamook, Oregon, 35 km (22 miles) to the north, and the construction of a feeder line to the site seems impracticable.[3] To gain access to the interstate system, it is necessary to travel 5 km (3 miles) on a county road to U.S. Highway 101 and then 155 km (96 miles) south on the highway.[5]

Because the site is on the northern edge of a sand dune that parallels the Pacific Coast, the uppermost part of the reactor containment vessel would be visible to people on the nearby county road, and part of the plant would be visible from even greater distances [e.g., on beach areas 5 km (3 miles) south, from offshore, and at higher elevations inland]. Also, the plant would be fully visible from a large segment of Highway 101. The transmission line from the site would be only partially visible because of the terrain and vegetation. The line will have to cross Highway 101 and traverse part of the Siuslaw National Forest.[3]

8.2 Geologic and Hydrologic Resources and Seismicity

Site preparation would necessitate the excavation of about 4.5 m (15 ft) each of sand and clay. The water table is about even with Miles Lake Creek, which cuts across the site, and thus excavation would necessitate dewatering. Miles Lake might be dewatered as a consequence.[26]

Measurements of a large number of dips and strikes from oriented core samples and the disturbed appearance of the clay suggest that the site is on a deep, tilted, fault block. The Miles Lake site is about 11 km (7 miles) from the town of Beaver, which registered an earthquake of intensity MM-VI in 1957. No movement was detected along the Beaver Creek fault related to that earthquake.

8.3 Aquatic Resources

Within the region of influence of a plant on the proposed site are sandy shore marine habitats and freshwater habitats of Miles Lake and Miles Lake Creek. No information is available on aquatic biota or habitats, except reports that the creek contains cutthroat trout.[13] Offshore sports fishing includes several varieties of bottomfish.[22]

Sedimentation impacts of unknown magnitude would be expected in Miles Lake, Miles Lake Creek, and nearby marine habitats from excavation of the site, rechannelization of the stream around the plant, placement of cooling water lines, and barge basin construction. In the absence of site-specific marine habitat descriptions, the staff cannot conclude that effluent effects would be different than comparable plants operating in comparable environments.

8.4 Terrestrial Resources

The Miles Lake site is in a low-lying portion of a sand dune area heavily covered with brush and timber. The site is used by black-tailed deer, songbirds, and small mammals.[5] There have been no terrestrial studies made of the site, but the staff expects that undisturbed communities would be characteristic of the sitka-spruce vegetation zone described for the Daley Lake site (Sec. 3.4 of Appendix B). Impacts of construction on the Miles Lake site would be expected to be more severe than at the Daley Lake site because of the fragility of vegetation communities developed on sand dunes at Miles Lake. Such communities are expected to require a much longer time for reestablishment than communities on more typical soils, largely because of low fertility, poor water-holding capacity, low organic matter content, and poor structure.

9. WARRENTON SITE

9.1 Socioeconomics

The Warrenton site is within 1.5 km (1 mile) of the town of Warrenton in Clatsop County, Oregon. (The demography of the county has been described in connection with the Bradwood site, Sec. 2.1 of this appendix.) More than 20,000 people live within 16 km (10 miles) of the site, many of them in the town of Astoria, Oregon.[7] Clatsop County Airport is about 3 km (2 miles) northeast of the site. Railroad and highway facilities are near the site boundaries.[7] There is a state park to the west of the site, along the coast, and Fort Stevens Military Reservation and Camp Clatsop Military Reservation are also situated along the coast in the area.

9.2 Geologic and Hydrologic Resources and Seismicity

The Warrenton site is on the coastal plains near the mouth of the Columbia River. It is 2.5 km (1.5 miles) south of Young's Bay at an elevation of between 8 and 15 m (25 and 50 ft) MSL. The site is underlain by shallow bedrock,[14] which may consist of marine-deposited sedimentary rocks.[27] There are no seismic or boring studies of the area.

9.3 Aquatic Resources

Because the proposed plant would be designed for once-through cooling with water withdrawn from Young's Bay and discharged across the Clatsop Pennisula to the Pacific Ocean, both marine and estuarine habitats would be impacted by plant construction and operation. The Columbia River estuary and adjacent ocean waters are an exceptionally rich fishery area. Rivers emptying into Young's Bay support runs of shad, cutthroat trout, and steelhead trout, and the Columbia estuary supports fisheries for bottom fish, as well as a variety of salmonid species. Shrimp, bottomfish, salmon, tuna, and crab are fished off the mouth of the Columbia.[22,28] The biotic richness of aquatic habitats near the Warrenton site increases the probability of significant impacts from turbidity and from effluents relative to plants of similar construction on open coastlines.

9.4 Terrestrial Resources

The site is an open space in the sitka-spruce forest vegetation zone. There have been no terrestrial studies of the site; however, characteristics of this vegetation zone in general are briefly described in Section 3.4 of Appendix B. The site is hilly, thus increasing the probability of severe erosion hazard during construction. Erosion and loss of habitat for the diverse fauna expected to reside on the site are expected to have greater impacts at the Warrenton site than at Pebble Springs.

10. WATSECO QUARRY SITE

10.1 Socioeconomics

The Watseco Quarry site is north of Tillamook Bay in Tillamook County, Oregon. (Population and other aspects of the county are discussed in the site description of Daley Lake, Sec. 3.1 of Appendix B.) Numerous tourists come

to the county to enjoy the ocean and surrounding countryside. In 1972, the year-round population within 1.5 km (1 mile) of the site was only 290 people, but tourists increased the population to 1550 people during the warmer months.[3]

There are residences and a sewage lagoon directly west of the site. These homes and the lagoon would have to be disturbed for emplacement of intake and outfall lines of a nuclear plant. Also, a number of homes and a church camp, the Friends Camp, are now situated within what would become the plant's exclusion area. Within 1.5 km (1 mile) of the site are Camp Magruder (a recreational camp), many homes, and a number of commercial (including lodging) facilities. The communities of Manhattan Beach, Rockaway, Twin Rocks, Watseco, Barview, and Garibaldi are within 5 km (3 miles) of the site.[3]

A temporary barge facility could be constructed at the north harbor entrance jetty at Barview, 2.5 km (1.5 miles) south of the site. The Southern Pacific Railroad line is only 900 m (3000 ft) from the site, but it probably is impracticable to extend a spur to the site because of the grade and the need to cross Highway 101. The site is 140 km (85 miles) from the nearest interstate highway. An access road of about 1 km (½ mile) would be required to connect the site with U.S. Highway 101.[3]

Transmission lines leaving the Watseco Quarry site would be shielded from view by topography and natural vegetation. Some of the plant, however, would be visible from certain portions of the shoreline. Visibility of the plant from the highway could be eliminated by vegetation screening.[3]

10.2 Geologic and Hydrologic Resources and Seismicity

The Watseco Quarry site extends from the floor of an abandoned siltstone quarry into the adjoining hillside. Except where the quarried rock is weathered, slopes have been observed to be stable, even when steep. There are old landslide scars in the weathered rock and soil on the slopes to the north and south of the site. Excavated material would be used as fill in the valley of a creek that crosses the site. The creek would have to be rerouted or enclosed. Potable water could be obtained from the City of Rockaway, if the city develops a proposed infiltration system and storage reservoir on Watseco Creek, or from wells installed in a nearby sand dune.

A possible extension of the Garibaldi fault system comes within 0.4 km (¼ mile) of the site.[21] This fault would require detailed investigation if Watseco Quarry were to be further considered as the site of a nuclear plant.

10.3 Aquatic Resources

Construction of a plant at the Watseco Quarry site would necessitate the rerouting of the small first-order stream that runs through the site. No information is available on the biota of the stream, other than reports of sea-run cutthroat trout and coho salmon, which presumably inhabit lower Watseco Creek, north of the site.[3]

The marine habitats near the proposed intake and outfall structures include sand beaches and sand subtidal near the shore; Twin Rocks is less than half a kilometer (⅓ mile) offshore to the northwest. The coastal waters surrounding Tillamook Bay are a major salmon fishing area, and bottom fish, as well as coho and chinook salmon,
* are fished in the area near where the outfall of a nuclear plant would be located.[23]

The impacts on aquatic biota expected from construction and operation of a nuclear plant at this site are principally those from sedimentation and effluent discharges. Steep slopes and high precipitation rates can be expected to produce short periods of heavy siltation during site excavation and stream rechannelization. In the absence of contrary evidence, the staff expects effluent effects to be comparable to those of other plants of similar design in similar locations.

10.4 Terrestrial Resources

The slopes surrounding the quarry are covered with brush and trees; there is some use of the area by black-tailed deer and songbirds.[3] There have been no terrestrial studies of the site, but the staff expects that the land surrounding the quarry would have the characteristics of sitka-spruce forest that has been logged (see Sec. 3.4 of Appendix B). Because of the steep terrain, the staff expects that erosion would be severe during construction.

11. WEST ROOSEVELT SITE

11.1 Socioeconomics

The West Roosevelt site is in Washington State across the Columbia River in a westerly direction from the Pebble Springs site. It consists primarily of irrigated wheat fields and rangeland. The unincorporated community of Roosevelt is 1.5 km (1 mile) west of the site. Roosevelt has an estimated population of 75 people and lies within the site area. The next closest community is Arlington, Oregon, 2.5 km (1.5 miles) southeast of the site and across the river. Both communities are highway service stops.[29] The next closest community is Goldendale, 32 km (20 miles) from the site. Goldendale is the county seat of Klickitat County and had 3306 residents in 1975.[2] Although there are few people in the area, an elementary school and small park are located within 1.5 km (1 mile) of the site.

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Klickitat County had a population of 13,728 in 1975; the population density was 2.7 people/km^2.[2] The county's population is concentrated along the Columbia River, and a large number of transients visit the county because of the scenic conditions and recreational facilities.

The West Roosevelt site is easily accessible; Highway 14 runs through the middle of the site, a transmission corridor parallels the highway, and the Burlington Northern Railroad follows the Columbia River south of the site.[29] A plant at the West Roosevelt site would be visible to people in cars on Interstate 80 along the Oregon side of the river and those driving on Washington Highway 14. A roadside rest area is across the river from the site.[29]

11.2 Geologic and Hydrologic Resources and Seismicity

The West Roosevelt site is at an elevation of 116 m (380 ft) MSL on an erosional bench of the Columbia River. It is about 41 m (135 ft) above the level of Lake Umatilla (the Columbia River) and 24 m (80 ft) above the river level expected if the Grand Coulee Dam should fail.[30] The site is underlain by 12 to 18 m (40 to 60 ft) of weathered basalt, a thin baked siltstone, 2 to 7 m (7 to 22 ft) of vesicular basalt, and more than 38 m (125 ft) of dense basalt. The containment structure would be founded on the lower, hard basalt.[31]

Several types of landslides are present on the slope just north of the site. The slides are believed to be associated with the rapid drawdown of glacial Lake Lewis.[31] Liquefaction potential and slope stability analyses indicate that slope failure is unlikely under present groundwater conditions, except in one area where displacements of several feet at the toe of the slope were predicted.[32] These are not expected to endanger the plant site. A thrust fault on the northern extension of the Roosevelt bench is noncapable; the nearest capable fault is 90 km (55 miles) away.

11.3 Aquatic Resources

The staff is unaware of any site-specific information on aquatic resources of the West Roosevelt site, but considers the river adjacent to the site (the John Day Dam pool) to be similar to that stretch of the river adjacent to the Pebble Springs site.[19,20] Impacts of construction and operation would probably be similar to those at the Pebble Springs site, except for potential impacts from cooling tower blowdown discharged into the Columbia River from the West Roosevelt site.

11.4 Terrestrial Resources

The West Roosevelt site consists of about 55% shrub-steppe vegetation, 35% rabbitbrush-grasses, and about 10% agricultural crops, primarily wheat. A preliminary county survey by the Soil Conservation Service indicated that about one-fourth of the site is Class III land, and the remainder is in Classes IV, VI, or VII. Fauna at the site include 40 species of mammals and 141 species of birds that are either residents or seasonal migrants.[29] The larger mammals are similar to those at Pebble Springs, as both these sites are in the shrub-steppe region of the Columbia Basin.

A preliminary environmental assessment of the site relative to a proposed energy center indicated that some critical habitat for the longbilled curlew and Canada goose exists on the site, and this habitat likely would be lost or severely altered by the siting of the energy center (four coal and six nuclear power plants) on the site.[33] The potential impacts of a two-unit power station on this critical habitat have not been determined. Other impacts to the terrestrial environment at this site are expected to be similar to those at the Pebble Springs site, except that as currently designed, the West Roosevelt project would use cooling towers rather than a cooling reservoir, thus resulting in less loss of habitat. Use of cooling towers, however, would introduce additional sources of impacts to the terrestrial environment: drift from the cooling towers and the potential for kills of migrant birds due to collision with the towers.

REFERENCES TO APPENDIX A

1. "Oregon County Economic Indicators," Department of Economic Development, State of Oregon, 1977.

2. "County and City Data Book: 1977," U.S. Department of Commerce, Bureau of the Census, 1977.

3. "Site Comparison Study--Oregon Coastal Nuclear Power Plant Sites for Portland General Electric Comp ," prepared by Stevens, Thompson & Runyan, Inc., February 1973.

4. "Site Selection Study for Nuclear Electric Generating Station for the Eugene Water and Electric Board," prepared by Stone & Webster Engineering Corporation, August 1970.

5. "Highway Access Descriptions, Big Creek, Jetty Creek, Watesco Quarry, Miles Lake, Daley Lake" (author and date unknown).

6. "Executive Summary: Siting Study for Washington Public Power Supply System," prepared by Woodward-Clyde Consultants, WCC-74-682, December 1975.

7. "Site Location Study for Portland General Electric Company," prepared by Bechtel, Inc., October 1966.

8. "Information on Timing and Abundance of Fishes near Prescott, Oregon, Important to the Commercial or Sport Fisheries of the Columbia River," prepared by Battelle Pacific Northwest Laboratory for Portland General Electric Company, February 1968.

9. "Final Environmental Statement Related to the Operation of the Trojan Nuclear Plant," U.S. Atomic Energy Commission, Docket Nos. 50-460 and 50-513.

10. "Water Resources Data for Oregon, Water Year 1977," U.S. Geological Survey, Water-Data Report OR-77-1, 1978.

11. "Supplemental Testimony of A. Dvorak, P. Leech, I. Peltier, and J. Parker for the U.S. Nuclear Regulatory Commission Staff on Alternative Sites, Puget Sound Power & Light Company, et al. (Skagit Nuclear Power Project, Units 1 and 2)," U.S. Nuclear Regulatory Commission, Docket Nos. 50-522 and 50-523, 1977.

12. "A Comparative Analysis of Geologic and Seismologic Conditions of the Alternative Sites to the Skagit Nuclear Power Project," Bechtel, Inc., December 1978.

13. "Nuclear Power Plant Siting in the Pacific Northwest," prepared by Battelle Pacific Northwest Laboratory for the Bonneville Power Administration, July 1, 1967.

14. "Site Location Study," prepared by Bechtel, Inc., for Puget Sound Power & Light Company, October 1966.

15. "Washington State Water Quality Standards," Department of Ecology, State of Washington, December 19, 1977.

16. G. Wilfert, J. Carroll, and R. Wimer, "Demographic Characteristics of the Boardman, Pebble Springs, and Fulton Ridge Potential Power Plant Sites, North Central Oregon," Portland General Electric Company, PGE-2006, July 1974.

17. "Environmental Report, Pebble Springs Nuclear Plant, Construction Permit Stage," Portland General Electric Company, Section 9.2, 1974.

18. R. C. Newcomb, "The Dalles-Umatilla Syncline, Oregon and Washington," U.S. Geologic Survey, Professional Paper 575-5, pp. B88-B93, 1967.

19. "Final Environmental Statement Related to Construction of Pebble Springs Nuclear Plant, Units 1 and 2," U.S. Nuclear Regulatory Commission, Docket Nos. 50-514 and 50-515, April 1975.

20. "Aquatic Ecology of the Columbia River at the Pebble Springs Site, Final Report, November 1974-October 1975," BEAK Consultants, Inc., May 1976.

21. "Preliminary Geologic and Subsurface Investigations, Jetty Creek, Watseco Quarry, Miles Lake, and Daley Lake Proposed Nuclear Power Plant Sites, Tillamook County, Oregon," prepared by Shannon and Wilson, Inc., for Portland General Electric Company, January 1973.

22. J. L. Squire, Jr., and S. E. Smith, "Angler's Guide to the United States Pacific Coast," National Marine Fisheries Service, U.S. Department of Commerce, November 1977.

23. "Fish and Wildlife," Appendix XIV in: Columbia-North Pacific Region Comprehensive Framework Study, Pacific Northwest River Basins Commission, Vancouver, WA, November 1971.

24. "Oregon Coastal Management Program, 1976," Oregon Land Conservation and Development Commission, 1976.

25. "State-wide Siting Task Force Report," Oregon Nuclear and Thermal Energy Council, July 1974.

26. "Subsurface Investigation, Proposed Miles Lake Nuclear Power Plant Site, Tillamook County, Oregon," prepared by Shannon and Wilson, Inc., for Portland General Electric Company, July 1973.

27. V. C. Newton, Jr., and N. V. Peterson, "Geologic Criteria for Siting Nuclear Power Plants in Oregon," prepared by the Oregon Department of Geology and Mineral Industries for the State Nuclear and Thermal Energy Council, 1973.

28. W. G. Loy, et al., "Atlas of Oregon," University of Oregon Books, 1976.

29. "Supplement to Power Plant Site Evaluation for Pacific Power and Light Company" (PP&L Nuclear Project No. 1), Woodward-Clyde Consultants, March 1, 1975.

30. "Power Plant Site Evaluation for Pacific Power and Light Company" (PP&L Nuclear Project No. 1), Woodward-Clyde Consultants, March 1975.

31. "Geotechnical Studies for Preliminary Evaluation of a Proposed Nuclear Plant Site at West Roosevelt, Washington," report by Shannon and Wilson, Inc., to Wood-Envicon, Inc., for Pacific Power and Light Company, November 1974.

32. "Slope Stability Studies, Columbia River Escarpment, West Roosevelt, Washington," Vol. 1, prepared by Shannon and Wilson, Inc., for Pacific Power and Light Company, February 1976.

33. "Preliminary Environmental Assessment, Pacific Power and Light Company's Proposed Energy Center at West Roosevelt, Washington," prepared by Dames and Moore for the State of Washington Energy Facility Site Evaluation Council, D&M Report 7959-001-05, 1976.

APPENDIX B. SITE DESCRIPTIONS AND IMPACT SUMMARIES FOR PEBBLE SPRINGS AND FOR THE SIX ALTERNATIVE SITES

This appendix contains descriptions of the Pebble Springs site and of the six alternative sites evaluated by the staff, as well as brief discussions of the impacts of construction and operation of two nuclear units at these sites and comparisons of the impacts at the alternative sites with those at Pebble Springs.

1. PEBBLE SPRINGS SITE

1.1 Socioeconomics

The Pebble Springs site (Figure B.1) consists of an irregularly shaped tract of about 3400 ha (8400 acres) in the northeastern corner of Gilliam County in north-central Oregon. The site is about 5 km (3 miles) southeast of the Columbia River in a sparsely populated, semiarid region. At present the site is used as dryland range, primarily for sheep (about 4 ha, or 10 acres, are necessary to support one sheep for the 6-month grazing season). Land in the vicinity of the site is devoted mainly to dryland agriculture, with wheat being the most important cash crop. Extensive acreage also is used as dryland range for cattle and sheep. There are no onsite residences.

The area in the site vicinity is sparsely populated. Gilliam County had an estimated population of 2200 in 1976.[1] The community closest to the site is Arlington, Oregon (395 residents in 1974),[2] 5 km (3 miles) west-northwest of the site. A number of small communities (Rhea, Cecil, Shutler, Roosevelt, Ewing, Moonax, and McCredie) are within 16 km (10 miles) of the site. The Tri-Cities Area (Kennewick, Pasco, and Richland, Washington), about 90 km (55 miles) east of the site, is the nearest population center (about 100,000 people).

Interstate 80 and the Union Pacific Railroad main line, both paralleling the Columbia River, are 5 km (3 miles) north of the site. North-south oriented roads pass both to the east and the west of the site; spur lines of the railroad parallel the two roads. Considerable road capacity exists in the area, and no traffic impacts are foreseen. The Columbia River is navigable for barges.[3]

The availability of community services varies among the surrounding three counties. Surplus capacity for various services is shown in Table B.1. In 1976, 11 new single-family housing units were built in Gilliam County, 40 in Morrow County, and 453 in Umatilla County.

Archeological sites in the area of the site have been investigated,[4,5] and the one such location examined at the plant site was found to have few remains and to provide little information about the prehistory of the area.[5]

1.2 Geologic and Hydrologic Resources and Seismicity

The Pebble Springs site is in the Walla Walla subsection of the Columbia River Plateau physiographic province. The plant site is in an area where glaciofluvial deposits and poorly consolidated silts and tuffs overlie basalts.[6] The heavier station structures would be founded on the basalt. The proposed reservoir site (southeast of the plant site) is a scabland channel that trends east-west. These units are described in the applicant's Environmental Report (ER) and in a 1975 report by Shannon and Wilson, Inc.[5,6]

The elevation at the plant site is 225 m (740 ft) MSL. The topography of the area consists of gentle slopes, with rises to 275 m (900 ft) MSL about 1.5 km (1 mile) north of the site and to 335 m (1100 ft) MSL about 5 km (3 miles) south. Narrow, steep-sided canyons pass within 1.5 km (1 mile) of the dam sites on each end of the proposed reservoir. Alkali Canyon (China Creek) to the west and Eightmile Canyon to the east both are about 60 m (200 ft) deep in this vicinity. Old landslides are present along both canyons in the Selah member of the Ellensberg formation. The present water table is well below the Selah. If the reservoir is filled to the design level of 220 m (720 ft), a perched water table is expected to develop at the top of the Pomona flow. Water might seep into the Selah and cause additional shallow sloughing along canyon walls.

There is no surface water on the Pebble Springs site except for a seasonal spring (in glaciofluvial deposits) after which the site was named. There are no known mineral deposits of economic value on the site. Uniform granular material to be used for backfill would be excavated from an area just north of the plant site.

The intensity of the Safe Shutdown Earthquake has been designated as MM VII. This is based on the nearest and largest earthquake recorded. This earthquake was not associated with a capable fault, and thus it is assumed that a similar earthquake could occur anywhere near the site. The design ground acceleration associated with the Safe Shutdown Earthquake is 0.20 g. Velocity and displacement values are 0.24 m/s (0.80 ft/s) and 0.18 m (0.60 ft), respectively.

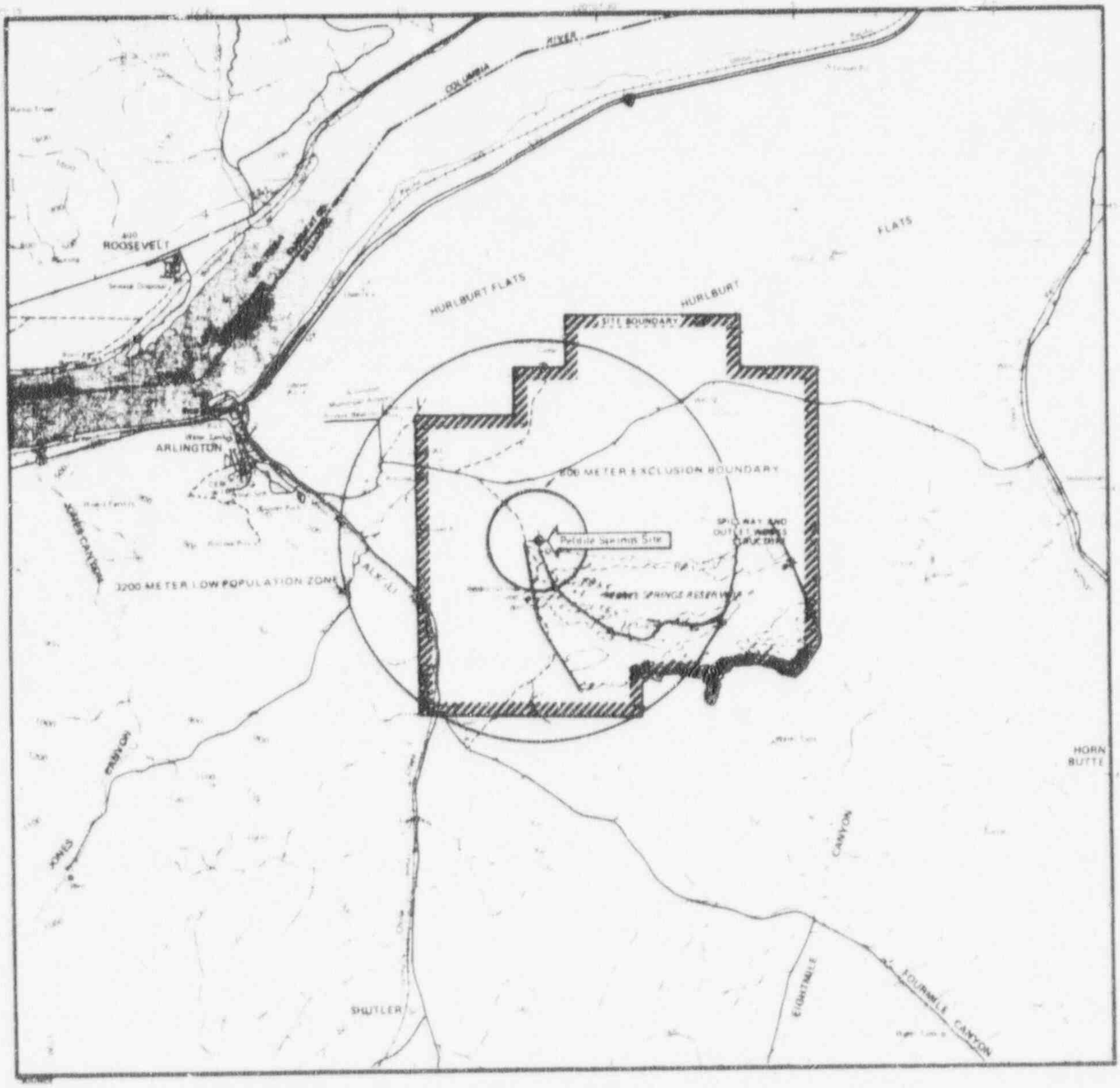

Figure B-1. Map Showing Boundary of Pebble Springs Site. [From "Environmental Report, Pebble Springs Nuclear Plant," Portland General Electric Company (undated).]

Table B.1 Community Services Profile in the Vicinity of the Pebble Springs Site: 1975[a]

County	Excess Sewer Capacity (people)	Excess Municipal Water Capacity (people)	Excess Primary School Capacity (students)	Excess Secondary School Capacity (students)	Excess Out-Patient Medical Capacity (people)	Excess In-Patient Medical Capacity (people)
Gilliam	2,395	503	266	80	-1,305[b]	-1,955
Morrow	575	896	13	253	-3,450	1,202
West Umatilla[c]	35,120	25,450	512	804	-21,100	28,418

[a] From "Projected Growth in Oregon's Northern Columbia River Basin Counties," Task Force Report prepared for the Office of the Governor, State of Oregon, August 25, 1975.

[b] Negative number indicates degree of deficiency in services available.

[c] Study area only included northwestern portion of Umatilla County.

Construction and operation of a nuclear power plant at the Pebble Springs site would have very little impact on site geology or hydrology. There are no streams or known mineral resources on the site which could be affected. The soils are preconsolidated, which means that the soil foundations should not be subject to excessive settlement. The deeper rocks having high residual stresses are already partially saturated and have been saturated in the past. They are not likely to rebound and create a shock when resaturated by reservoir leakage. Blowing of dust, slumping along the walls of excavations, and slumping of the Selah along the nearby canyon walls are the only probable adverse geological or hydrological impacts that would occur. Blowdown from the cooling reservoir would be available for irrigation, a positive impact. The power plant would have no effect on potential for utilization of groundwater.

1.3 Aquatic Resources

The only permanent natural aquatic habitat adjacent to the plant site is the John Day pool of the Columbia River, from which cooling pond makeup water would be withdrawn. Water levels fluctuate up to 3.3 m (11 ft) in a channel ranging from 27 to 36 m (90 to 120 ft) deep. The shoreline at the intake location is contoured, riprapped, and has a slope of 0.35 m/m.[7] The mid-Columbia River is classified by Washington State as Class A (excellent) waters.[8] Average annual discharge of the river at The Dalles, Oregon, is 5497 m^3/s (194,100 ft^3/s).[9]

The Columbia River supports a diverse and abundant aquatic biota; none of the species present are rare, endangered, or protected. Four species of salmon and steelhead trout are significant commercial and sports fisheries species. These five species, as well as smelt and American shad, are anadromous; adults pass the Pebble Springs site on their way upstream to spawn, and juveniles pass the site on their way downstream. (Some evidence from the unimpounded section of the river near Richland, Washington, suggests that migrating salmon tend to prefer shallow river water near the shore.) Habitats near the proposed site of the Pebble Springs intakes are not those preferred by salmon for reproductive activities, and it is doubtful if newly emerged juveniles susceptible to impingement and entrainment are ever present. Other important fish species in the Columbia River include native fishes in the minnow and sucker families, the native white sturgeon, and introduced warmwater species, such as bass, walleye, perch, catfish, and various sunfish. Other abundant biota of the river include a variety of planktonic algae, a diatom-dominated periphyton community; larvae of caddisflies, mayflies, and true flies; and crayfish.[7]

Construction of the Pebble Springs intakes would temporarily increase turbidity in the Columbia River, and operation of the intakes would entrain or impinge aquatic organisms unable to overcome intake velocities. Since no newly emerged salmon or steelhead juveniles are expected to pass the intakes, and since little spawning is expected in the intake area, the staff expects fish impingement and entrainment to be negligible. Since plant effluents are to be confined to the cooling pond, no effluent impacts are expected on the Columbia River.[7]

Construction of the Pebble Springs reservoir would produce a new aquatic environment which should be colonized rapidly by biota entrained with the water withdrawn from the Columbia River. Since the summer temperature of reservoir waters is expected to range from 36°C to 48°C (97°F to 119°F),[7] only the most thermal-tolerant biota would persist. These probably would include fly larvae and introduced warmwater fishes.

1.4 Terrestrial Resources

The Pebble Springs site is within the semiarid, nonforested region of eastern Oregon that has a natural vegetation termed "steppe."[10] This region is part of the Columbia basin vegetational province, which consists primarily of perennial shrubs, particularly big sagebrush and rabbitbrush. The understory consists of perennial bunch grasses, dominated by bluebunch wheatgrass, needle-and-thread grass, and Sandberg bluegrass. Since about 1800, however, sheep and cattle have severely overgrazed most of the steppe vegetation in the Pacific Northwest;[10] together with fire and agriculture, overgrazing has caused the disappearance of the "natural climax" vegetation and has increased annual grasses, particularly cheatgrass. The most common plants on the Pebble Springs site are rabbitbrush, snakeweed, cheatgrass, and Russian thistle.[7] Bunch grasses are scattered and infrequent, with the densest stands occurring on steep hillsides. Sagebrush is generally found only in small stands on sandy hillsides, although denser stands can be found in Eightmile Canyon and on the northern portion of Hurlburt Flat. A taxonomic listing of vegetation found on the Pebble Springs site is given in Reference 7.

Terrestrial wildlife species found on the site include coyote, mule deer, black-tailed jackrabbit, pocket mouse, and deer mouse. Of the 51 species of birds observed during studies of the site, 31 were found in the grass and shrub habitat, and 20 were found principally in riparian habitat along Eightmile Canyon.[11] Migratory birds did not appear to use the area as an important stopover.[11] One of the bird species found on the site, the northern longbilled curlew (*Numenius americanus parvus*), is currently under consideration by federal and state agencies for classification as endangered or threatened, due partly to the extensive loss of curlew breeding habitat to agricultural development.[12] Prairie falcons and golden eagles do not nest on the site, but have been observed to forage over it.[7]

The power transmission system for the Pebble Springs Station would require 10.4 km (6.5 miles) of line; two single-circuit, 500-kV transmission lines about 1.5 km (1 mile) long would require a 150-m (500-ft) wide right-of-way involving about 25 ha (60 acres); a single-circuit, 230-kV line 7.2 km (4.5 miles) long would require a 40-m (125-ft) right-of-way and would occupy about 28 ha (68 acres).[7] A makeup water pipeline from the Columbia River would require 6.4 km (4 miles) of right-of-way occupying 3 ha (7.5 acres) of land. Vegetation along these rights-of-way is similar to that of the site proper, i.e., severely grazed steppe and shrub-steppe.

Construction of the power station at the Pebble Springs site would result in the loss or alteration of about 825 ha (2045 acres) of dryland range, including the area to be disturbed by construction of the pipeline and transmission facilities. Small rodents would be destroyed, and displacement of more mobile animals would increase competition for terrestrial habitat in undisturbed areas. This would lead to a decrease in the number of individuals of certain species. Populations of the more common species (e.g., rodents) are expected to suffer no long-term effects on structure and stability; however, the loss of habitat might have long-term effects on larger mammals, such as the coyote and mule deer, and on species such as the northern long-billed curlew, which may nest on the site. The staff presently is unable to assess the magnitude of the impact on the latter species. The largest loss of terrestrial habitat would result from construction of the cooling reservoir [810 ha (2000 acres)]; however, the terrestrial habitat lost would be replaced by aquatic habitat. The desirability of one over the other is dependent on needs of the human community and is largely a socioeconomic consideration.

The major impacts of power plant operation on the terrestrial environment would be primarily due to the presence of the cooling reservoir. It is expected that riparian vegetation would become established along the perimeter of the reservoir, thus providing new habitat for other species of wildlife and increasing the species diversity of the county. Because of the temperatures expected in the reservoir, the species of vegetation established would most likely be those tolerant of warmer temperatures.

Water from the reservoir is intended to be used for agricultural purposes, including livestock watering. The staff has assessed the possibility of livestock poisoning due to toxins produced in the reservoir by blue-green algal blooms;[7] monitoring for this potential hazard would be made a requirement of the station's operating license.[7]

2. BOARDMAN SITE

2.1 Socioeconomics

The Boardman site (Figure B.2) is in Morrow County, Oregon, on the western shore of Carty Reservoir, 16 km (10 miles) south of the Columbia River. The site is in a sparsely populated, semiarid, nonforested region of eastern Oregon.

The plant site is within a 40,000-ha (100,000-acre) tract of land known as the Boeing Boardman Development, an agricultural-industrial park owned by the State of Oregon and leased to the Boeing Company for a 77-year period. The park is closed to the general public and no one resides within 6 km (4 miles) of the site.[4,13] The plant site is adjacent to the 2000-ha (5000-acre) Carty Reservoir, constructed to provide cooling water for a coal-fired generating facility being built at the park and for storage of irrigation water.[13]

The closest community to the site is Boardman, Oregon, about 19 km (12 miles) to the northeast. The population of the community has been estimated to be 555 people in 1979.[14] Ione, also in Morrow County, is 21 km (13 miles) south of the site, and Arlington, in Gilliam County, is 24 km (15 miles) west. These three communities had an 1973 estimated population of 1115 people.[15] The closest population center, the Tri-Cities Area (Kennewick, Pasco, and Richland, Washington) is about 80 km (50 miles) northeast of the site. The estimated population of the Tri-Cities metropolitan area was about 105,000 in 1975.[1]

In 1976, the estimated population of Morrow County was 5400 people, or three persons per square mile.[1,3] The population increased by 20% between 1970 and 1976 because of the large in-migration of people, a reversal of the previous decade's 14.5% out-migration.[1,3] Part of this growth was a result of several major construction projects and the growth of agriculture and related industries in the area. The economic base of the county consists of agriculture, food processing, forest products industries, and retail trade serving commercial and recreational travel along Interstate 80.[13] The labor force of the county increased from 1749 in 1970 to 3820 in 1976, and unemployment dropped from 7% to 6.5% during the same period.[1,3]

The transmission system for the coal-fired units at the Boardman site will consist of an extensive network of lines, some of which already exist and others of which are under construction. At present, 500-kV, 230-kV, 34.5-kV lines are under construction. The large lines will connect with the existing Bonneville Power Administration McNary transmission corridor that parallels the Columbia River. Access to the site is by road and railroad spur constructed for the coal-fired generating facility. Road capacity is adequate and no traffic impacts are foreseen. The road links with Highway 80 and the rail spur connects with the mainline of the Union Pacific Railroad.[13,16] The U.S. Navy Weapons System Training Facility is 5 km (3 miles) east of the site. Aircraft make about 17,000 target approaches annually.[16]

The coal-fired generating facility at the park is expected to be completed by 1981. Approximately 875 construction workers were working in June 1978.[17] About 150 operational employees will be required to service the plant. The impacts of these and previous construction workers have been assessed.[14] Additional housing was negotiated by the utility to provide residences for some of its employees.[16]

An archeological survey was conducted of the site,[18] and some locations were subjected to further archeological research;[19] however, no historic, scenic, or cultural landmarks are present in the area near the site.[13]

The Boardman and Pebble Springs sites are only about 16 km (10 miles) apart. The same labor supply would be tapped for both sites, workers would reside in the same communities, and the demographic composition of the two areas is almost identical. Although the Pebble Springs site is closer to a community and Interstate 80 than

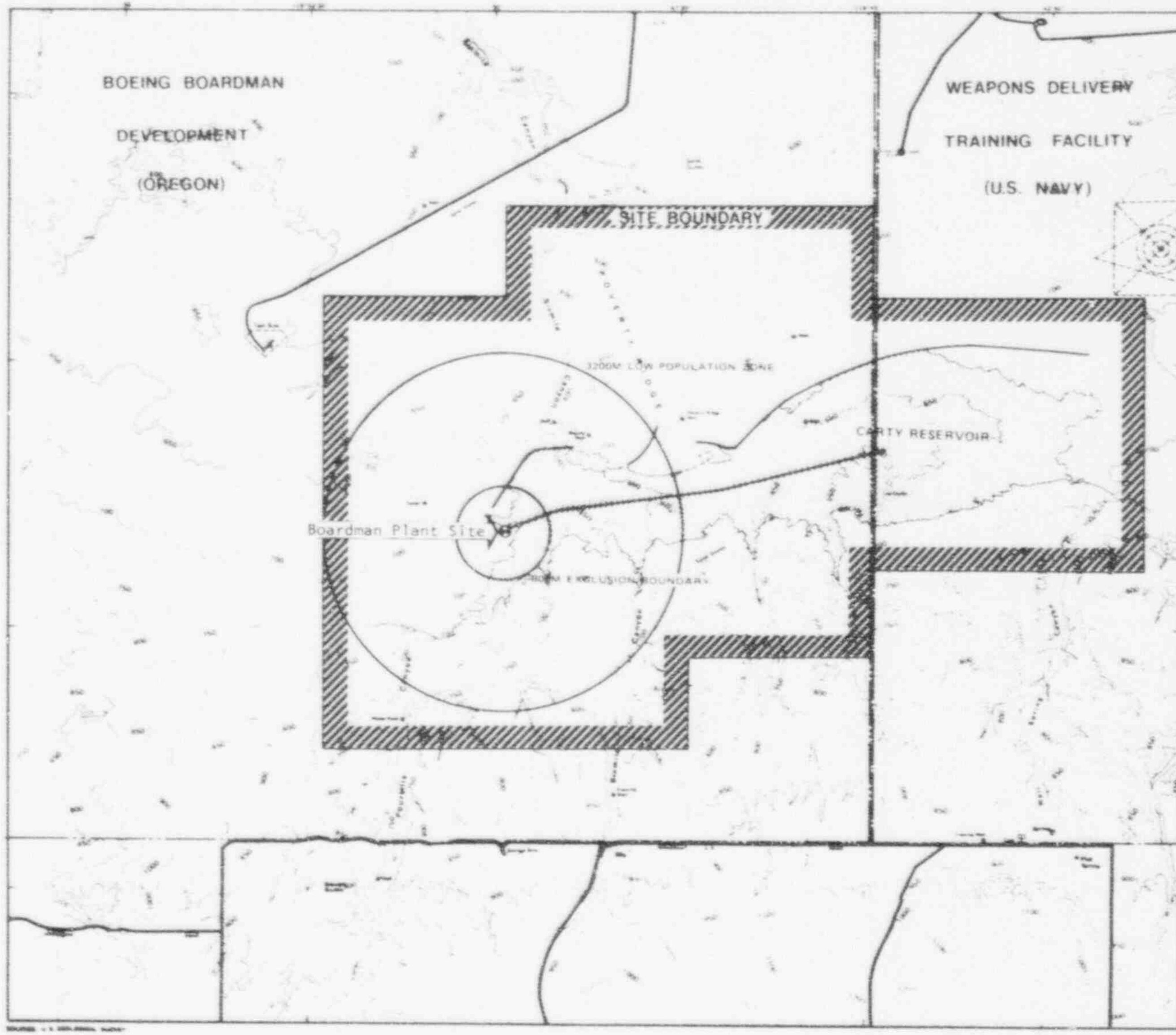

Figure B-2. Map Showing Boundary of Boardman Site. [From "Environmental Report, Boardman Nuclear Plant," Portland General Electric Company (undated).]

Boardman, the only station features that would be visible to the public would be transmission lines. The Boardman site is in an isolated area and the nuclear plant would be near another generating facility. No significant archeological sites have been found at either location.

In terms of the socioeconomic and community service factors considered, the only major difference between the sites, as far as suitability for a nuclear power plant, is accessibility. Boardman already has the necessary roads, railroad spur, and other facilities required for a power plant. Such facilities would have to be constructed or upgraded at the Pebble Springs site.

2.2 Geologic and Hydrologic Resources and Seismicity

The Boardman site is in the Walla Walla subsection of the Columbia Plateau physiographic province. It is in an area where relatively flat desert terrain is cut by several north-trending canyons. Surface elevations vary from about 180 to 210 m (600 to 695 ft) but are most commonly above 205 m (675 ft). The reactor site would be graded to an elevation of 209 m (685 ft) and would be situated just west of Carty Reservoir, elevation 205 m (675 ft). The 2000-ha (5000-acre) reservoir, intended to provide water for cooling for the Boardman coal-fired power plant and for irrigation, is partially constructed. The reservoir consists of dams across two of the principal upper channels of Sixmile Creek, which is an ephemeral stream in its natural state.

The present surface sediments in the site vicinity consist of windblown silt and silty sand (known as loess). Underlying this are 2 m (6 ft) of caliche-cemented silts of The Dalles formation. Beneath this are 2 to 4 m (6-12 ft) of the basalt of the Elephant Mountain flow. The Elephant Mountain flow overlies the Rattlesnake Ridge member of the Ellensburg formation. The Pomona basalt flow extends 44 m (145 ft) below the Rattlesnake Ridge member.

Because of material property irregularities, the loess, The Dalles formation, the Elephant Mountain Flow, and part of the Rattlesnake Ridge member would be excavated from the plant site. Buildings would be constructed on a clean, sandy gravel backfill.

Prior to construction of Carty Reservoir, groundwater under artesian pressure was encountered at elevations of 94 m and 98 m (310 and 320 ft). Water from the reservoir will eventually saturate the more shallow rock units. The Dalles, Elephant Mountain, and the upper part of the Pomona have relatively high hydraulic conductivities, 10^{-3} to 10^{-5} cm/s. The hydraulic conductivities of the other units vary from 10^{-5} to 10^{-8} cm/s.[20]

The Safe Shutdown Earthquake for the Boardman site has a magnitude of 6.7 and an epicenter 72 km (45 miles) away on the axis of the Rattlesnake Hill-Walla Walla structure. The plant would be designed for a horizontal ground acceleration of 0.20 g, a velocity of 24 cm/s (0.8 ft/s) and a displacement of 0.2 m (0.60 ft).[20]

Impacts to the geology and hydrology from construction and operation of a nuclear power plant at Boardman would be insignificant and essentially would be the same as impacts that would occur at Pebble Springs. Since part of the reservoir at Boardman has already been built, ground disturbance for dam construction and resultant erosion could be less at Boardman than at Pebble Springs.

2.3 Aquatic Resources*

Aquatic habitats potentially influenced by a nuclear generating facility at the Boardman site would be Carty Reservoir and the Columbia River.

The reservoir is located near lands leased to the Boeing Company for agricultural development using reservoir waters for spray irrigation of up to 16,000 ha (39,000 acres). Water would be supplied to Carty Reservoir through two pipelines--one maintained by agreement between Boeing and the applicant to supply irrigation water and cooling water for the Boardman coal-fired plant, the other to supply cooling water for the nuclear plant. Normal operating procedure would not include the discharging of water from the reservoir to the river; however, dam design includes an outlet to Sixmile Canyon for emergency drawdown.

The applicant has estimated that a nuclear plant at this site would require withdrawals of 4.3 m^3/s (69,000 gpm) of water under normal operating conditions. There would be no agricultural withdrawals from the reservoir in the winter; the agricultural withdrawal rate during July would be 7.6 m^3/s (120,000 gpm). Storage volume for irrigation would be 43 x 10^6 m^3 (35,000 acre-ft). Annual use of Columbia River water would total 120 x 10^6 m^3 (100,000 acre-ft), of which 86 x 10^6 m^3 (70,000 acre-ft) would be for irrigation.[21] Since water would be pumped into the reservoir both by the applicant and by Boeing, it is not clear what rates of pumping are expected through the applicant's intakes on the Columbia. In its environmental report, the applicant indicated that the Columbia River intake for the nuclear plant would use four pumps of 3.5 m^3/s (56,000 gpm) capacity, which is less than the 4.3 m^3/s (69,000 gpm) expected to be needed for the nuclear plant.

The staff expects Carty Reservoir to be colonized rapidly by biota entrained with the makeup water from the Columbia River. Establishment of dense growth of aquatic macrophytes should be precluded by the steep, riprapped shore. Composition and productivity of the plankton community will be determined by both natural hydrological

*The discussion in this section is based on the assumption that a two-unit nuclear plant, a coal-fired plant, and an irrigation project all would be operated simultaneously at this site.

processes and by plant operation procedures. Fish populations may become established as a result of entrainment of larvae and juveniles from the Columbia River. Salmon and trout are unlikely to become established because surface temperatures of the reservoir probably would be too hot, above 21°C (70°F) from May through September. Fish that might become established in the reservoir include bass, sunfish, catfish, and carp.

The staff has not included construction and operation impacts on Carty Reservoir in this impact assessment. The reservoir would be maintained primarily as a cooling facility, the public would be excluded from the reservoir, and the development of aquatic life in the reservoir would be completely fortuitous.

Sedimentation impacts from construction of the Boardman plant are expected to be limited to minor, short-term turbidity increases in the Columbia River during construction of intakes and the makeup-water pipeline. Placement of the intake structure would be on a shoreline already contoured and riprapped; thus, no important aquatic habitat would be disturbed. The nature of the reservoir banks (straight and steep) probably does not encourage fish aggregations in the area of the proposed intakes. Thus, if sidewall collectors were flush with the bank, impingement and entrainment should be negligible. No impacts on the thermal or chemical properties of the river are expected because plant discharges would be confined to the cooling pond. Since the average discharge and recorded minimum discharge of the river are 5497 m^3/s (19,290 cfs)[21] and 343 m^3/s (1204 cfs), the staff concludes that competing water use is not an important issue at this site.

2.4 Terrestrial Resources

The Boardman site is within the steppe region of eastern Oregon. In undisturbed areas the vegetation is dominated by big sagebrush and rabbitbrush, with the understory consisting mainly of bluebunch wheatgrass, needle-and-thread grass, and Sandberg bluegrass. Because of overgrazing, however, cheatgrass, Kentucky bluegrass, and Russian thistle have invaded the region and are common on the site.

Mammals of the site are coyote, bobcat, black-tailed jackrabbit, pocket mouse, deer mouse, and kangaroo rat. Birds reported to nest on the site include horned lark, western meadowlark, mourning dove, and long-billed curlew (Numenius americanus parvus), which is under consideration for endangered or threatened status. The prairie falcon and golden eagle forage on the site, and the burrowing owl and ferruginous hawk are summer residents on the site and in the nearby vicinity.

Presently, about 2600 ha (6300 acres) of the site are irrigated cropland; much of the remainder is used for grazing. Proposed development of the Boeing industrial/agricultural tract includes additional land for irrigated crops and a cattle feedlot.

It is expected by the staff that impacts to the terrestrial environment from construction and operation of two nuclear units at the Boardman site, in addition to the coal-fired units, would be less than the impacts that would occur if the two nuclear units were placed at the Pebble Springs site. Construction at the Boardman site, which already has a cooling reservoir, would disrupt less than 20 ha (50 acres) of terrestrial habitat, compared to over 800 ha (2000 acres) at the Pebble Springs site. In addition, no new transmission corridors are expected to be required for the two units at the Boardman site, with the exception of tie ins to existing lines.

Use of the water from the Boardman reservoir for livestock watering is subject to the same potential hazard as described in Section 1 of this appendix for the Pebble Springs site. Although the Boardman reservoir is larger [2000 ha (5000 acres)], if a two-unit nuclear plant were placed there the reservoir would have to cool four units (two coal-fired and two nuclear) and, therefore, it is likely that water temperatures similar to those expected at Pebble Springs [an 800-ha (2000-acre) lake for two units] would be attained at the Boardman reservoir.

3. DALEY LAKE SITE

3.1 Socioeconomics

The Daley Lake site (Figure B.3) is in Tillamook County in an open area between Highway 101 and the ocean. Present land use within ½ mile of the site is open meadow, and there are two residences in this area. Construction of a nuclear plant at this site would displace the people and homes, and preempt farming. The closest communities are Pacific City, Oretown, and Neskowin. Within 1.5 km (1 mile) of the site are Camp Winema and a number of small residential areas. County and state parks and a golf course are within 5 km (3 miles) of the site. The largest towns within 40 km (25 miles) of the site--Lincoln City and Tillamook--have less than 5000 residents.

Tillamook County has had a stable permanent population since 1970 (18,600 in 1976),[3] but does have a large number of transients. In 1972, the permanent population within one mile of the site consisted of 50 people, but during the peak vacation period, 1350 people were staying in the area.[22] Tourists are primarily attracted to the area for the ocean, the scenic panorama, and the Siuslaw National Forest.

The closest interchange to an interstate highway is 142 km (88 miles) south on Highway 101.[23] A barge-docking facility would have to be built at the site. There are no railroads within 40 km (25 miles) of the site, and rail access has been judged to be unfeasible at the site.[22] Highway access to the site will be via U.S. Highway 101. Highway 101 may be adequate, except at some intersections where congestion may occur, particularly during the summer season.

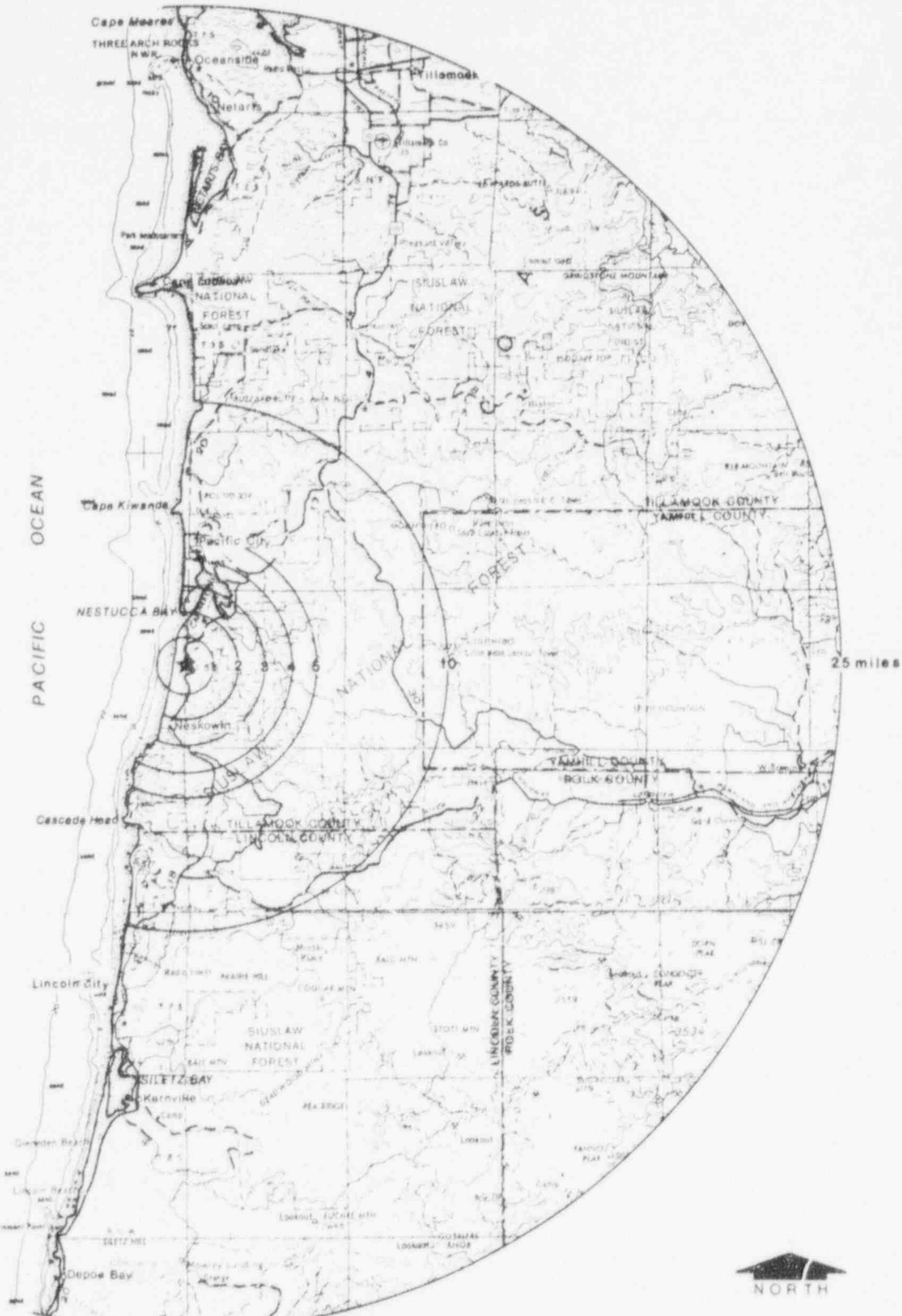

Figure B-3. Map Showing Location of Daley Lake Site. [From "Site Comparison S`udy, Oregon Coastal Nuclear Power Plant Sites," Stevens, Thompson & Runyon, Inc., 1973.]

The Daley Lake site has a high degree of full and partial visibility. Effective screening of plant facilities is considered to be difficult. Transmission lines from the site would have to cross Highway 101 and would be visible for about 3 km (2 miles). Also, the transmission lines would either have to cross part of the Siuslaw National Forest or run parallel to Highway 101.[22]

In terms of socioeconomic factors, the Daley Lake site is considered to be inferior for the siting of a nuclear generating facility as compared to Pebble Springs.

The disadvantages of the Daley Lake site become evident when it is compared to Pebble Springs. The Pebble Springs site has the following positive characteristics not found at Daley Lake:

- low transient population
- no parks or national forests near the site
- plant will be seen by few people
- transmission corridor exists near the site
- interstate highway within 5 km of the site
- railroad main line within 5 km of the site.

3.2 Geologic and Hydrologic Resources and Seismicity

The Daley Lake site is in the Oregon Coast Range section of the Pacific Border physiographic province. The topography consists of rolling coastal hills. The site is drained by Kiwanda Creek, which flows into Daley Lake and ultimately the ocean. Cooling water for a once-through cooling system would be piped from and returned to the ocean. Elevation at the plant site is 15 m (50 ft) MSL. Surface sediments at the site consist of about 1.5 m (5 ft) of soft silt underlain by up to 3 m (10 ft) of medium-dense to dense sand. The only rock unit penetrated by exploratory drilling to a depth of 31 m (102 ft) was an Oligocene to Miocene massive sandstone. Dips are nearly horizontal. A thin slickenside zone exists at a depth of about 22 m (73 ft). Regional information suggests that this sandstone may be intruded by volcanics and that it overlies Eocene sedimentary and volcanic rocks.[24]

Both shallow groundwater in the overburden and deep artesian groundwater in the sandstone are present at the Daley Lake site. Numerous ancient, shallow landslides are present in the nearby hills. The slides and the hummocky ground surface, which indicate soil creep, may be due in part to the shallow water table.

Kiwanda Creek would have to be rerouted around the plant site or enclosed in a culvert. A study of potential flooding of Kiwanda Creek is needed. The site is just above the expected reach of a Pacific tsunami.

The safe shutdown earthquake has not yet been determined for the Daley Lake site.

The soil units at the Daley Lake site are saturated and have a history of sliding. Construction could trigger additional small landslides. The site would require dewatering for construction. The lateral extent to which the water table would be affected by such dewatering has not been determined, but nearby wells could be affected. The artesian aquifer needs to be pinpointed and identified more exactly before it can be determined whether dewatering would include bleeding pressure from that aquifer as well. Another impact to be considered is the effect that rerouting would have on the erosional or depositional character of Kiwanda Creek. Because of these potential impacts, the Daley Lake site is inferior to the Pebble Springs site by geological and hydrological standards.

3.3 Aquatic Resources

A nuclear plant at this site probably would be constructed on Kiwanda Creek, a tributary of Daley Lake, which is a small coastal pond.[22] Little site-specific information is available on aquatic habitats or biota of Daley Lake. Whether the sea-run cutthroat trout reported at the Daley Lake site are found in the upper reaches of the stream is not known. Some offshore areas support a sport fishery for bottom fish.[25]

Impacts of construction and operation of a nuclear power plant at this site would include sedimentation impacts to Kiwanda Creek and Daley Lake, impacts associated with rerouting of Kiwanda Creek around the plant (or enclosing the creek in a culvert), sedimentation impacts to marine habitats from construction of intake-outfall structures and a barge basin, impingement and entrainment of marine organisms by once-through cooling, and discharge of heated and chemically treated effluents to the sea. Daley Lake is in an area judged "suitable" for nuclear plant siting.[26]

3.4 Terrestrial Resources

The Daley Lake site is an open meadow within about 1 km (½ mile) of the ocean. No site-specific data on vegetation and wildlife are available, but the staff expects that the terrestrial characteristics of the site are similar to those of open spaces within the sitka-spruce vegetation zone. This is a zone only a few kilometers wide along the coast of Washington and Oregon. It contains some of the finest forest soils in the region--deep, relatively rich, fine-textured, and high in organic matter and total nitrogen.[27]

Forest stands in this zone are typically dense, tall, and among the most productive in the world. Constitutent trees are sitka spruce, western hemlock, western redcedar, Douglas fir, grand fir, and (in Washington) Pacific

silver fir. Mature forests have lush understories with dense growths of shrubs, dicotyledons, herbs, ferns and cryptogams. Following fires or logging, there is a tendency toward development of dense shrub communities dominated by salmonberry, red elderberry, and huckleberry. The hardwood red alder grows fast on disturbed forest land and often overtops regeneration of conifers. Red alder fixes significant amounts of nitrogen in this region.[27]

The most common large mammals in this habitat include elk, deer, black bear, and moose, but because the site is an open meadow, it is unlikely that any of these large mammals reside there. Mammalian predators that are possibly present include mountain lion, bobcat, the Pacific marten, and the western spotted skunk. Smaller animals include the deer mouse, Douglas squirrel, bushy-tailed wood rat, Townsend's chipmunk, and coast mole. The more common birds include the red crossbill, chestnut-backed chickadee, red-breasted nuthatch, raven, gray jay, Steller's jay, hermit warbler, western wood pewee, and pine siskin. Blue and ruffed grouse are also present.[27] A list of the species actually present at the site is not available.

Three threatened animal species may occur in the coastal region of Oregon: the western snowy plover (Charadrius alexandrinus nivosus), which is a permanent resident along the Oregon coast in areas of dry sand between the highest high tide line and the vegetation line; the spotted owl (Strix occidentalis caurina), found in primary-growth coniferous forest of the Coast and Cascade Mountains to an elevation of about 1800 m (5800 ft); and the sea otter (Enhydra lutris), which has been introduced along the southern Oregon coast.[27]

In addition to the area that would be disturbed for construction of the plant, about 80 km (50 miles) of new transmission right-of-way, primarily through forest habitat, would be required to connect the site to the Carlton substation.

Loss of meadow habitat due to construction of the plant would probably have little effect on populations of larger mammals, since it is unlikely that any reside on the site. More likely to be affected are bird species which nest or feed in the meadow. Construction of the pipeline to the ocean and of the 80 km of transmission corridor through forest is expected to have greater impacts on the terrestrial habitat and on soil erosion than construction of the power plant itself. These impacts are also expected to be more severe in this region than impacts of the pipeline and transmission corridor construction for the Pebble Springs site.

4. HANFORD SITE

4.1 Socioeconomics

The Hanford site is within the Hanford Reservation (Figure B.4) in southeastern Washington. The reservation is controlled by the federal government and dedicated to nuclear activities. There are now three nuclear generating facilities (WPPSS 1, 2, and 4), Hanford Generating Project, and the Fast Flux Test Facility at the reservation. The Hanford Reservation consists of 1450 km^2 (560 mi^2) in Grant, Franklin, and Benton counties, Washington.[28]

The reservation has been closed to the general public since 1943. Except for a small portion of Richland, Washington, no towns are located within 16 km (10 miles) of the site. Only 130 people reside within 8 km (5 miles) of the site, and there are no public facilities, businesses, or primary transportation routes within 8 km (5 miles).[28]

The major population center in the region is the Tri-Cities Area of Richland, Pasco, and Kennewick, Washington. This area grew by 9.6% from 1970 to 1975 (93,356 to 105,022 residents).[1] A large construction force is currently residing in this area because of the construction activities at the reservation over the past decade.

The reservation is traversed by railroad and road systems. A spur line links the reservation with the Burlington Northern Railroad at Richland. State Highways 240 and 24 connect with the reservation, and the reservation has an internal road system.[28] However, traffic congestion has become a problem in parts of the Tri-Cities area because of limited access to the Reservation. Commuters to the Reservation from Kennewick and Pasco must pass through Richland or take the bypass route. Highways are affected by the one-way surge of traffic from Hanford in the evening and to the Reservation in the morning. Barges of up to 3000-ton capacity can be accommodated on the section of the Columbia River adjacent to the Hanford Reservation. Other barge-unloading facilities are located 13 km (8 miles) south of the site at the Port of Benton in North Richland.[29] Transmission lines already cross the reservation.

Archeological surveys have been conducted over various sections of the reservation. Six properties within the boundaries of the Hanford Reservation have been determined to be eligible for inclusion in the National Register of Historic Places.[30] No other registered historic, archeological, or cultural sites are within 40 km (25 miles).[29]

The Hanford site has been judged by the staff to be superior to Pebble Springs in terms of socioeconomic factors, the primary reason being that nuclear generating stations already exist at the Hanford Reservation. The population is small within 8 km (5 miles) of the Hanford Reservation, but a metropolitan area, with all its supporting facilities, is only 16 km (10 miles) away. A large labor force has been employed at the reservation for over a decade for the construction of different nuclear stations. Support facilities, railroad spur, transmission lines, roads, and barge facilities have been built for the other plants and are available for any new plants. In summary, all the basic service requirements and the necessary community infrastructure are available at or near the Hanford Reservation. These conditions are not found at Pebble Springs.

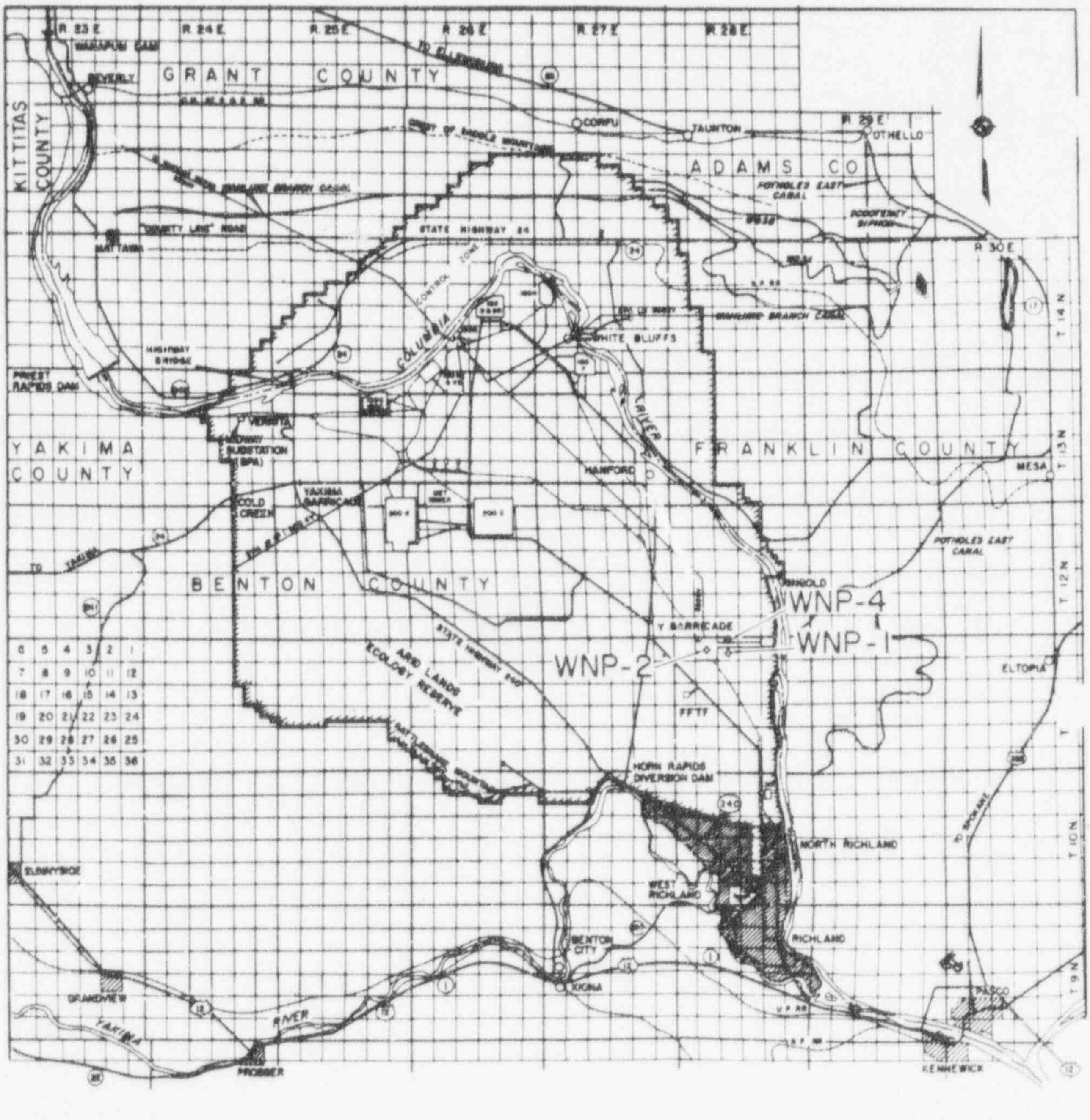

Figure B-4. Map Showing Location of the Handford Reservation. [From "Environmental Report, Washington Public Power Supply System, WPPSSS Nuclear Project No. 2," 1978.]

Potential impacts on esthetics and on cultural, historical, and recreational resources are expected to be about the same at the two sites. The landscape at the Hanford Reservation has been disturbed by the construction and presence of other plants; so while a new plant would be visible to people, it would blend in with the surrounding man-made structures. Only a portion of the Pebble Springs complex would be visible to the public, but what could be seen might be considered by some to be unpleasant. Esthetically, both sites would be disruptive, but in a limited way. The Hanford Reservation is large, and a number of facilities could be sited without disturbing the six archeological sites that have been found. Neither the Hanford site nor the Pebble Springs site is close enough to any parks, landmarks, or similar facilities to have any impact on them.

4.2 Geologic and Hydrologic Resources and Seismicity

The Hanford site is in the Pasco basin of the Columbia Plateau physiographic province. The area is characterized by low-lying hills, dunes, and intermittent streams. The Columbia River is the closest perennial stream. It is 4 km (2½ miles) to the east of the site at an average water elevation of about 110 m (360 ft). The site is at approximately 120 m (400 ft) MSL; the land surface slopes gently toward the river.

The Hanford site is in a part of the channeled scablands characterized by silt and gravel deposits. Windblown silt and sand, undifferentiable from the glaciofluvial sediments, extend to a depth of 15 to 18 m (50 to 60 ft). This is underlain by the 120-m (400-ft) thick Ringold Formation, which consists of an upper unit of lake-deposited silt and fine sand, a middle unit of gravel and conglomerate, and a lower unit of "blue clays." Below the Ringold are a series of basalt flows and interbeds. Average thickness of the basalt flows is between 40 and 46 m (130 and 150 ft).[31]

The water table at the Hanford site is about 15 m (50 ft) below ground level. In areas where they are saturated, glaciofluvial sediments may have hydraulic conductivities as high as 4.23 cm/s (12,000 ft/day). The hydraulic conductivities in the Ringold range from 3×10^{-4} to 6×10^{-2} cm/s (1 to 200 ft/day). Some of the lower clay beds are barriers to confined aquifers. The surface of the unconfined aquifer slopes toward the river.

The maximum possible flood of the Columbia River under present regulated conditions is estimated by the Army Corps of Engineers to have a crest elevation of 119 m (390 ft). There are no other local stream channels.

The nearest capable fault is along the Rattlesnake Hills-Walla Walla structural trend. Assuming that an earthquake of intensity VIII MM occurs there, the acceleration level recommended for the safe shutdown earthquake is 0.25 g. This intensity is considerably larger than any observed in Washington east of the High Cascades.

In terms of geologic and hydrologic factors, the impacts of power-plant construction and operation at the Hanford site would be similar to those at Pebble Springs, except Hanford, which has no reservoir, lacks the positive impact of increasing water availability. Ground settlement at Hanford is expected to be within design limits. There are no mineral resources or streams onsite, and the potential for groundwater utilization would be unaffected by the project. The Hanford site is considered to be equal to Pebble Springs on the basis of availability of water.

4.3 Aquatic Resources

Aquatic biota of the Columbia River near the Hanford site include a rich benthic community of periphyton and insects and a full complement of Columbia River fish species. Important members of the fish community are trout and salmon juveniles produced in the hatcheries and natural spawning area near Priest Rapids Dam.

It is presumed by the staff that the design of a new plant in this area would be similar to that of WPPSS Units 1, 2 and 4. Makeup water for natural-draft cooling towers would be withdrawn through intake structures in the Columbia River. These perforated pipes would parallel the current and would be designed to minimize fish impingement and entrainment. The Hanford site is situated on the only free-flowing reach of the river, immediately downstream of the Priest Rapids spawning area used by fall chinook salmon and steelhead trout. The plant blowdown would be discharged through slotted pipes placed in midcurrent so as to promote rapid mixing with the river water.

A temporary increase in turbidity might occur downstream during construction of intake and discharge structures. Since newly emerged salmon juveniles are periodically abundant in the Hanford Reach, there would be a potential impingement and entrainment problem unless best available technology were used to incorporate intake designs similar to those for the WPPSS units. Although impingement and entrainment rates of the WPPSS No. 2 plant have not yet been estimated, the staff has indicated in another document that such impacts are expected to be negligible.[32]

When the three nuclear power plants (WPPSS 1, 2, and 4) currently under construction at Hanford become operational, the addition of two more units equivalent to those proposed for Pebble Springs could result in five simultaneously operating units. Effluent effects from two more units should be considered as additions to the effects of three other units. Major effluent issues at Hanford are thermal impacts on salmonid fishes and the effects of chlorine in the blowdown. However, the magnitude of these impacts could be controlled by the relative positions of the five discharge diffusers with respect to each other and to current flow.

4.4 Terrestrial Resources

Vegetation of the site is typical of steppe vegetation that has been severely burned and overgrazed. Natural plant communities undisturbed by fire or overgrazing are dominated by big sagebrush and bitterbrush, with an understory of grasses and forbs. In 1970, a wildfire destroyed most of the plant and animal communities over 7600 m (19,000 acres) of the Hanford Reservation.[33] New vegetation in the burned areas has consisted mainly of annual grasses and forbs, with cheatgrass, Russian thistle, and mustard common.

Wildlife species on the site are similar to those at Pebble Springs, coyote, jackrabbit, pocket mouse, and deer mouse being among the common species. Mule deer are found near the Columbia River, and occasionally move inland, particularly in the summer, when they frequent Rattlesnake Hills. Most of the animals at the site reside in the riparian habitats. The most abundant birds in the area are the horned lark and meadowlark. The site is also a forage area for birds of prey, with Swainson's hawk prevalent in spring and summer and the golden eagle in the winter. The bald eagle (Halioetus leucocephalus) has been observed on the Hanford Reservation and is the only endangered wildlife species known to frequent the area.[33] A list of the flora and fauna observed on the site or along the portion of the river associated with the site is given in Appendix C of Reference 32. The Columbia River is a major migration route for waterfowl along the Pacific Flyway, and large numbers of ducks and Canada geese winter in the Hanford Reach of the river.[33]

Portions of the 150,000 ha (380,000 acres) encompassed by the Hanford Reservation are devoted to industry (plutonium production, power generation) and portions are used for a wildlife-game refuge and ecology reserve. It is assumed by the staff that the new power units would be located in the same general area as the existing power plants, and that tie-ins with existing pipelines and transmission lines would be made onsite so that no offsite habitat would be altered for these new facilities. For these reasons, the staff expects that the impacts to the terrestrial environment from construction and operation of two more nuclear units at the Hanford site would be much less than the impacts expected at the Pebble Springs site.

5. LEBANON SITE

5.1 Socioeconomics

The Lebanon site (Figure B.5) is in the Willamette Valley in Linn County. The site is owned by PP&L and is leased to 11 families. About 156 acres are under cultivation and 359 acres are used for grazing. The use of this site for power generation will displace these families and their residences and will preempt the farming activity. The closest community to the site is Lebanon, 8 km (5 miles) west, which is the second largest (population of 8137 in 1974) and second fastest growing city in the county.[2] The site is situated near several large urban areas. Salem (78,168 people in 1975), Eugene (92,541 in 1975), and Springfield (33,168 in 1975) are within a 1-hour drive of the site.[1] About 35% of Oregon's population resides within 80 km (50 miles) of the site, and thus a large labor force would be available for work at the site.

The economy of Linn County is based upon natural resources, particularly agriculture, for which 25% of the county's land area is used. Forest products and food processing are the principal commodity-producing industries.[2] Linn County's industrial development and urban concentration is centered in the communities of Albany, Lebanon, and Sweet Home, which are along Route 20. The county's population (81,000 in 1975) increased by 12.6% from 1970 to 1975, primarily because of net in-migration.[1] Albany is the county seat; it has about 22,000 residents and is about 25 km (15 miles) northeast of the site.

The Lebanon site currently is used for field crops and pasture, and the area around it is sparsely populated. The site is secluded and screened by surrounding buttes. Thus, the facility would not be seen by the residents of Lebanon, and esthetic impacts would be limited to those in the immediate vicinity of the site.[2] Two existing transmission corridors are located within 3 km (2 miles) east and west of the Lebanon site.[2] No major highways are in the immediate area. Workers driving from the north or south on I-5 to the site would exit on U.S. 20 and then proceed on State Road 226 to the site. A congestion point would occur at the intersection of U.S. 20 and State Road 226. Some upgrading of this intersection and State Road 226 would be required.

The area in the vicinity of the Lebanon site is expected to experience population increases because it is part of the Willamette Valley growth corridor along Interstate 5. In addition, a large number of seasonal farm workers and vacationers enter the county at various times of the year. In contrast, for the last 15 years the population has been declining in the county in which the Pebble Springs site is located. Only 510 people are expected to be living within 8 km (5 miles) of the Pebble Springs site in 1980, declining to 500 people by the year 2000.

An existing labor supply would be available within commuting distance of the Lebanon site, and the few new construction workers that would move into the Lebanon area probably could be absorbed into the communities around the site without severe impacts. On the other hand, almost all of the construction employees at Pebble Springs would have to relocate around the site, and the infrastructure of the immediate communities would be taxed to meet this influx of workers.

The Pebble Springs site has the advantage of being more accessible than the Lebanon site. The construction of the plant at Pebble Springs could occur with minimal development of related access facilities because of existing transmission lines and the proximity of the Columbia River and a major highway.

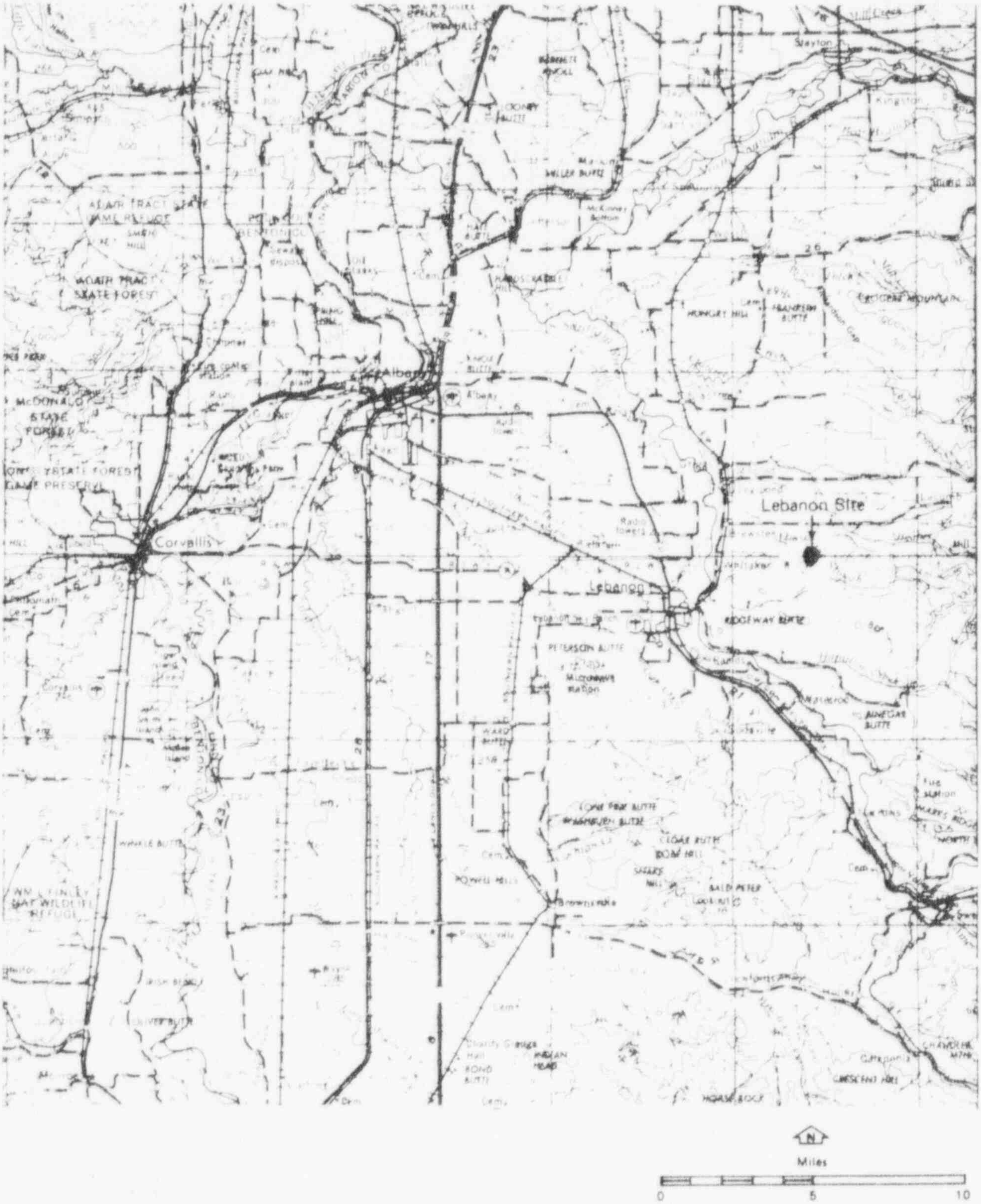

Figure B-5. Map Showing Location of the Lebanon Site.
[From "Power Plant Site Elevation," Woodward-Clyde Consultants for Pacific Power and Light Company.]

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5.2 Geologic and Hydrologic Resources and Seismicity

The Lebanon site is situated where the eastern margin of the Willamette Valley lowland merges with the lower hills and valleys of the Cascade Range. It is part of the Puget Trough section of the Pacific Border physiographic province. The site is about 5 km (3 miles) from the South Santiam River, which would be the source of cooling water for the plant. The site is adjacent to Onehorse Slough, which would be dammed to form a holding pond for blowdown from the plant during the summer months. Plant-yard elevation would be 134 m (440 ft) MSL. The plant would be well above the probable maximum flood elevation, with the possible exception of flooding combined with the release of water by failure of the Green Peter Dam. This possible combination requires additional study. Water levels in the holding pond would not exceed 125 m (410 ft) MSL.

Soils at the site are residual, stiff, clayey silts and silty clays. The contact between the soil and underlying rock units is gradational. Generally, the soils are about 3 to 9 m (10 to 30 ft) thick. The upper bedrock units may contain as much as 80% clay in a matrix around volcanic rock fragments. Both the soil and underlying tuffs have a very low hydraulic conductivity, and most of the flow is through the joints. Flow rates of local wells average 0.06 to 0.6 L/s (1 to 10 gpm) for wells 30 to 120 m (100 to 400 ft) deep. The water quality is good.[34]

It is expected that foundation excavations of 10 to 24 m (35 to 80 ft) would be necessary for the containment structure of a nuclear unit at this site. A mat foundation on the uppermost rock unit is suggested for the turbine building.[34] Settlement is expected to be less than 2 cm (0.8 inch).

The Corvallis fault, 32 km (20 miles) from the site, could be the location of an earthquake registering 6.8 on the Richter scale. The corresponding maximum horizontal ground acceleration at the plant site is estimated to be 0.25 g on bedrock. Velocity and displacement values are 23 cm/s (0.75 ft/s) and 0.12 m (0.38 ft), respectively.

In terms of geologic and hydrologic resources and seismicity, the impacts of construction and operation of a nuclear power plant at the Lebanon site would be essentially the same as at Pebble Springs, except that at the Lebanon site it would be necessary to dam a stream. Ground response to the construction and operation of the Onehorse Slough Reservoir at the Lebanon site has not been investigated. The site has no mineral resources, and hydraulic conductivities are so low that groundwater is not utilized. Soil slumping might occur during construction. Depending upon water quality and company policy for water use, the impoundment of blowdown in the summertime could become a positive impact. The Lebanon site is considered to be inferior to the Pebble Springs site, principally because the Onehorse Slough Dam would disrupt established flow patterns.

5.3 Aquatic Resources

Site facilities would include cooling towers and a reservoir to store blowdown water during low riverflows in the summer. Flow rates in the South Santiam River, the source of cooling water, are below the criterion used by the staff to select resource areas.[35] Average discharge at Waterloo is 83.18 m^3/s (2940 cfs), minimum discharge for the period of record is 1.73 m^3/s (61 cfs), and one-in-ten-year low flows (month) are 16 m^3/s (560 cfs).[36] South Santiam River periodically experiences low oxygen concentrations (1 to 4 mg/L) below Lebanon in the vicinity of a pulp mill and municipal sewage outfall. The condition is sufficient to inhibit salmonid migration and restrict recreational and domestic use.[36]

No endangered, rare, or protected aquatic species are known to be present in the vicinity of the site; however, no site-specific information is available on aquatic biota. The South Santiam River contains runs of chinook, coho, and sockeye salmon and steelhead trout. Other recreationally important fish include cutthroat trout, mountain whitefish, and largemouth bass.

Impacts expected at the Lebanon site would include short periods of high turbidity and sedimentation in the South Santiam River during plant construction. Although most chemicals in effluents discharged into the storage reservoir during plant operation would be carried to the South Santiam River by pipeline, water released to maintain flow in Onehorse Slough would receive relatively little dilution and could potentially impact downstream communities. Since temperature is critically high for salmonid fishes in the South Santiam River, and since flow rates are relatively low, release of heated effluents to the river would be a source of potential adverse impact. Intake structures would be placed above Lebanon Dam in the reservoir pool. This area of slack water is the type of habitat where resident fish might school or where salmon juveniles migrating downstream might congregate. Therefore, the staff concludes that fish impingement and entrainment rates might be significant.

5.4 Terrestrial Ecology

The area of the site has been logged, and secondary forest (predominantly Douglas fir and oaks) has become established. About 12% of the 650-ha (1600-acre) site is predominantly oak forest, 29% is predominantly Douglas fir forest, 47% is old field/pasture, and about 12% is riparian vegetation, mainly Oregon alder, Oregon ash, willows, big-leaf maple, and cottonwood.[2] Vegetation at the proposed reservoir site is mainly pasture and riparian. About 10% of the Lebanon site has been mapped as Class II land by the Soil Conservation Service, 42% as Class III, 34% as Class IV, and about 14% as Classes VI and VII.[2]

On the basis of information on wildlife distribution in the region, it has been estimated that 56 species of mammals, including the Columbian black-tailed deer, mountain lion, and black bear, could be present on the

site.[2] About 156 species of birds, most of which are residents, are expected to frequent the site, including the whistling swan, Canada goose, ferruginous hawk, golden eagle, and osprey.[2] Both the Artic peregrine falcon (Falco peregrinus tundrius) and the American peregrine falcon (Falco peregrinus anatum), which are federally endangered species, may visit the site.

The makeup and discharge pipeline would traverse Douglas fir-white oak forest and old-field/pasture habitats on land designated for "exclusive farm use."[2] About 3 km (2 miles) of new transmission corridor, traversing principally forest habitat and agricultural land, would be required to connect the Lebanon site with existing lines.

Construction of a power station and the associated cooling reservoir at the Lebanon site is expected to have a major adverse impact upon the diverse terrestrial biota. The loss of about 800 ha (2000 acres) of habitat may appear to be a relatively small portion of the total habitat in Oregon and Washington, but when added to the loss of similar "small" areas to other human activities in the region such losses can lead to the eventual extinction of certain species and loss of some "quality of life" factors that are valuable to the human species. Such losses are to be avoided when alternatives are available. As discussed in the text, habitat loss and soil erosion are expected to be of greater magnitude at the Lebanon site than at Pebble Springs.

6. RYDERWOOD SITE

6.1 Socioeconomics

Ryderwood, a community of 300 people (1970 census) is less than 1.5 km (1 mile) from the site.[37] Construction at this location would displace about 12 residences to accommodate the site and access corridors. The site is shown in Figure B.6. Two other small communities, Vader (387 people in 1970) and Castle Rock (1647 people in 1970), are within 16 km (10 miles) of the site.[37] Longview (29,137 in 1975) and Centralia (10,516 in 1975) are the largest communities within 40 km (25 miles).[1] No large labor force is located within commuting distance.[37]

Principal land uses at the site currently include timber production, pasture, and residences. The area in the vicinity of the site is sparsely populated. Lewis County had a 1975 population of about 49,500, with a population density of 8 people/km^2 (20/mi^2). This is considerably less than the state average of 20 people/km^2 (53/mi^2); however, the population of the county grew at a faster rate (7.5%) between 1970 and 1975 than did the state in general (3.9%).[1]

The site is 25 km (15 miles) from Interstate 5 on State Road 506. Workers driving to the site would use I-5, which connects to State Road 506. The two-lane, paved State Road 506 would have to be upgraded to carry the heavy construction traffic. Local roads in the vicinity are inadequate for construction traffic, and access to and from Ryderwood is poor. A 6-km (4-mile) railroad spur would be required. About 10 km (6 miles) of new transmission corridor, primarily through forest habitat, would be needed to connect the site to existing lines.[37] The site is remote, and the topography is such that the plant would be hidden from public view.[37] The only recreational area within 16 km (10 miles) of the site is Barnes State Park.

Of the socioeconomic variables considered, there is none that makes the Ryderwood location a better candidate site than Pebble Springs, and one--the retirement community nature of Ryderwood--that could make Ryderwood less desirable. However, the two sites have been judged by the staff to be equal in terms of socioeconomic impacts. Both sites are situated in counties of low population density and small communities are located within 16 km (10 miles) of each. Each site is near an interstate highway, a railroad line, and transmission lines. The remoteness of these sites and the nature of the surrounding terrain at both locations would make a nuclear station partially visible to only a limited number of people. It is expected that the majority of the labor force would have to move to these areas and may adversely impact the local communities. It is possible that this impact could be particularly severe at Ryderwood. There are few parks, recreational facilities, or other public sites close to either the Ryderwood or Pebble Springs sites.

6.2 Geologic and Hydrologic Resources and Seismicity

The site is within the Willapa Hills area of the Coast Range section of the Pacific Border physiographic province. It is in a valley known as Cougar Flat located in an area where mountains rise an additional 310 m (1000 ft) within 2.5 km (1.5 miles). Stillwater Creek flows through the site. Cooling water for the plant would be piped to the site from the Cowlitz River, 8 km (5 miles) to the east. The plant-site elevation would be about 60 m (200 ft) MSL.

The surface sediments at the site consist of 3 to 6 m (10 to 20 ft) of alluvial deposits of clay, sand, silt, and gravel. They are underlain by siltstones, sandstones, and shales upon which reactor foundations would be set. These rock formations, about 1600 m (5400 ft) thick, are poorly cemented, but they are dense enough and sufficiently cemented that liquefaction should not be a problem. Foundation conditions are uniform.[38]

Information on groundwater conditions in the area is scanty. Many local wells draw water from the alluvium. The Stillwater Creek flows through the site. It is joined upstream by Campbell Creek. Flood-stage flows should be considered in plant design.

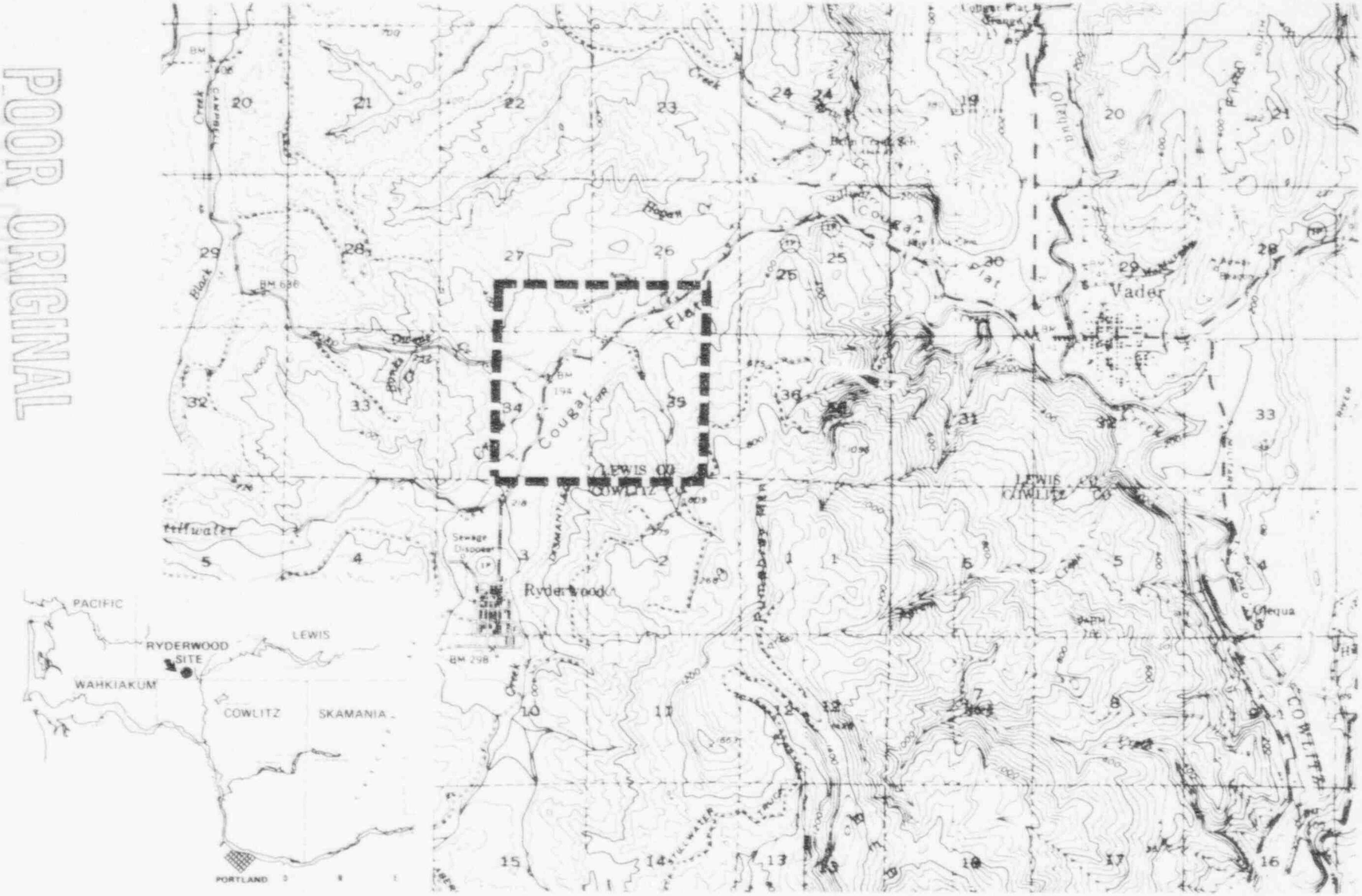

Figure B-6. Map Showing Location of Ryderwood Site. [Modified from "Environmental Report, Skagit Nuclear Power Project," Puget Sound Power & Light Company, 1974.]

The closest capable lineament is the Olympia lineament, 64 km (40 miles) away. A 7.1-magnitude earthquake occurred there in 1949. The corresponding intensity at the Ryderwood site was VII or VIII MM. The closest recorded earthquake occurred 24 km (15 miles) away in 1895 and had an intensity of V MM.

The most significant impact to geology or hydrology of construction and operation of a power plant at Ryderwood would be to Stillwater Creek. The plant site is on the floodplain of the creek. Flood protection embankments would restrict the channel during flooding. Slope stability for the site and the adjacent hillsides has not been calculated. There are oil and gas deposits in the vicinity of Ryderwood, but plant construction and operation should not affect exploitation of these resources. Because of its location on a floodplain, the Ryderwood site is rated as inferior to the Pebble Springs site.

6.3 Aquatic Resources

Little information on aquatic resources is available for the Ryderwood site. The site is near the Cowlitz River, from which cooling waters would be withdrawn. Stillwater Creek would be impacted by plant construction at the site identified by PGE.[37] The Cowlitz River harbors a significant run of steelhead trout and euchelon (smelt).[39] Mossyrock Hatchery on the Cowlitz River produced 42,293 pounds of fish in 1965, Blue Creek Slough Rearing Area produced 102,300 fish in 1965, and Toutle State Salmon Hatchery produced 66,203 pounds of fish in 1965.[40] Sufficient information is not available to judge comprehensively the relative siting merits of Ryderwood. Construction of intake and outfall structures on the Cowlitz River might have some potential for sedimentation impacts, and plant effluents discharged to the Cowlitz River might have a greater potential for adverse impact on aquatic resources than expected at Pebble Springs.

6.4 Terrestrial Resources

No site-specific data on terrestrial habitat are available, but the staff expects that the terrestrial characteristics of the Ryderwood site are, in general, those of the western hemlock vegetation zone. This is the most extensive vegetation zone in western Washington and Oregon and the most important in terms of timber production. Much of the zone has been logged, and/or burned, and large areas are now dominated by second-growth Douglas fir. Soils are generally moderately deep and of medium acidity, and surface horizons are well-aggregated and porous. The major forest tree species in this zone are Douglas fir, western hemlock, and western redcedar. Hardwoods are not common in these forests except on recently disturbed sites or in riparian habitats. The most widespread hardwoods are red alder, bigleaf maple, and golden chinkapin.

The fauna of this zone include elk, deer, black bear, moose, mountain lion, bobcat, Pacific marten, western spotted skunk, and a variety of smaller mammals, such as deer mouse, Douglas squirrel, and bushy-tailed woodrat. Avian predators are the red-tailed hawk, screech owl, pygmy owl, and great horned owl. The more common birds include the red crossbill, chestnut-backed chickadee, red-breasted nuthatch, Steller's jay, gray jay, hermit warbler, western wood pewee, and pine siskin. Blue and ruffed grouse are also present in the zone. The actual occurrence of these or other species on the site is not known. The site is in the Pacific Flyway for migratory waterfowl.

Two nationally endangered species may occur in this general region: the Columbia white-tailed deer (Odocoileus virgianus leucurus) and the California brown pelican (Pelecanus occidentalis californicus), which is regularly seen in Oregon estuaries and along the coast from June to December.

The major impact to the terrestrial environment from siting a power station at this site would be the loss of habitat for a diverse fauna that includes large mammals and possibly two federally endangered species. During periods of low cloud ceiling, the two cooling towers that would be erected on the site might be a hazard to waterfowl migrating along the Pacific Flyway. Impacts to terrestrial biota as a result of habitat loss are expected to be more severe at this site than at Pebble Springs. Soil erosion during construction, with subsequent siltation of riparian habitat suitable for resting and feeding by migratory birds, is expected to be greater at the Ryderwood site than at the Pebble Springs site because of the higher rainfall and steeper slopes at the former.

7. SKAGIT SITE

7.1 Socioeconomics

The Skage site (Figure B.7) is located in Skagit County, Washington, about 103 km (64 miles) north of Seattle. Four small communities are within 16 km (10 miles) of the site--Lyman (324 people in 1970), Hamilton (196 people in 1970), Sedro Wooley (5285 people in 1975), and Burlington (3534 people in 1975).[1,41] Eleven schools are within 16 km (10 miles) of the site.[41]

It is projected that the site will have two units already built. The local area will have experienced the various stages and positive and negative impacts of nuclear plant construction. Thus, the communities will be able to make the necessary changes or accommodations to cope with another construction project, and no additional displacement of human activities would be anticipated.

Bacus Road provides access to the site from State Highway 20, which is south of the site boundary. A new access road would have been constructed and any traffic congestion problems resolved. A rail spur also would have been

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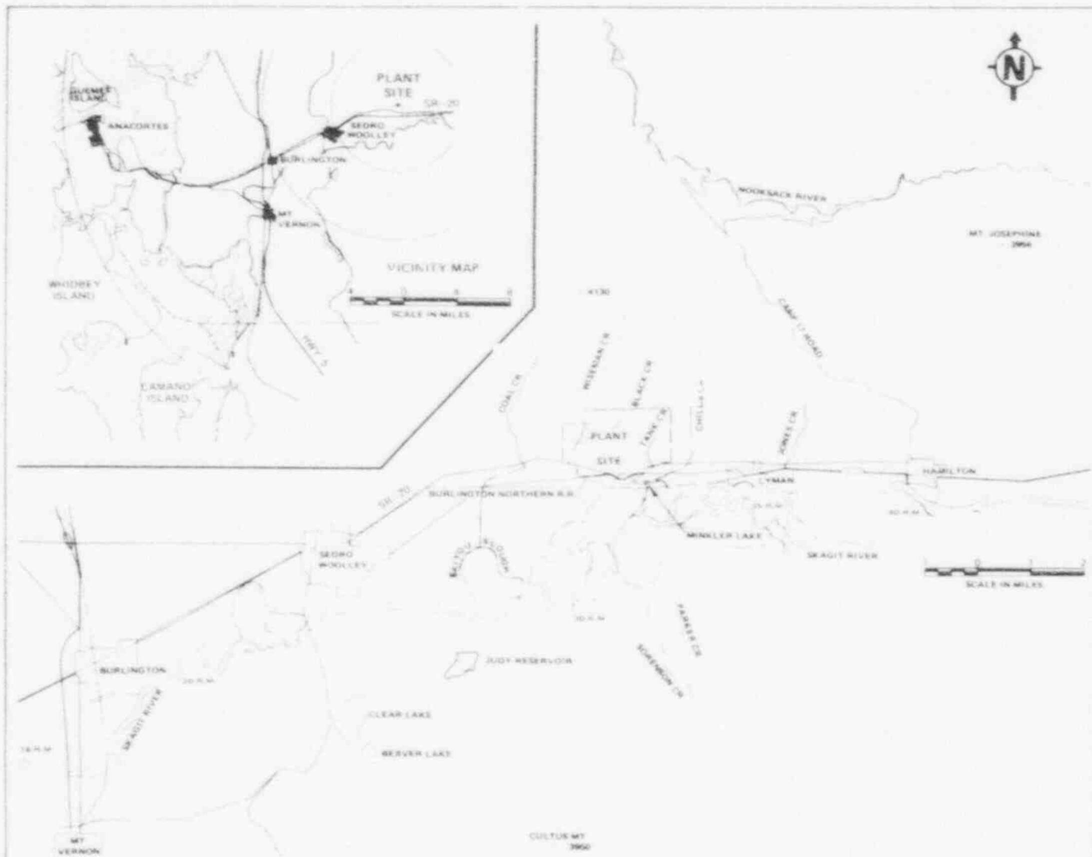

Figure B-7. Map Showing Location of Skagit Site. [From "Environmental Report, Skagit Nuclear Power Project," Puget Sound Power & Light Company, 1974.]

built to connect the site with the railroad line 11 km (7 miles) northwest of the site. In addition, a barge-unloading facility would have been constructed at the riverbank. About 8 km (5 miles) of new transmission line would have been strung to link the site with the 500-kV lines to the west.[41-43] Archeological field surveys and literature reviews conducted for the site and for areas along transmission corridor, railroad, and pipeline rights-of-way revealed no sites of prehistoric or historic interest.[41]

Various recreational facilities are scattered around the area, including city parks, a national forest preserve, national parks, and a national recreation area. Route 20, which passes close to the site, is the major artery to some of these areas. Construction of the plant might increase congestion along this transportation corridor.[41]

The site has been used mainly for forest products, pasture, field crops, and residences. Land-use plans by the Skagit County Planning Department include recommendations that commercial and industrial development be designated for upland areas, away from prime agricultural and pastoral lands, and away from unprotected floodplain. Industry is recommended to be located near urban centers or where land uses are "conducive to and compatible with the proposed industrial development."[44]

A separate environmental evaluation regarding placing a nuclear plant at the Skagit site was made in 1976 after the Skagit River was named as a study river under the Wild and Scenic Rivers Act (P.L. 90-542).[42,43] It was determined that there would be an inconvenience to boaters during construction of the pipeline and the barge-unloading facility and from operating noise from the collector pumps. The impact to recreational use was considered to be minimal since the section of the river involved is used primarily for fishing. The large natural-draft cooling towers and their plumes would be prominent and unnatural features that would be visible from many locations along the river.[42,43] The size and location of the reactor containment buildings and cooling towers (and their plumes) would also cause them to be visible from Highway 20 and nearby residential areas.[41] Further review by the Department of Agriculture found that the proposed project of two units would cause adverse effects;[45] however, the Department accepted mitigation measures proposed by the applicant.[46]

Since many of the construction workers would commute from Seattle and Vancouver, relatively few would move to the local area, and the communities in the vicinity could absorb them with minimal impact.[3] On the other hand, the labor needed at Pebble Springs could not be obtained in the local area. Thus, a large number of workers would have to move to the region, and the immediate communities do not have the infrastructures to meet a large influx of people.

The Pebble Springs site has the advantage of having fewer people around the site (both now and in the future). Also, the location of the Pebble Springs site would screen the plant from the view of local residents and people travelling on the interstate highway.

7.2 Geologic and Hydrologic Resources and Seismicity

The Skagit site is in the foothills of the Northern Cascade Mountains at the western boundary of the Cascade Range physiographic province. It is about 0.8 km (½ mile) north and 90 m (300 ft) above the floodplain of the Skagit River.

The site is on a glaciated bedrock bench. Surface sediments are primarily glacial till and outwash consisting of unstratified and unsorted deposits of silts, clays, sands, and gravels. Thickness ranges up to 30 m (100 ft), but in most places, the glacial material forms just a thin veneer. The reactor foundation would be set on the underlying Chuckanut sandstones and siltstones. The Chuckanut formation contains some coal beds, but they have not been mined in the vicinity of the site.

Cooling water would be obtained from the Skagit River. The mean annual discharge measured at nearby Sedro Woolley is 460 m^3/s (16,000 cfs). From records at Sedro Woolley, the 100-year instantaneous low flow at the intake location is estimated to be 66 m^3/s (2330 cfs).[47] Five upstream dams control the flow of the Skagit River past the site. Normal river elevation is 6 m (20 ft) MSL. The plant elevation is 128 m (420 ft) MSL. Three small streams cross the plant site. The flows of two of these, Wiseman and Tank creeks, average 0.2 m^3/s (7 cfs); peak discharges exceed 1.4 to 2.8 m^3/s (50 to 100 cfs). Black Creek would have to be rerouted around the plant site. Flood protection might be necessary along all three.

The most productive aquifers in the vicinity of the site are the glacial deposits and the alluvial deposits in the Skagit River Valley. Hydraulic conductivities in the glacial material may vary between 0 and 12×10^{-3} cm/s (0 and 1270 ft/yr). The bedrock has low porosity except along joints, fractures, and bedding plains. Hydraulic conductivities have been measured at from 9.7×10^{-7} to 8.2×10^{-4} cm/s (1 to 845 ft/yr), but the rock units are considered poor aquifers. Groundwater beneath the site flows to the south toward the Skagit River.

The Devils Mountain Fault Zone, 24 km (15 miles) away, is the nearest capable fault. Intensities of VI MM have been measured on the alluvium in the Skagit Valley from large, distant earthquakes and a small local one. Intensities on the bedrock would be less. The Skagit site is located in seismic risk zone III.

The Skagit site is considered by the staff to be inferior to the Pebble Springs site relative to geological and hydrological factors because of the stream rerouting that would be necessary at Skagit. Some sloughing of glacial outwash might also occur. There are deposits of coal with a high ash content beneath the Skagit site,

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but at present they are not economical to mine. A power plant would have little effect on either groundwater or surface water availability.

7.3 Aquatic Resources

The ecological resources of the Skagit site and the impacts of nuclear plant construction and operation have been extensively reviewed by the NRC staff as part of its licensing procedure.[41]

The State of Washington classified the reach of the Skagit River near the site as "Class AA - Extraordinary." The dominant fauna of the river are salmonid fishes--94% of the fish collected during ecological studies for the proposed Skagit Nuclear Power Project were chinook, chum, coho, and pink salmon; steelhead, cutthroat, and Dolly Varden trout; and mountain whitefish. Largemouth bass were also abundant. Average annual commercial landings for Skagit Bay are 320,000 fish for all salmonid species. Skagit River salmon runs are estimated to have a total value of $3.8 million to $17 million. The Skagit River salmon sport fishery is Puget Sound's largest.[48] The river also contains an abundant and diverse assemblage of aquatic invertebrates. Two of the three streams that drain the Skagit site (Wiseman and Tank creeks) are used for spawning by coho salmon, steelhead trout, and cutthroat trout.[41]

Temporary sedimentation and turbidity impacts are expected at Skagit during construction of intake and discharge structures. Construction of roads to the site would disrupt important aquatic habitat since it would be necessary to cross several creeks that support salmonid runs. Currently specified designs for the proposed Skagit Nuclear Power Project include Ranney collector intakes to minimize fish impingement and entrainment. The Skagit River at the site must meet Class AA water quality standards near the site and Class A standards at the discharge area downstream.

7.4 Terrestrial Resources

The site is within the western hemlock vegetation zone, the most extensive forest zone and the most important source of timber in western Washington. The major vegetation communities on the site are shown in Table B.2.

Vegetation in areas that have been clear-cut and/or slash-burned consist of annual weeds such as groundsel and sow thistle, with sword fern, red elderberry, bigleaf maple and several perennial herbs. The vegetational diversity of recently cutover lands is the highest of any community found in the area. The tree plantations contain Douglas fir, grand fir, and black cottonwood, with a dense understory of salmonberry. Alder stands have developed on areas logged in the late 1800s or early 1900s that were not replanted. Red alder is dominant, but western redcedar is invading throughout the wetter portions of this forest. The mixed hardwood/conifer forest occurs mainly on the upland portions of the site, along with red alder and western hemlock.[47] The rest of the site is in pasture. A vegetation species list for this community is given in Reference 49.

The combination of diversified successional stages, topography, climate, and sparsely populated uplands of the general area provide an environment favorable to a wide variety of wildlife.[47] Larger mammals include the black-tailed deer, black bear, and Canadian elk. Small animals include the snowshoe hare, eastern cottontail rabbit, and the marten. The most abundant of the 26 species of mammals observed on the site in 1973-1974 was the deer mouse.[49] Over 250 species of birds were identified on and/or expected to inhabit the site. Bird diversity was highest in the recent clear-cut communities and lowest in the cedar forest.[49] Game birds identified included ruffed grouse, blue grouse, mourning dove, band-tailed pigeon, ring-necked pheasant, and California quail. Birds of prey observed on the site or along the Skagit River included the northern bald eagle, red-tailed hawk, marsh hawk, sparrow hawk, Cooper's hawk, sharp-shinned hawk, great-horned owl, barn owl, and osprey. The site is located in the Pacific Flyway, and a number of waterfowl visit the area. Species lists can be found in References 47 and 49.

As with the Ryderwood and Lebanon sites, the Skagit site has a diverse terrestrial vegetation and animal life, including large mammals. Loss of habitat at this site is expected to have more severe impacts to the terrestrial ecosystem in terms of the numbers of species affected than at the Pebble Springs site, where a less diverse community exists. Similarly, because more rain falls and because the slopes are steeper at the Skagit site than at Pebble Springs, erosional loss of soil, with consequent adverse effects, is expected to be greater at the Skagit site, as discussed in the text.

Table B.2 Vegetational Communities on the Skagit Site[a]

Vegetational Community	Area of Coverage	
	Acres[b]	%
Clearcut	85	3.5
Recent clearcut and slash burn	44	1.8
Recent clearcut/weed stage	246	10.0
Pasturelands	649	26.5
Tree plantations	120	4.9
Alder forest	334	13.6
Mixed hardwood/conifer forest	607	24.8
Coniferous forest	269	11.0
Douglas fir forest	56	2.3
Cedar forest	39	1.6

[a]Table taken from "Final Environmental Statement, Skagit Nuclear Power Project Units 1 and 2," U.S. Nuclear Regulatory Commission, NUREG-75/055, Docket Nos. 50-522 and 50-523, May 1975.

[b]To convert acres into hectares, multiply the number of acres by 0.4047 (1 hectare = 2.5 acres).

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REFERENCES FOR APPENDIX B

1. "County and City Data Book: 1977," Bureau of the Census, U.S. Department of Commerce, 1977.

2. "Supplement to Power Plant Site Evaluation for Pacific Power and Light Company," Woodward-Clyde Consultants, for PP&L Nuclear Project No. 1, March 1, 1975.

3. "Oregon County Economic Indicators," Department of Economic Development, State of Oregon, 1977.

4. G. Wilfert, J. Carroll, and R. Wimer, "Demographic Characteristics of the Boardman, Pebble Springs, and Fulton Ridge Potential Power Plant Sites, North Central Oregon," Portland General Electric Company, PGE-2006, July 1974.

5. "Pebble Springs Nuclear Plant Environmental Report, Construction Permit Stage," Section 9.2, Portland General Electric Company, 1974.

6. "Geotechnical Investigation for Central Plant Facilities, Pebble Springs Site, Boardman Nuclear Project, Gilliam County, Oregon," Vol. I, prepared by Shannon and Wilson, Inc., for Portland General Electric Company, March 1975.

7. "Final Environmental Statement Related to Construction of Pebble Springs Nuclear Plant, Units 1 and 2," U.S. Nuclear Regulatory Commission, Docket Nos. 50-514 and 50-515, April 1975.

8. "Washington State Water Quality Standards," Department of Ecology, State of Washington, December 19, 1977.

9. "Water Resources Data for Washington, Water Year 1977," Volume 2, Eastern Washington, U.S. Geological Survey, Water Data Report WA-77-1, 1978.

10. J. F. Franklin and C. T. Dyrness, "Natural Vegetation of Oregon and Washington," U.S. Forest Service, Forest Service General Technical Report PNW-8, Portland, OR, 1973.

11. "Preconstruction Ecological Studies for the Pebble Springs Site," final report prepared by BEAK Consultants for Portland General Electric, 1978.

12. "Threatened Wildlife of the United States," Offices of Endangered Species and International Activities, U.S. Fish and Wildlife Services, Resource Publication 114, 1973.

13. "Environmental Report, Boardman Nuclear Plant, Construction Permit Stage," Portland General Electric Company (undated).

14. "Housing and Community Facility Requirements, Portland General Electric Company, Thermal Power Facilities: Pebble Springs and Carty Sites," Skidmore, Owings & Merrill, May 1975.

15. "Supplement to Certificate of Population Enumerations and Estimates of Counties and Incorporated Cities of Oregon, July 1, 1972," Portland State University, Supplement No. 14, September 30, 1972.

16. "Environmental Analysis, Proposed Participation in Portland General Electric Company's Boardman Coal Plant," Pacific Northwest Generating Company, October 1976.

17. "Housing and Community Facility Requirements Update," prepared by skidmore, Owings & Merrill for Portland General Electric, June 1979.

18. D. L. Cole, "Survey of the Carty Reservoir, Morrow County, Oregon, for Nonrenewable Resources," prepared by Battelle Pacific Northwest Laboratory for Portland General Electric Company, October 1973.

19. D. L. Cole, "Archaeological Research in the Carty and Pebble Springs Reservoir Areas in the Columbia Plateau of Oregon," Museum of Natural History, Eugene, OR, October 14, 1977.

20. "Geotechnical Investigation for Central Plant Facilities, Carthy West Site, Boardman Nuclear Project, Morrow County, Oregon," Vol. I, prepared by Shannon and Wilson, Inc., for Portland General Electric Company, September 1973.

21. "Water Resources Data for Oregon, Water Year 1977," U.S. Geological Survey, Water Data Report OR-77-1, 1978.

22. "Site Comparison Study, Oregon Coastal Nuclear Power Plant Sites for Portland General Electric Company," Stevens, Thompson & Runyan, Inc., February 1973.

23. "Highway Access Descriptions, Big Creek, Jetty Creek, Watseco Quarry, Miles Lake, Daley Lake" (author and data unknown).

24. "Preliminary Geologic and Subsurface Investigations, Jetty Creek, Watseco Quarry, Miles Lake, and Daley Lake Proposed Nuclear Power Plant Sites, Tillamook County, Oregon," prepared by Shannon and Wilson, Inc., for Portland General Electric Company, January 1973.

25. J. L. Squire, Jr., and S. E. Smith, "Angler's Guide to the United States Pacific Coast," National Marine Fisheries Service, U.S. Department of Commerce, November 1977.

26. "State-Wide Siting Task Force Report," Oregon Nuclear and Thermal Energy Council, July 1974.

27. G. A. Garrison, A. J. Bjugstad, D. A. Duncan, M. E. Lewis, and D. R. Smith, "Vegetation and Environmental Features of Forest and Range Ecosystems," U.S. Forest Service, Handbook No. 475, 1977.

28. "Environmental Report, Operating License Stage, WPPSS Nuclear Project No. 2," Washington Public Power Supply System, March 1977.

29. "Final Environmental Statement, Washington Public Power Supply System Nuclear Projects 1 and 4," U.S. Nuclear Regulatory Commission, NUREG-75/012, March 1975.

30. "National Register of Historic Places," U.S. Department of the Interior, 44 FR 7415-7649, February 6, 1979.

31. "Environmental Report, WPPS Nuclear Project No. 1," Washington Public Power Supply System, 1974.

32. "Preliminary Draft Environmental Statement, Related to Operation of Hanford Nuclear Plant No. 2," U.S. Nuclear Regulatory Commission, Docket No. 50-397 (in preparation).

33. "Final Environmental Statement, Related to Construction of Hanford Number Two Nuclear Power Plant," U.S. Atomic Energy Commission, Docket No. 50-397, December 1972.

34. "Geotechnical Studies for Preliminary Evaluation of a Proposed Nuclear Power Plant Site at Lebanon, Oregon," Shannon and Wilson, Inc., report to Woodward-Envicon, Inc., for Pacific Power and Light Company, November 1974.

35. "Power Plant Site Evaluation for Pacific Power and Light," Woodward-Clyde Consultants, March 1, 1975.

36. "Water Quality and Pollution Control," Appendix XII in: Columbia-North Pacific Region Comprehensive Framework Study, Pacific Northwest River Basins Commission, December 1971.

37. "Supplemental Testimony of A. Dvorak, P. Leech, I. Peltier, and J. Parker for the U.S. Nuclear Regulatory Commission Staff on Alternative Sites, Puget Sound Power & Light Company, et al. (Skagit Nuclear Power Project Units 1 and 2)," U.S. Nuclear Regulatory Commission, Docket Nos. 50-522 and 50-523, 1977.

38. "A Comparative Analysis of Geologic and Seismologic Conditions of the Alternative Sites to the Skagit Nuclear Power Project," Bechtel, Inc., December 1978.

39. "Information on Timing and Abundance of Fishes near Prescott, Oregon, Important to the Commercial or Sport Fisheries of the Columbia River," prepared by Battelle Pacific Northwest Laboratory for Portland General Electric Company, February 1968.

40. "Fish and Wildlife," Appendix XIV in: Columbia-North Pacific Region Comprehensive Framework Study, Pacific Northwest River Basins Commission, November 1971.

41. "Final Environmental Statement, Skagit Nuclear Power Project Units 1 and 2," U.S. Nuclear Regulatory Commission, Docket Nos. 50-522 and 50-523, NUREG-75/055, May 1975.

42. "Draft Supplement to the Final Environmental Statement: Skagit Nuclear Power Project Units 1 and 2," U.S. Nuclear Regulatory Commission, NUREG-0089, July 1976.

43. "Skagit Nuclear Power Project: Environmental Analysis Report," U.S. Forest Service, May 1976.

44. "North Central District Comprehensive Plan," Skagit County Planning Department, 1973.

45. Letter from M. R. Cutler, Assistant Secretary, U.S. Department of Agriculture, to L. V. Gossick, Executive Director for Operations, U.S. Nuclear Regulatory Commission, April 11, 1978.

46. "Nuclear Plant Mitigation Assessment," U.S. Department of Agriculture, pp. 7-9, April 19, 1979.

47. "Draft Environmental Statement, Skagit Nuclear Power Project Units 1 and 2," U.S. Nuclear Regulatory Commission, Docket Nos. 50-522 and 50-523, January 1975.

48. "The Skagit," Wild and Scenic River Study Report by the U.S. Forest Service, 1977.

49. "Environmental Report for Skagit Nuclear Power Project Units 1 and 2," Puget Sound Power and Light Company, U.S. Nuclear Regulatory Commission, Docket Nos. 50-522 and 50-523, 1974.

APPENDIX C.

ANALYSIS OF BULK TRANSMISSION SYSTEM REQUIREMENTS ASSOCIATED WITH ALTERNATIVE SITES FOR THE PEBBLE SPRINGS NUCLEAR GENERATING FACILITIES

1. INTRODUCTION

At the request of the NRC staff, the Bonneville Power Administration (BPA) conducted an examination to estimate the transmission system facilities and associated costs which would be required to integrate the output of a power plant at each of seven sites in the Pacific Northwest bulk power transmission system. The sites were identified for the purpose of this study by an NRC contractor and then furnished to BPA. These sites are: Pebble Springs (the proposed site); Boardman (north central Oregon); Hanford (south central Washington); Lebanon (west central Oregon); Daley Lake (north Oregon coast); Ryderwood (southwest Washington); and Skagit (northwest Washington).

These alternate sites are in the BPA service area. It is reasonable to expect that each site could be integrated into the BPA 500-kV main grid transmission system and BPA could provide wheeling services for participants. The participants are:

- Portland General Electric Company
- Pacific Power and Light Company
- Puget Sound Power and Light Company

All the participants presently have wheeling contracts for other generating resources in effect with BPA. Wheeling agreements have not been initiated for the Pebble Springs Nuclear Plant.

The BPA transmission system is the main bulk power transmission grid in the Pacific Northwest. BPA facilities in the States of Oregon, Washington, Idaho, and Montana interconnect with the non-Federal systems forming a coordinated regional network. About 80 percent of this network is owned and operated by BPA.

Approximately 75 percent of the load in the BPA service area is located west of the Cascade Mountain Range in Oregon and Washington. The remainder is dispersed throughout the region with load concentrations in the Spokane, Yakima, and Tri-Cities areas of Washington and in southern Idaho areas.

Most of the electric power is presently obtained from Federal and non-Federal hydroelectric dams east of the Cascade Mountains. Most of it flows westerly from these dams to serve load located west of the Cascades. The long-range need for transmission system reinforcement would be minimized by locating future generating resources in generation deficient areas. This report concentrates on transmission system additions required to interconnect the alternative sites to the main grid and main grid additions that would be required to serve Northwest loads.

2. INVESTIGATIVE APPROACH

Precise locations of each site were provided by the Argonne National Laboratory. Based on this information, BPA conducted several power flows studies for each alternative site to determine minimum transmission requirements. The base cases depict August 1988 and January 1989 system conditions with the assumption that both Pebble Springs units are in service. Those studies included existing transmission facilities and facilities presently planned or expected to be in service by the commercial operating dates scheduled for the Pebble Springs units. In some cases the interconnection facilities for the alternate sites interface with planned or programmed transmission facilities not yet constructed. Power flow studies use a mathematical model of busses, lines, loads, and generation in the interconnected Northwest transmission system and re[illegible] systems of the Western Systems Coordinating Council (WSCC). That council covers all or parts of the 14 [illegible]ern states and British Columbia, Canada. The studies were, thus, broad in scope.

Stability studies were also conducted to determine dynamic system response for system disturbances at critical locations. These studies measure the performance of the system when it is perturbed by faults.

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During the course of transmission studies, BPA planning staff discussed the studies with Portland General Electric planning staff. It was agreed that the integrating facilities and main grid reinforcement identified in the studies are consistent with the transmission requirements.

It is important to note that transmission facilities constructed by BPA must undergo the environmental review process. That procedure has not been conducted for any of the sites. Also, plans of service for other projects are tentative at this time. Since the plans for alternative sites interrelate with other transmission projects not yet in service, these transmission facilities may change if an alternative site is approved and more detailed site-specific studies show that a different plan of service is appropriate. However, changes in transmission plans are not likely to significantly impact transmission requirements for alternative sites.

3. CRITERIA APPLIED

The BPA transmission system is planned and constructed in accordance with two sets of reliability criteria. The two sets of criteria are compatible.

The reliability criteria adopted by BPA describe the performance and planning reliability of the BPA system.

The second set of reliability criteria is that adopted by the WSCC. It describes the limitation of the effects that disturbances on one system can have on other member systems.

Studies to assure adherence with the criteria include simulation of all the transmission facilities, generating resources and loads in the WSCC.

The two sets of reliability criteria are lengthy and relate to many planning considerations. The portions relating to main grid transmission requirements for the Pebble Springs alternative sites are included in Appendix D in the form of performance tables. They describe system performance and permissible remedial action for multiple contingencies.

Specific tests to determine adequacy of transmission facilities for each site include:

- Steady state tests (power flow studies) to assure full load operation of the plant with one line out of service.
- Transient stability tests to assure that the plant will maintain synchronous operation (stability studies) when a three-phase fault is cleared by normal automatic circuit breaker operation.
- Transient stability tests with one line out of service to assure that a single-phase-ground fault on another line will not limit full load operation of the plant. To satisfy this test, single-pole relaying and single-pole circuit breaker operation is necessary in some cases.

4. GENERAL PLANNING CONSIDERATIONS

The BPA system is designed and constructed to serve the electric power demands in the Pacific Northwest. Facilities are timed to satisfy that objective reliably and economically. Main grid facilities that are described in the sections of the report that follow are likely to be required at some future date regardless of Pebble Springs or its alternate sites. The sections that follow are, therefore, presented to assist in the environmental evaluation of alternate sites.

The direct interconnection facilities, on the other hand, are site-specific. Those facilities connect each site to the main grid.

Power flows on a transmission system in accordance with the laws of physics. Power generated at any site tends to serve load nearest that site. Power from sources that would otherwise serve those same loads is redistributed on the system to serve other loads. This is the principal of displacement. On this basis, the typical cost of transmission for sites located near loads is less than for sites located far from loads. Similarly, sites located in generation deficient areas minimize the long-range requirements for transmission system reinforcement. The BPA system can be divided into five zones. The lowest transmission cost is in Zone 1. It includes the major load areas in the Puget Sound, Portland, and Willamette Valley trough. It is a narrow zone running from the Canadian border to Eugene, Oregon. Zone 2 includes the Pacific Coast, with the exception of the Olympic Peninsula and the western slopes of the Cascade Mountains. Zones 3, 4, and 5 are mostly east of the Cascades. Zone 5 is the highest cost zone.

Skagit, Ryderwood, and Lebanon are in Zone 1 and have the lowest transmission cost. Daley Lake is in Zone 2. Pebble Springs, Boardman, and Hanford are in Zone 4.

Long-range transmission cost is essentially the same for any site within each zone. The following table uses this concept; main grid reinforcement is included in these costs:

Zone 1	Annual Cost/kW 1/	Total Annual Cost
Skagit, Ryderwood, Lebanon	$1.70	$4,250,000
Zone 2		
Daley Lake	$1.90	$4,750,000
Zone 4		
Pebble Springs, Boardman, Hanford	$3.50	$8,750,000

1/ These rates are being reviewed and may be increased about 50 percent.

The above numbers include main grid additions and use of main grid facilities.

5. COST DATA FOR INTERCONNECTION FACILITY ADDITIONS

As a result of the limited availability of right-of-way in the Pacific Northwest, it is appropriate to construct high capacity transmission facilities. These facilities may exceed the initial transmission capacities required for integrating generating resources. The long-range effect is to minimize the environmental impact of future transmission facilities.

The highest capacity standard 500-kV single-circuit transmission line presently used by BPA utilizes three 1.602-inch (Chukar) conductors per phase. The three phases are arranged in a delta configuration that maximizes power transfer capability and minimizes right-of-way width requirements.

Double-circuit 500-kV lines are recommended for some of the alternative sites. These use taller transmission line towers that have one three-phase circuit mounted on each side of the tower. Each phase of both circuits use the same conductors as for the single-phase line configuration described above.

Each circuit of the lines described is capable of transmitting the generating capacity of two units with one circuit out of service. Their design capacity is 2,500 MW per circuit.

Lines to provide station service power are required for some sites. These lines are rated for 230-kV operation. They use conductors which are adequate for station service requirements for two units.

Switching facilities are appropriately designed to accommodate the transmission lines connected to them.

The costs for transmission lines represent BPA typical estimates based on 1979 prices. The following table shows the typical per-unit cost of transmission facilities. They exclude land, clearing, site development, and administrative overheads.

	Investment $(000)
500-kV single-circuit line (3-1780 kcmil conductors/phase)	250/mile
500-kV double-circuit line (3-1780 kcmil conductors/phase)	480/mile
230-kV single-circuit line (1-1272 kcmil conductor/phase)	100/mile
500-kV circuit breaker with disconnect switches, substation dead-end tower and auxiliary equipment (3,000 amp. rated capacity)	900 Ea

90002055

6. SITE INTERCONNECTION AND MAIN GRID FACILITIES FOR EACH SITE

This section describes transmission system requirements for the proposed Pebble Springs site and each alternate site and is intended to assist the environmental assessment of each site. The interconnection and main grid facilities identified for each site interface with existing system facilities, facilities programmed for construction or facilities presently planned to be in place before 1989. The costs shown in this section are interconnection facilities. The costs shown in Table 1 are the zone costs plus the cost to connect the sites to the main grid.

6.1 Pebble Springs Site (See Figure 1)

A 500-kV double circuit 5,000 MW capacity line from Ashe Substation (in the Hanford area) to Marion Substation in the Willamette Valley is under construction. This line will interconnect with the proposed Slatt Substation and proposed Buckley Substation. The Pebble Springs units would be tied directly to Slatt Substation. The Slatt Substation will also integrate the Boardman coal plant, which is under construction, into the BPA main grid system.

Interconnection facilities for the Pebble Springs site consist of switching facilities at Slatt Substation.

Figure 1 shows the 500-kV transmission system facilities in the vicinity of the Pebble Springs site.

Offsite power for this site would be provided over a one mile 230-kV line to an existing 230-kV line.

Land description:

Approximately one mile of 230-kV line would be required across range land for offsite power.

Cost estimate:		Interconnection Facilities
Slatt Substation 3-500-kV circuit breakers		$2,700,000
Offsite power 230-kV line, 1-mile		100,000
	Total	$2,800,000

6.2 Boardman Site (See Figure 2)

The Boardman site is about 17 miles east of the Pebble Springs (Slatt Substation) site. Development of Slatt Substation would be the same as for the Pebble Springs site. The connection diagram is shown in Figure 2.

Two 500-kV circuits would be extended from Slatt Substation to the Boardman site. They would probably parallel the 500-kV line to the Boardman coal plant. A 500-kV switchyard at Boardman would integrate the two nuclear units.

Offsite power would be derived from the facilities constructed for the coal plant.

Land description:

Agriculture in this area is rapidly expanding. Large parcels are irrigated with circular sprinklers. Water is pumped from the ground or from the Columbia River. A corridor through this area could interfere with farming practices or buried water lines. Water fowl from Wildlife Refuges along the Columbia feed in fields along the path of the corridor.

Cost estimate:		Interconnection Facilities
Boardman Substation 4-500 kV circuit breakers		$ 3,600,000
Slatt Substation 3-500-kV circuit breakers		2,700,000
2-Boardman-Slatt 500-kV lines 17 miles each		8,500,000
Offsite power - Locally available		-
	Total	$14,800,000

FIGURE 1

500 Kv TRANSMISSION SYSTEM CONNECTIONS FOR
PEBBLE SPRINGS UNITS 1 & 2

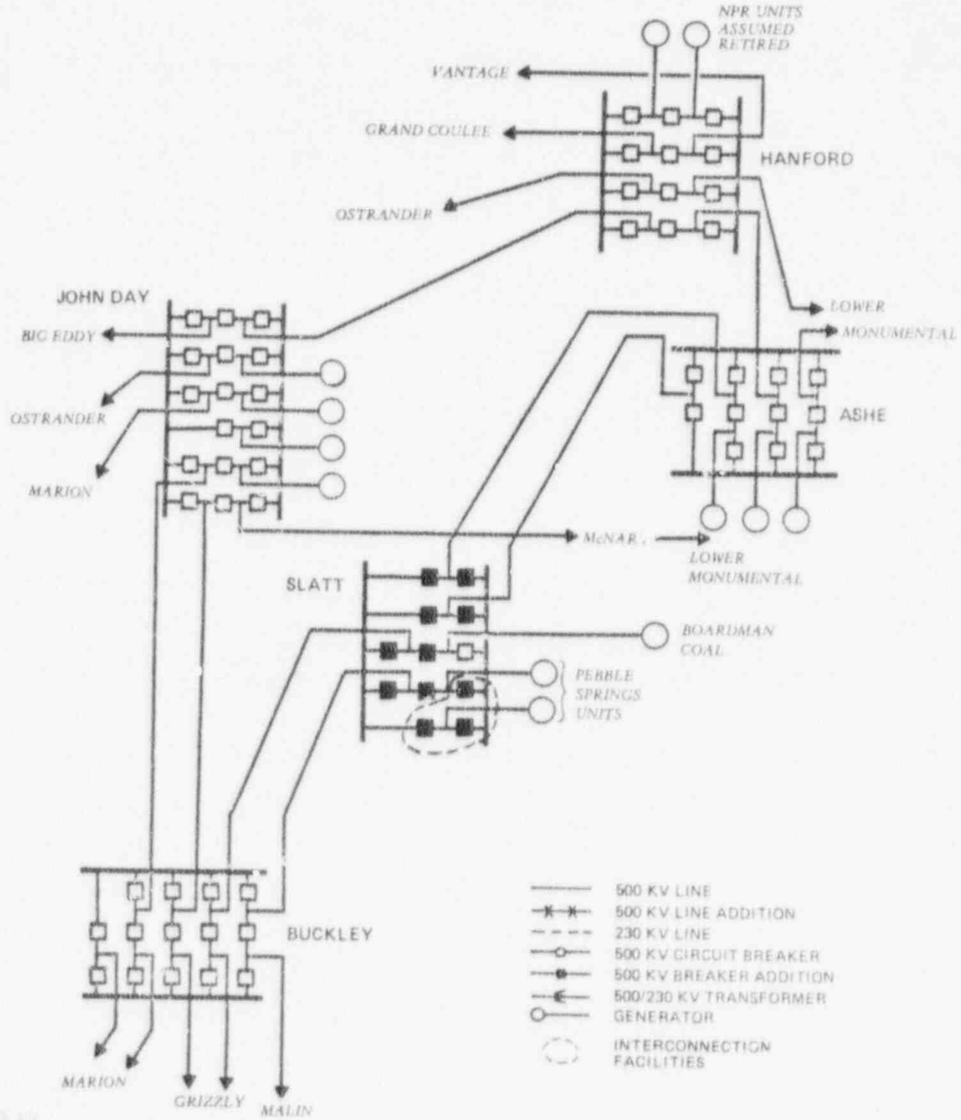

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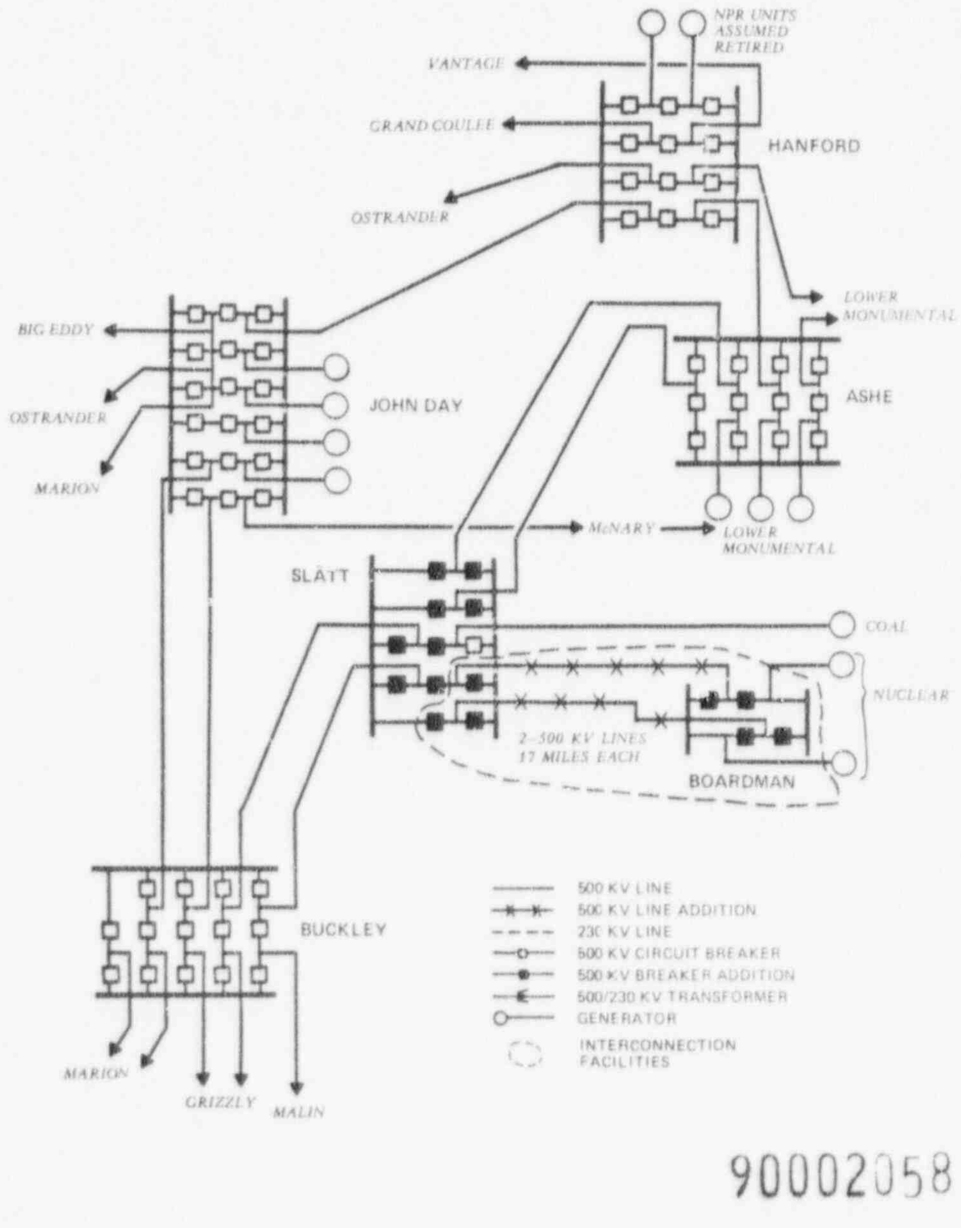
FIGURE 2

500 Kv TRANSMISSION SYSTEM CONNECTIONS FOR
UNITS 1 & 2 AT THE BOARDMAN NUCLEAR SITE
AS AN ALTERNATE TO PEBBLE SPRINGS UNITS 1 & 2



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6.3 Hanford Site (See Figure 3)

If the two Pebble Springs units are moved to the Hanford site, they would be the fourth and fifth units integrated into the BPA main grid system at Ashe Substation. The other three units are WNP Units 1, 2, and 4. Interconnection of the fourth and fifth units can be accomplished with switching facilities at Ashe Substation.

Offsite power would be similar to that provided for the WNP units.

Cost estimate:		Interconnection Facilities
Ashe Substation		
3-500-kV circuit breakers		$2,700,000
Offsite power (locally available)		-
	Total	$2,700,000

6.4 Ryderwood Site (See Figure 4)

The Ryderwood site is located near the city of Ryderwood, Washington. Integration of that site would include two 500-kV lines that would tap the existing 500-kV lines running between the BPA Paul and Allston Substations. Main grid additions would include an additional 500-kV line between Ryderwood and Allston and a second line between Allston and Keeler Substations. Switching facilities would be required at Ryderwood, Allston, and Keeler Substations.

Land description:

500-kV Ryderwood tap lines

Corridor length	3 miles
Timber lands	3 miles
Access roads required	4 miles

500-kV Ryderwood-Allston line (main grid)

Corridor length	23 miles
Timber lands	19 miles
Farm lands	3 miles
River crossing	1 mile

The corridor for the tap would cross 3 miles of rolling, timber covered terrain. A double-circuit line supporting 230 kV on one side for offsite power and the Ryderwood-Allston line on the other side would share this corridor. From the tap point extending 20 miles south to Allston, one 500-kV line would be required parallel to the existing Paul-Allston lines. This stretch is mostly wooded with sparse populations. Near Longview the corridor crosses areas of congestion. It also crosses sensitive soil conditions before spanning the Columbia River. Additional corridor description suitable for this site is described under the Paul-Allston line associated with the Skagit site (Figure 7).

500-kV Allston-Keeler line (main grid)

Corridor length	44 miles
Timber lands	36 miles
Farm lands	8 miles

The line would assume a position parallel to the existing Keller-Allston line. Farms are scattered along this corridor. Christmas tree farms, holly, hay, and pastures dominate. Some berry farms and cereal crops are grown. Wood lots are prevalent, and some marketable timber exists. Population is scattered.

Dwellings are mostly on small acreages. From Allston to about 5 miles north of Keller substation lands are primarily timbered. There are some good second growth timber stands here. Most of the timber was harvested in the early part of this century and the timber base does not produce regrowth rapidly.

Population along this stretch is very sparse. The last 5-mile segment into the Keller Substation crosses diversified farms and the population is moderately heavy. Soils through this entire area are susceptible to erosion and slides.

FIGURE 3

500 Kv TRANSMISSION SYSTEM CONNECTIONS FOR UNITS 4 & 5
AT THE HANFORD NUCLEAR SITE AS AN ALTERNATE TO
PEBBLE SPRINGS UNITS 1 & 2

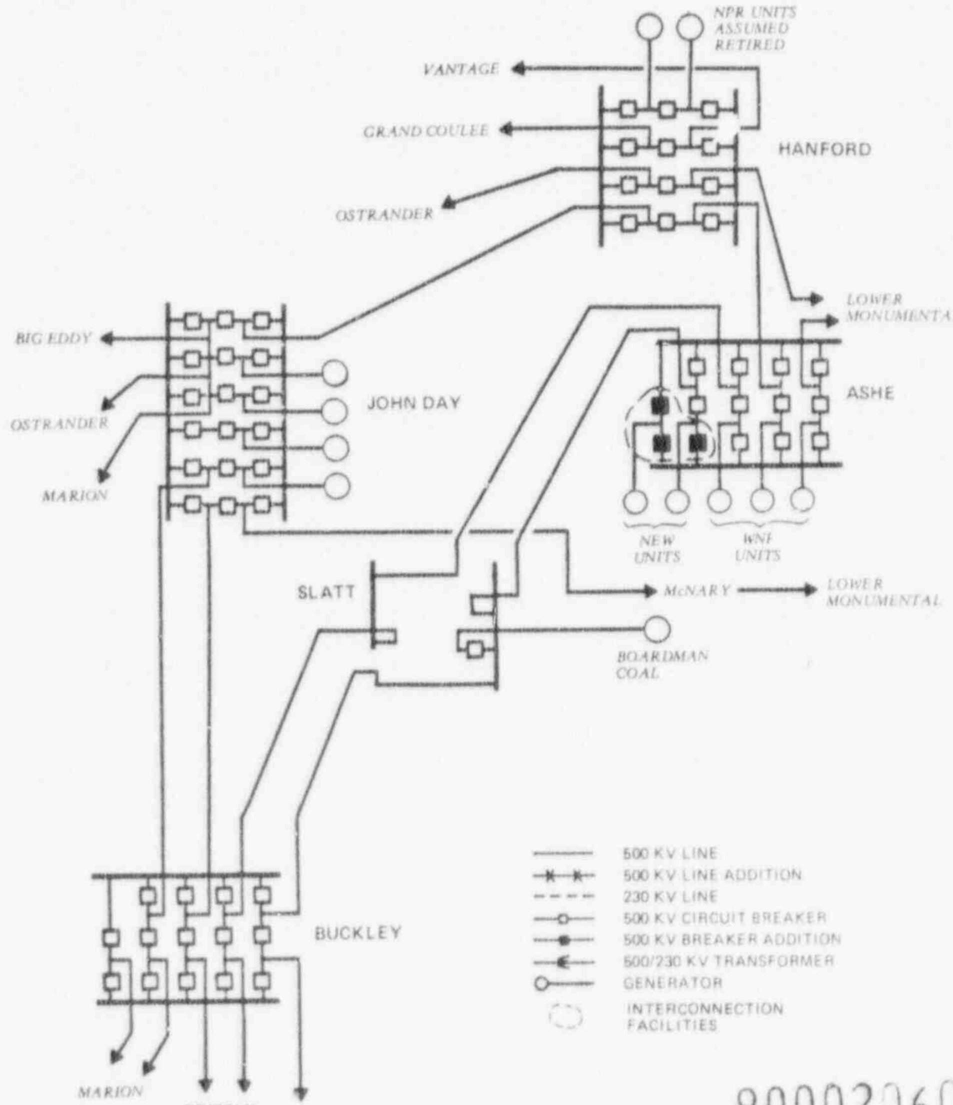

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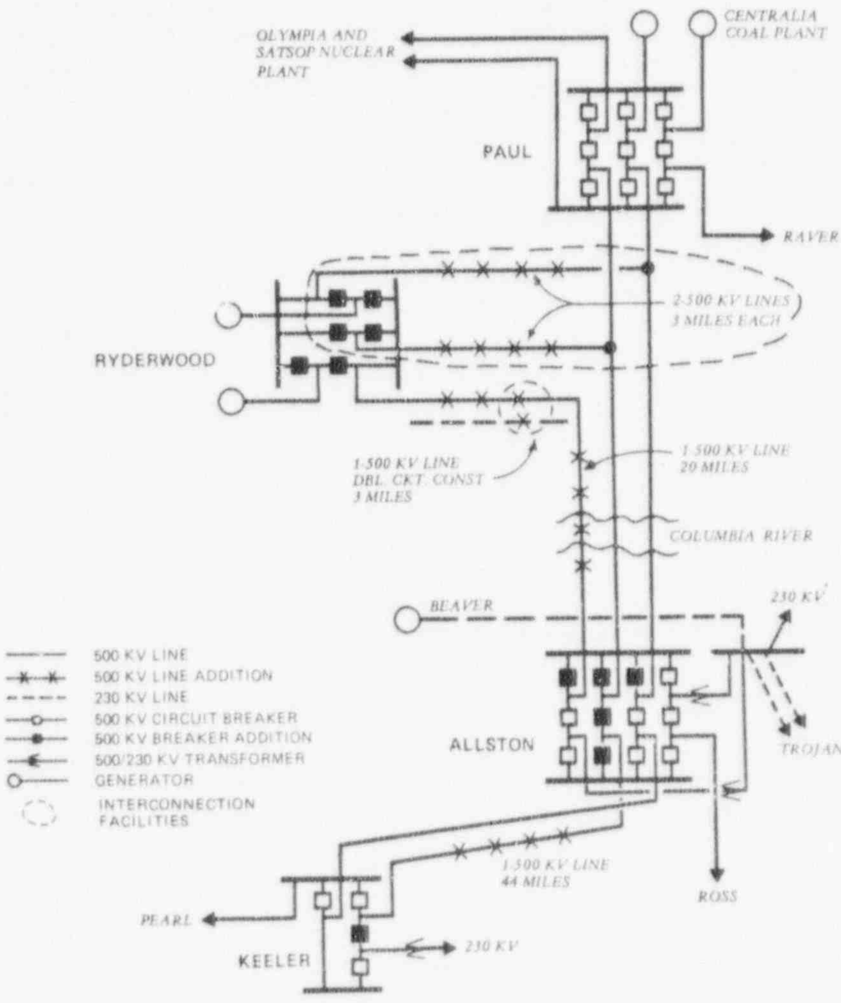
FIGURE 4

500 Kv TRANSMISSION SYSTEM CONNECTIONS FOR UNITS 1 & 2
AT THE RYDERWOOD NUCLEAR SITE AS AN ALTERNATE TO
PEBBLE SPRINGS UNITS 1 & 2



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Cost estimate:		Interconnection Facilities
Ryderwood Substation 4-500-kV circuit breakers		$3,600,000
2-500-kV tap lines, 3 miles ea.		1,500,000
Offsite power - uses one side of double-circuit section		-
	Total	$5,100,000

6.5 Lebanon Site (See Figure 5)

The Lebanon site is near the city of Lebanon, Oregon, about 19 miles south of the BPA Marion substation. Interconnection facilities would require two double-circuit 500-kV lines, each about 2.5 miles long, to loop the existing Marion-Lane and Marion-Alvey 500-kV lines into the site. No main grid reinforcement would be required. Switching facilities would be required at Lebanon Substation.

Offsite power would be provided over a 3-mile 230-kV line line tapping an existing line.

500-kV Lebanon loop lines

Corridor length	2½ miles
Timber lands	1½ miles
Farm lands	1 mile
Access roads required	1½ miles

The 500-kV corridor would cross mixed conifers and hardwoods. The timber base is poor. Farms are not highly productive. Soils in this area are subject to erosion and slides are easily triggered on steep slopes.

Population is sparse along the 500-kV corridor. Dwellings seem to be suburban type where residents depend upon activities other than farming for livelihood.

The 230-kV corridor would stretch across relatively good farm lands. Here, dwellings are scattered and some reflect a degree of prosperity.

Cost estimate:		Interconnection Facilities
Lebanon Substation 7-500-kV circuit breakers		$6,300,000
2-500-kV double-circuit loop lines, 2.5 miles ea.		2,400,000
Offsite power 1-230-kV line, 3 miles		300,000
	Total	$9,000,000

6.6 Daley Lake Site (See Figure 6)

The Daley Lake site is located on the Oregon coast about halfway between the cities of Tillamook and Lincoln City, Oregon. There are no main grid transmission facilities in the immediate vicinity of the site. Interconnection facilities would consist of two 500-kV lines, each about 65 miles long, to a proposed Conser Substation near Albany, Oregon.

The proposed Conser Substation is planned to be connected to the BPA main grid by a proposed double-circuit 500-kV line between Marion Substation and Conser. Initially that line would operate with one circuit at 500 kV and the other at 230 kV. It would be converted to double-circuit, 500-kV operation.

FIGURE 5

500 Kv TRANSMISSION SYSTEM CONNECTIONS FOR UNITS 1 & 2
AT THE LEBANON NUCLEAR SITE AS AN ALTERNATE TO
PEBBLE SPRINGS UNITS 1 & 2

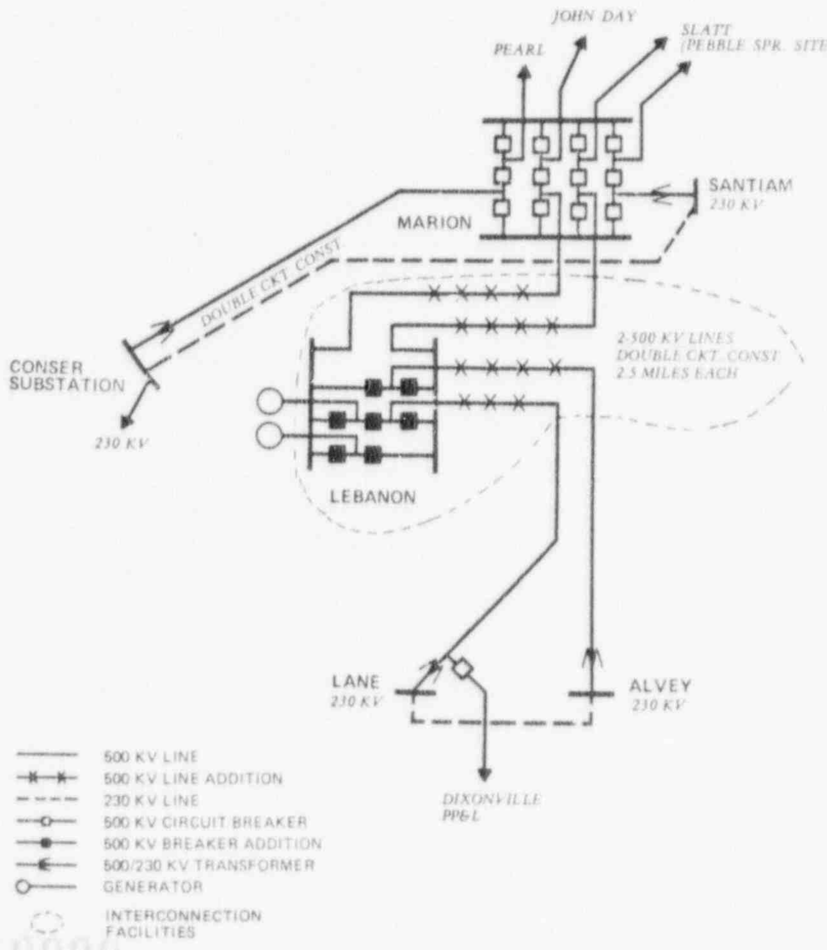

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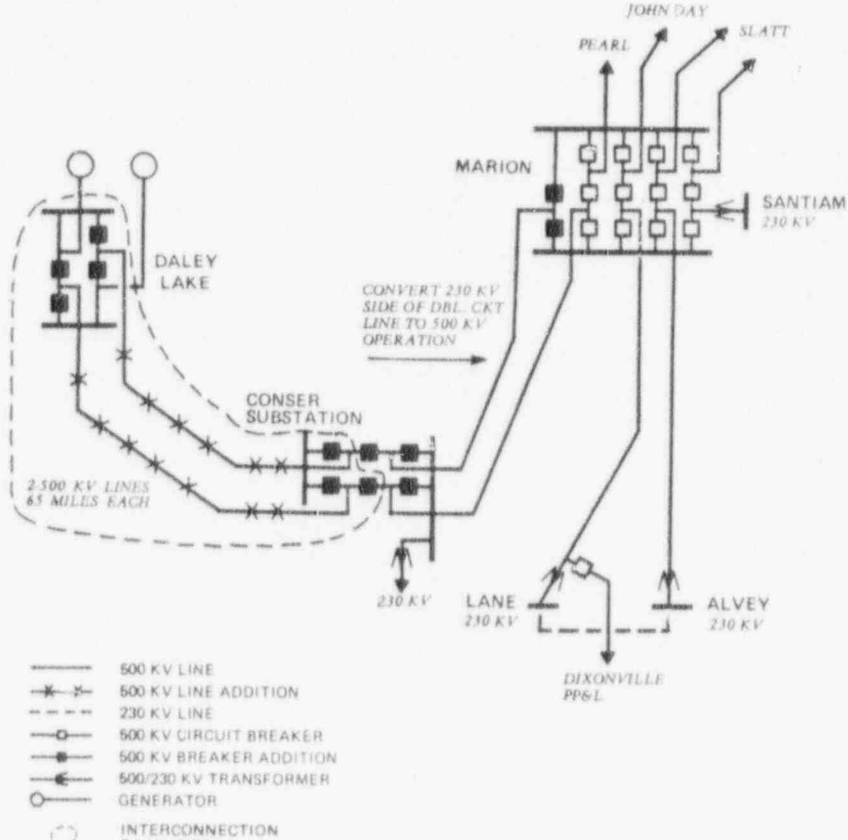
FIGURE 6

500 Kv TRANSMISSION SYSTEM CONNECTIONS FOR UNITS 1 & 2
AT THE DALEY LAKE NUCLEAR SITE AS AN ALTERNATE TO
PEBBLE SPRINGS UNITS 1 & 2



Switching facilities would be required at Daley Lake, Conser and Marion Substations.

Approximately 30 miles of 230-kV line would be required to provide offsite power to the Daley Lake Site. It would probably terminate on the 230-kV bus at Tillamook, Oregon.

500-kV Daley Lake-Conser lines

Corridor length	65 miles
Timber lands	20 miles
Farm Lands	25 miles
Mixed farms and hardwoods (Savanna-type landscape)	20 miles
Access roads required	60 miles

230-kV Offsite power lines

Corridor length	30 miles
Timber lands	22 miles
Farm lands	8 miles
Access roads required	10 miles

The 500-kV corridor would cross the Coast Range through about 12 miles of National Forest. Rich soil and abundant rainfall combine to make this coastal zone a prime timber growing area. There are opportunities to parallel about 24 miles of the Salem-Tillamook 115-kV line from the summit of the Coast Range to the Willamette Valley. Timber quality gradually declines along the eastern slopes of the range and gives way to savanna-type landscape at the eastern foothills of the Coast Range. Here, for about 20 miles, oak, alder and maple compete with farming. Scattered well-kept farm dwellings dot the hills.

The last 10 miles of the corridor would cross concentrated diversified farm lands before terminating at Conser Substation.

Two National Wildlife Refuges lie near the corridor. Upland game birds, along with resident and migrant water fowl, are abundant.

The 230-kV line would require about 7 miles of new corridor, with 23 miles parallel to the Salem-Tillamook line. The entire line would be under the influence of coastal climate where timber grows well. Dairy production and pasture are the primary farm interest in this area.

The area around the Daley Lake plant site is heavily used for seasonal and permanent dwellings and recreation. Additional home sites are under development, with roads and underground utility services in.

Cost estimate:	Interconnection Facilities
Daley Lake Substation 4-500-kV circuit breakers	$3,600,000
Conser Substation 3-500-kV circuit breakers	2,700,000
2-500-kV Daley Lake-Conser lines, 65 miles ea.	32,500,000
Offsite power, 1-230-kV line, 30 miles	3,000,000
Total	$41,800,000

6.7 Skagit Site (See Figure 7)

If the Pebble Springs units are moved to the Skagit site, they would be the third and fourth units at that site. The units would be connected to the proposed Skagit 500-kV substation. A 500-kV main grid line, about 48 miles long would be added between Skagit and Monroe Substations. Another main grid 500-kV line, about 48 miles long, would be added between Paul and Allston Substations. Switching facilities would be required at Skagit, Monroe, Paul, and Allston Substations. The Paul-Allston line would require a crossing over the Columbia River.

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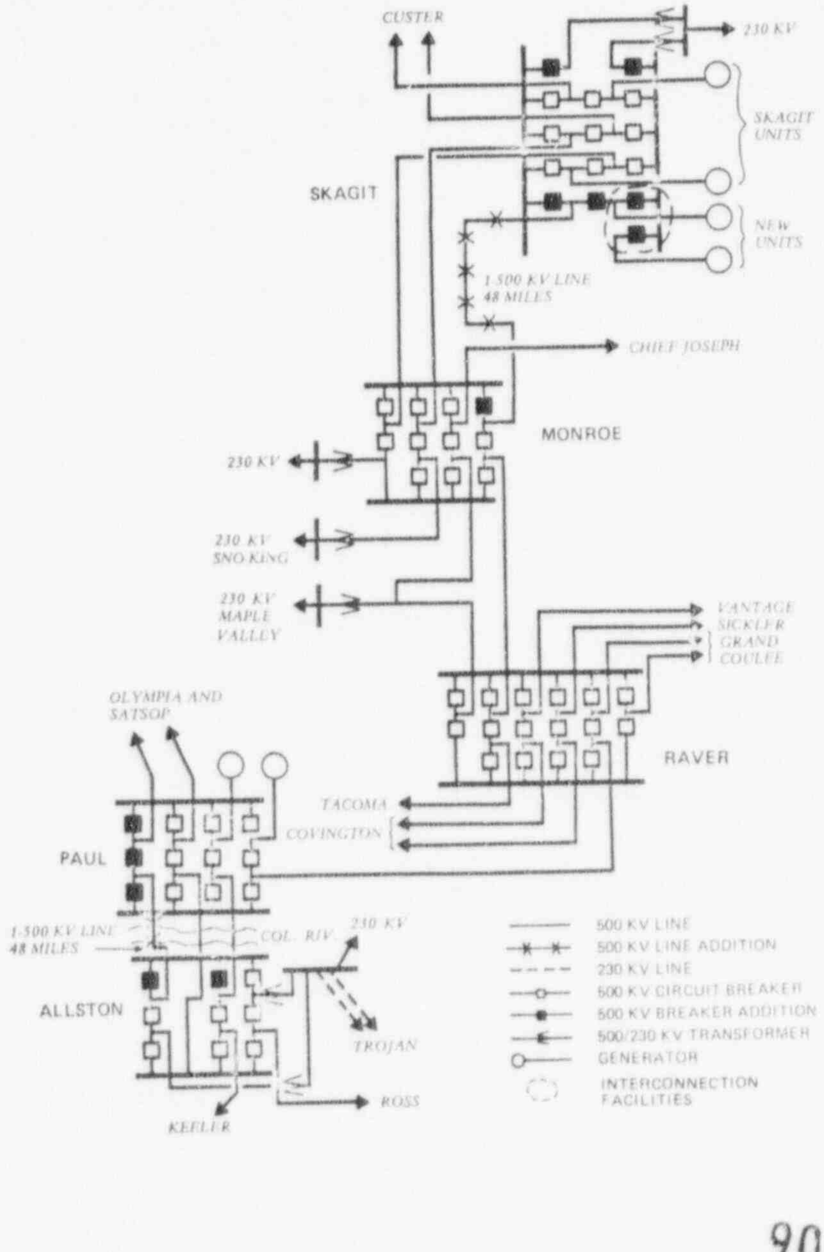
FIGURE 7

500 Kv TRANSMISSION SYSTEM CONNECTIONS FOR UNITS 3 & 4
AT THE SKAGIT NUCLEAR SITE AS AN ALTERNATE TO
PEBBLE SPRINGS UNITS 1 & 2



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Offsite power would be obtained from facilities provided for the Skagit units.

Land description:

500-kV Skagit-Monroe line (main grid)

Corridor length	48 miles
Timber lands	42 miles
Farm Lands	6 miles

This corridor would parallel the existing Skagit-Monroe lines over flat to rolling terrain. Second growth conifers are mixed with hardwoods and brush. Soils are basic glacial debris with a thin overburden. Soils in the valleys are deep enough to support a moderate amount of diversified farming. Population is sparsely scattered along most of the corridor. Some dwellings are built next to the right-of-way. The area near Monroe Substation is rapidly developing and dominated by suburban dwellings.

500-Paul-Allston line (main grid)

Corridor length	48 miles
Timber lands	30 miles
Farm lands	16 miles
Industrial lands	1 mile
River crossing	1 mile
Access roads	3 miles

Second growth conifers dominate the timber base along this corridor, although some large patches of alder and maple are found. Timber base is good. Terrain through the timber is rolling and soils are susceptible to erosion on steep slopes. Scattered farms lie in the valleys and lowlands. Farm buildings and dwellings just off the present right-of-way would interfere with additional lines. About 15 miles from the Ryderwood Tap (See Ryderwood Site) to the Longview area is heavily wooded with a few scattered dwellings near the right-of-way. West of Longview the corridor crosses about 2 miles of flat land where suburban dwellings are built adjacent to the right-of-way. The area most north of the Columbia River was zoned as industrial. North of this area, existing lines cross the Solo Mountain. Erosive soils and slides continually threaten an existing BPA line here. One tower has been moved and others may need moving.

South of the industrial area, existing lines cross the Columbia River, with about a 1-mile span to Lord Island and about a 3-quarter-mile span to the south bank before they ascend the steep slopes into Allston Substation.

Cost estimate:		Interconnection Facilities
Skagit Substation		
2-500-kV circuit breakers		$1,800,000
Offsite power - locally available		-
	Total	$1,800,000

7. TRANSMISSION INTERCONNECTION COST

Total typical costs to integrate each site are summarized in Table 1. Included are zone wheeling costs for each site and interconnection costs to connect the plant into the BPA main grid. The costs exclude land acquisition, clearing, substation site development, and administrative overhead. Main grid facilities would become an integral part of the main grid and allocable to all system uses and are included as part of the zone wheeling costs. Modifications to reflect ultimate plans of service and line routings may modify the indicated costs. However, modifications are not expected to change the cost ranking of the alternate sites.

8. SUMMARY OF TRANSMISSION LINE IMPACT

A preliminary analysis of land impact of interconnection transmission lines for Pebble Springs alternative sites is shown in Table 2. The impacts are broken down into approximate line mileages for timber lands, farm lands, savanna landscape, range lands, and access roads.

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TABLE 1

TRANSMISSION COST COMPARISON FOR ALTERNATE SITES

Site	Main Grid Cost		Interconnection Cost		Total
	Zone	Annual Cost	Investment	Annual Cost	Annual Cost
Pebble Springs	4	$8,750,000	$ 2,800,000	$ 280,000	$ 9,030,000
Boardman	4	8,750,000	14,800,000	1,480,000	10,230,000
Hanford	4	8,750,000	2,700,000	270,000	9,020,000
Ryderwood	1	4,250,000	5,100,000	510,000	4,760,000
Lebanon	1	4,250,000	9,000,000	900,000	5,150,000
Daley Lake	2	4,750,000	41,800,000	4,180,000	8,930,000
Skagit	1	4,250,000	1,800,000	180,000	4,430,000

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TABLE 2

LAND USE FOR INTERCONNECTING TRANSMISSION LINES FOR
PEBBLE SPRINGS AND ALTERNATE SITES
(Miles of Impact) 1/

Site	Timber Lands	Farm Lands	Savanna Landscape	Range Lands	Access Roads	Total
Pebble Springs	-	-	-	1	-	1
Boardman	-	15	-	2	-	17
Hanford	-	-	-	-	-	0
Ryderwood	3	-	-	-	4	7
Lebanon	1½	4	-	-	2½	8
Daley Lake	42	33	20	-	70	165
Skagit	-	-	-	-	-	0

1/ Includes corridor miles for 500-kV lines, 230-kV lines for offsite power, and access roads.

Some relocation of dwellings would likely be required for the Ryderwood and Skagit alternatives. Relocation of dwellings associated with other sites have not been observed, though scattered relocations may be required following more detailed reconnaissance.

The data in Table 2 is converted to typical acreage in Table 3. It should be noted that the figures in Table 3 tend to overstate social impact. It is BPA policy to permit and encourage multiple use of BPA corridors. This includes the production of farm crops, Christmas trees, and recreational usage.

The acreage values are typical for single-circuit 500-kV lines, double-circuit 500-kV lines, single-circuit 230-kV lines and access roads. Actual corridor widths for the facilities depend upon the terrain crossed.

TABLE 3

TYPICAL ACREAGE OF LAND IMPACT OF INTERCONNECTION TRANSMISSION LINES FOR PEBBLE SPRINGS AND ALTERNATE SITES

Site	Total Miles of Impact 1/	Typical Acres 2/
Pebble Springs	1	11
Boardman	34	433
Hanford	0	0
Ryderwood	7	45
Lebanon	10½	113
Daley Lake	230	2,100
Skagit	0	0

1/ Structure miles of transmission lines and miles of access roads.

2/ Typical acres per mile - BPA design:

500-kV single-circuit lines	12.73
500-kV double-circuit lines	15.15
230-kV single-circuit lines	10.91
Access roads	1.70

Interconnection lines only.

90002071

APPENDIX D
TRANSMISSION SYSTEM RELIABILITY CRITERIA FOR SYSTEM PLANNING

The BPA transmission system is planned and constructed according to two sets of reliability criteria. The first set is the BPA criteria which defines internal system design to serve Pacific Northwest load. The second criteria is the Western Systems Coordinating Council (WSCC) criteria which defines the effects that disturbances on one system can have on other systems.

Both criteria are lengthy but summarized in performance tables.

BPA Reliability Performance Table

OUTAGE TYPE AND LOCATION

Item	Facility Outage		Same NW Area		Different NW Area	
			System Adjusted After First Outage	Simultaneous Outage	System Adjusted After First Outage	Simultaneous Outage
1.	1 Plant	1 Line	B	C	A	B
2.	1 Plant	1 Plant	B	C	B	B
3.	1 Line	1 Line	C	D	B	C
4.	2 Plants	1 Line	C	D	B	C
5.	1 Plant	2 Lines	D	D	C	C

Plant - Generators 300 MW and larger or all units that can be dropped for loss of a bus section.

Line - Excludes powerhouse lines, includes single circuits of a double-circuit line and single-circuit lines.

A permanent single-contingency outage of any main grid line or any plant will provide performance Level A.

B. Reliability Level: Definitions for Multiple Contingencies

- A - Serves all peakloads during abnormal weather
- B - Serves all peakloads during normal weather
- C - Automatic Load Tripping: Automatic disconnection of certain selected loads to prevent system breakup when critical transmission system components are automatically disconnected.
- D - Area Separation: Splitting of one major load area or intermediate load area from the rest of the regional grid.

Interregional Ties and Interconnections:

The Western Systems Coordinating Council "Reliability Criteria for System Design" shall be utilized when determining the performance of the Northwest Grid in relationship to interregional ties and interconnections.

The reliability performance table for the WSCC is reproduced on the following page.

WESTERN SYSTEMS COORDINATING COUNCIL
DISTURBANCE - PERFORMANCE TABLE

DISTURBANCE →	NO FAULT	3-φ FAULT W/NORMAL CLEARING OR SLG FAULT W/STUCK BREAKER	3-φ FAULT W/NORMAL CLEARING			
PRIOR SYSTEM CONDITION →	NORMAL	NORMAL	ONE GENERATOR OUT		ONE LINE OUT	
			SYSTEM READJUSTED	NOT READJUSTED	SYSTEM READJUSTED	NOT READJUSTED
↓ ELEMENTS LOST OR FAULTED ↓						
1. LOAD	A	A	A	A	A	A
2. TRANSFORMERS	A	A	A	A	A	B
3. LINE	A	A	A	A	B	C
4. GENERATOR	A	A	A	B	A	C
5. BUS SECTION	B	B	B	B	C	C
6. TWO GENERATORS	C	C	C	D	C	D
7. TWO LINES	C	C	C	D	C	D
8. ALL LINES ON RIGHT-OF-WAY	D	D	D	D	D	D
9. ENTIRE SUBSTATION	D	D	D	D	D	D
10. ENTIRE PLANT INCLUDING SWITCH YARD	D	D	D	D	D	D

SEPTEMBER 6, 1972

PERFORMANCE LEVELS

ALLOWABLE CONDITIONS OR ACTIONS ON INTERCONNECTED SYSTEMS (1)	PERFORMANCE LEVEL (2)			
	A	B	C	D
REMEDIAL ACTION	NO	AS PERMITTED BELOW		
DROPPING OF INTERRUPTIBLE LOAD	NO	YES	YES	YES
GEN DROPPING OR EQUIVALENT REDUCTION OF ENERGY INPUT TO THE SYSTEM	NO	YES	YES	YES
CONTROLLED OPENING OF INTER-CONNECTIONS AND/OR OTHER LINES INCLUDING SYSTEM ISLANDING AND ATTENDANT UNDERFREQUENCY LOAD DROPPING IF REQUIRED	NO	NO	YES	YES
CONTROLLED DROPPING OF FIRM LOAD	NO	NO	NO	YES
SUB ISLANDING AND GENERATION SEPARATION MAY OCCUR	NO	NO	NO	YES
POST DISTURBANCE LOADINGS AND VOLTAGES OUTSIDE OF EMERGENCY LIMITS PRIOR TO READJUSTMENT	NO	NO	NO	YES

(1) ACTION OR CONDITIONS ON SYSTEMS OTHER THAN ONE ON WHICH DISTURBANCE OCCURRED

(2) A "YES" INDICATES THE ACTION OR CONDITION IS PERMITTED IN SIMULATION TESTING TO MEET THE PERFORMANCE LEVEL IF REQUIRED TO PREVENT CASCADING. A "NO" INDICATES THAT THE ACTION OR CONDITION IS NOT ALLOWED

JUNE 10, 1971

90002073

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