NUREG-0775

Draft Environmental Statement

related to the operation of Comanche Peak Steam Electric Station, Units 1 and 2

Docket Nos. 50-445 and 50-446

Texas Utilities Generating Company

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

May 1981

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SUMMARY AND CONCLUSIONS

This environmental statement, related to operation of the Comanche Peak Steam Electric Station Units 1 and 2, was prepared by the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation (the staff).

1. The action is administrative.

2. The proposed action is the issuance of operating licenses to the Texas Utilities Generating Company for the startup and operation of Units 1 and 2 of the Comanche Peak Steam Electric Station (Docket Nos. 50-445 and 50-446) located on Squaw Creek Reservoir in Somervell County, Texas, about 7 km north-northeast of Glen Rose, Texas, and about 65 km southwest of Fort Worth in north-central Texas.

   The facility will employ two pressurized-water reactors to produce 3411 megawatts thermal (MWt) per unit. A steam turbine-generator will use this heat to provide 1159 megawatts electric (MWe) per unit. The maximum design thermal output of each unit is 3565 MWt, with a corresponding maximum calculated electrical output of 1203 MWe. The exhaust steam will be condensed by cooling water taken from and returned to Squaw Creek Reservoir; makeup and blowdown water (i.e. water to replace that lost by evaporation and water to control the buildup of dissolved solids, respectively) for the reservoir will be taken from and discharged to Lake Granbury.

3. The information in this environmental statement represents the second assessment of the environmental impact associated with the Comanche Peak Steam Electric Station pursuant to the guidelines of the National Environmental Policy Act of 1969 (NEPA) and 10 CFR Part 51 of the Commission's Regulations. After receiving an application in June 1973 to construct this station, the staff carried out a review of impact that would occur during its construction and operation. This evaluation was issued as a Final Environmental Statement - Construction Phase in June 1974. After this environmental review, a safety review, an evaluation by the Advisory Committee on Reactor Safeguards, and public hearings in Glen Rose, Texas, the U.S. Atomic Energy Commission (now U.S. Nuclear Regulatory Commission) issued construction permits Nos. CPPR-126 and CPPR-127 on December 19, 1974 for the construction of Units 1 and 2 of the Comanche Peak Steam Electric Station. As of December 31, 1980, the construction of Unit 1 was about 87% complete and Unit 2 was about 50% complete. With a target fuel-loading date of December 1981* for Unit 1 and December 1983 for Unit 2, the applicant has applied for operating licenses for both units and in January 1979, submitted the required safety and environmental reports in support of the applications.

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*Based on a site visit in October 1980, the NRC staff projects a fuel loading date of December 1982 for Unit 1 and December 1984 for Unit 2.

4. Major Issues and Areas of Controversy

a. Issues in Controversy in the Operating License Hearing

Three contentions of the intervenors related to the following aspects of environmental impacts of operation of CPSES have been admitted as issues in controversy in that proceeding:

(1) Impacts of the drawdown of groundwater during and as a result of CPSES operation (Sec. 5.3.1.2).
(2) Effects of radioactive release on the general public (Sec. 5.8.1).
(3) Cost/benefit balance (Sec. 5.16).

It is not certain whether the above issues will actually be litigated during the operating license hearing since, under the summary disposition procedures in the NRC Rules of Practice (10 CFR 2.749), issues to which there is no genuine issue as to any material fact can be determined by the Atomic Safety and Licensing Board rather than by conducting an evidentiary hearing.

b. Other Outstanding Issues

The following issues relating to the environmental impacts of the operation of CPSES have not been completely resolved either by the NRC staff or by the applicant:

(1) Use of groundwater by CPSES during operation. The staff has recommended that a condition be imposed in the operating license on this subject (Sec. 5.3.1.2).

(2) Effects of the intake structure on aquatic biota during operation. A study to determine these effects will be performed during plant operation under the requirements of the NPDES permit for CPSES (Sec. 5.5.2).

(3) Effects of the circulating water chlorination system on aquatic biota during operation. A study to determine the minimum amount of chlorine to be used at CPSES and the effects on the receiving water biota will be performed during plant operation under the requirements of the NPDES permit (Sec. 4.2.4.1).

5. The staff has reviewed the activities associated with the proposed operation of the station and the potential impacts, both beneficial and adverse, are summarized as follows:

a. Increased baseload generating capacity will support the increased load demand of the combined systems and will result in increased system and regional reliability (Sec. 2.4). The increased electrical energy production at the Comanche Peak station will be less expensive than any other generation alternative, and will also reduce dependence on oil- and gas-fired generation and promote fuel diversification, because CPSES will be the first nuclear generating facility in the Texas Utilities Company System (TUCS) (Sec. 2.2).

b. Impoundment of Squaw Creek Reservoir at the Comanche Peak Steam Electric Station site will result in a lake that can serve various recreational purposes (Sec. 4.3.6).

c. Conversion of about 3100 ha for the site and about 185 ha for the transmission-line corridors has been necessary (Sec. 4.3.1). About 1480 ha will be used for the station and its cooling pond (Sec. 4.3.1).

d. The heat-dissipation system will result in an average consumptive use (by evaporation from the cooling reservoir) of 0.81 m^3/s. During a dry year, net diversions from Lake Granbury will be 47.2 million m^3; during an average year, 32.3 million m^3; and during a wet year, 10.9 million m^3. These diversions will not interfere with water use and quality in Lake Granbury (Sec. 5.3.3).

e. Heat and chemical and sanitary wastes discharged into Squaw Creek Reservoir and Lake Granbury in accordance with the provisions of the National Pollutant Discharge Elimination System Permit (NPDES) issued for the plant will be rapidly assimilated; thus, no adverse impacts on downstream water users or aquatic biota are expected (Secs. 5.3 and 5.5).

f. Heated water released through the modified circulating-water discharge canal into the Squaw Creek Reservoir will be rapidly diluted; thus, the blowdown discharge will have an insignificant effect on water temperature in Lake Granbury (Sec. 5.3.3).

g. No measurable radiological impact on man or biota other than man is expected to result from routine operation (Sec. 5.8.1). The risk associated with accidental radiation exposure is very low (Sec. 5.8.2).

h. The implementation of the applicant's postconstruction landscaping plan will enhance the quality of the terrestrial environment in the vicinity of the plant (Sec. 5.2).

i. The impacts on terrestrial resources from plant operation and transmission-line right-of-way (ROW) maintenance will be acceptable. However, there exist potential adverse impacts as a result of the following: ice-loading of local vegetation resulting from steam fog from the cooling pond during cold weather (Sec. 5.4.1).

j. The increased total dissolved solids in the return water flow from SCR to Lake Granbury will raise the already high levels in Lake Granbury and Squaw Creek Reservoir, but is not believed to be unacceptable for this area (Sec. 5.5.2).

k. No significant social or economic impacts on nearby communities are expected as a result of plant operation (Sec. 5.7.4).

l. The potential effects of impingement and entrainment on the fish population in Squaw Creek Reservoir as a result of the high circulating-water intake velocity when both units are operational remain to be determined by prescribed testing and monitoring programs (Secs. 5.5.2 and 5.10).

6. The accident-analysis section has been revised to include severe accidents and the lessons learned from the accident at Three Mile Island Unit 2 (Sec. 5.8.2).

7. The analysis of the health effects of the uranium fuel cycle has been revised to include the latest information (Sec. 5.8.3).

8. This environmental statement was made available to the public, to the Environmental Protection Agency, and to other specified agencies in May 1981 (Sec. 7).

9. On the basis of the analysis and evaluation set forth in this environmental statement, and after weighing the environmental, economic, technical, and other benefits against environmental and economic costs and after considering available alternatives at the operating-license stage, it is concluded that the action called for under NEPA and 10 CFR Part 51 is the issuance of operating licenses for Units 1 and 2 of the Comanche Peak Steam Electric Station, subject to the following conditions recommended by the staff for the protection of the environment:

   a. Before engaging in additional construction or operational activities that may result in a significant adverse environmental impact that was not evaluated or that is significantly greater than that evaluated in this environmental statement the applicant shall provide written notification of such activities to the Director of the Office of Nuclear Reactor Regulation and shall receive written approval before proceeding with such activities.

   b. The applicant shall carry out the environmental monitoring programs outlined in this environmental statement as modified and approved by the staff and implemented in the environmental protection plan and the technical specifications incorporated in the operating licenses for the Comanche Peak Steam Electric Station (Sec. 5.11.3).

   c. The applicant shall be required to restrict the use of groundwater for CPSES operation to that amount needed for potable and sanitary purposes and for supplementing the supply of treated surface water during short periods of peak demand when station requirements exceed the capacity of the reverse-osmosis surface-water-treatment plant (Sec. 5.3.1.2).

   d. If harmful effects or evidence of irreversible damage are detected during the operating life of the station, the applicant shall provide the staff with an analysis of the problem and a proposed course of action to alleviate it.

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FOREWORD

This environmental statement was prepared by the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation (the staff), in accordance with the Commission's regulation, 10 CFR 51, which implements the requirements of the National Environmental Policy Act of 1969 (NEPA).

NEPA states, among other things, that it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the nation may:

- Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
- Assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings.
- Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences.
- Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment that supports diversity and variety of individual choice.
- Achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities.
- Enhance the quality of renewable resources and approach the maximum-attainable recycling of depletable resources.

Further, with respect to major Federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of NEPA calls for preparation of a detailed statement on:

(i) the environmental impact of the proposed action,

(ii) any adverse environmental effects that cannot be avoided should the proposal be implemented,

(iii) alternatives to the proposed action,

(iv) the relationship between local short-term uses of the human environment and the maintenance and enhancement of long-term productivity, and

(v) any irreversible and irretrievable commitments of resources that would be involved in the proposed action should it be implemented.

An Environmental Report accompanies each application for a construction permit or a full-power operating license. A notice of availability of the report is issued. Any comments by interested persons on the report are considered by the staff. In conducting the required NEPA review, the staff meets with the applicant to discuss items of information in the Environmental Report, to seek new information from the applicant that might be needed for an adequate assessment, and to ensure that the staff has a thorough understanding of the proposed project. In addition, the staff seeks information from other sources that will assist in the evaluation and visits and inspects the project site and surrounding vicinity. Members of the staff may meet with state and local officials who are charged with protecting state and local interests. On the basis of all the foregoing and other such activities or inquiries as are deemed useful and appropriate, the staff makes an independent assessment of the considerations specified in Sect. 102(2)(C) of the NEPA and 10 CFR Part 51.

This evaluation leads to the publication of a Draft Environmental Statement, prepared by the Office of Nuclear Reactor Regulation, which is then circulated to Federal, state, and local government agencies for comment. A summary notice is published in the Federal Register of the availability of the applicant's Environmental Report and the Draft Environmental Statement. Interested persons are also invited to comment on the proposed action and the draft statement. Comments should be addressed to the Director, Division of Licensing, at the address shown below.

After receipt and consideration of comments on the draft statement, the staff prepares a Final Environmental Statement, which includes a discussion of questions and objections raised by the comments and the disposition thereof; a final cost-benefit analysis, which considers and balances the environmental effects of the facility and the alternatives available for reducing or avoiding adverse environmental effects with the environmental, economic, technical, and other benefits of the facility; and a conclusion as to whether - after the environmental, economic, technical, and other benefits are weighed against environmental costs and after available alternatives have been considered - the action called for, with respect to environmental issues, is the issuance or denial of the proposed permit or license or its appropriate conditioning to protect environmental values. This Final Environmental Statement and the Safety Evaluation Report prepared by the staff are submitted to the Atomic Safety and Licensing Board (ASLB) for its consideration at public hearings held in connection with all construction permit applications and with operating license applications as ordered.

This environmental review deals with the impacts of operation of the Comanche Peak Steam Electric Station Units 1 and 2. Assessments relating to operation that are found in this environmental statement augment those described in the FES-CP that was issued in June 1974, in support of issuance of construction permits for CPSES.

The information in the various sections of this environmental statement updates the FES-CP in four ways: (1) by identifying differences between environmental effects of operation (including those that would enhance as well as degrade the environment) currently projected and impacts that were described in the preconstruction review; (2) by reporting the results of studies relating to operation that had not been completed at the time of issuance of the FES-CP and that the staff required to be completed before initiation of the operating-license review; (3) by evaluating the applicant's preoperational monitoring program, and factoring the results of this program into the design of an operational surveillance program and into the development of environmental technical specifications; and (4) by identifying studies being performed by the applicant that will yield additional information relevant to the environmental impacts of operating the Comanche Peak Steam Electric Station Units 1 and 2.

The staff recognizes the difficulty a reader would encounter in trying to establish the conformance of this review with the requirements of NEPA with only updating information. Consequently, a copy of the FES-CP is reproduced in Appendix C of this Environmental Statement. In addition, introductory résumés in appropriate sections of this Environmental Statement summarize both the extent of updating and the degree to which the staff considers the subject to be adequately reviewed.

Copies of this Environmental Statement are available for inspection at the Commission's Public Document Room, 1717 H Street NW, Washington, DC, and at the Somervell County Public Library, Glen Rose, TX. Single copies may be obtained by writing to:

Director, Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Mr. Spottswood Burwell is the NRC Licensing Project Manager for this project. Mr. Burwell may be contacted at the above address or at 301/492-8535.

1 INTRODUCTION

1.1 The Proposed Action

The proposed action is the issuance of operating licenses to the Texas Utilities Generating Company (TUGCO) of Dallas, Texas, for startup and operation of Units 1 and 2 of the Comanche Peak Steam Electric Station (CPSES) in Somervell County near Glen Rose, Texas.

Each of the two generating units consists of one pressurized-water reactor, four steam generators, one steam turbine-generator, a heat-dissipation system, and associated auxiliary and engineered safeguards. Waste heat will be dissipated to the atmosphere from Squaw Creek Reservoir (SCR). Makeup water for the cooling pond will come from Squaw Creek and Lake Granbury; blowdown from SCR will go into both the lower reaches of Squaw Creek and Lake Granbury.

Design power levels for each reactor are 3411 MWt and 1159 MWe; in-house consumption of electric power will be 48 MWe. Stretch (maximum-design) power levels are 3565 MWt and 1203 MWe, with in-house consumption of 50 MWe (ER-OL,* Sec. 3.2).

CPSES is being constructed for TUGCO, which is lead applicant and agent for the co-owners (Dallas Power and Light Company, Texas Electric Service Company, Texas Power and Light Company, Brazos Electric Power Cooperative, Inc., and Texas Municipal Power Agency). TUGCO prepared the ER-OL and will operate the station on behalf of the co-owners.

1.2 Administrative History

1.2.1 Prior Staff Action

On July 20, 1973, TUGCO (the applicant) filed an application with the Atomic Energy Commission (AEC), now Nuclear Regulatory Commission (NRC), for a permit to construct CPSES. Following reviews by the AEC regulatory staff and its Advisory Committee on Reactor Safeguards, public hearings were held before an Atomic Safety and Licensing Board in Glen Rose, Texas, between July 31, and

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*"Comanche Peak Steam Electric Station Environmental Report, Operating License Stage," Vols. 1 and 2, Texas Utilities Generating Company, January 19, 1979. Hereinafter this document is cited in the body of the text as ER-OL, usually followed by a specific section, page, figure, or table number. Similar citation is made to ER-OL, Amendment 1, September 17, 1980. Likewise, "Comanche Peak Steam Electric Station Environmental Report, Construction Stage," Vols. 1 and 2, as amended, Texas Utilities Generating Company, June 5, 1973, is cited as ER-CP. "Final environmental Statement Related to the Proposed Comanche Peak Steam Electric Station Units 1 and 2," issued in June 1974 by the U.S. Atomic Energy Commission, is referred to as FES-CP and is reproduced herein as an appendix.

November 26, 1974. The conclusions resulting from the staff's environmental review were issued as a Final Environmental Statement - Construction Phase (FES-CP) in June 1974. Construction permits Nos. CPPR-126 and CPPR-127 were issued on December 19, 1974.

In February 1978, TUGCO submitted an application including a Final Safety Analysis Report (FSAR) and Environmental Report (ER-OL) requesting issuance of operating licenses for Units 1 and 2. These documents were docketed on May 12, 1978 and January 19, 1979, respectively. Operational safety and environmental reviews were then initiated.

As of December 31, 1980, construction of Unit 1 was about 87% complete and the staff estimates that the reactor will be ready for fuel loading in December 1982. Unit 2 was about 50% complete and has a tentative fuel-loading date approximately two years later.

1.2.2 Status of Reviews and Approvals

The applicant has provided a status listing, as of September 12, 1980, of environmentally related permits, approvals, licenses, etc. required from Federal, regional, state, and local agencies in connection with the proposed project in the ER-OL (Sec. 12). The staff has reviewed the listing and is not aware of any potential non-NRC licensing difficulties that would significantly delay or preclude the proposed operation of the station. The issuance of a water-quality certificate pursuant to Section 401 of the Clean Water Act of 1977 by the Texas State Environmental Protection Agency is a necessary prerequisite for the issuance of an operating license by the Nuclear Regulatory Commission. This certification was received by the applicant on 14 November 1974. The U.S. Environmental Protection Agency issued an NPDES permit to the applicant for CPSES, pursuant to Section 402 of the Clean Water Act of 1977, on December 16, 1978 (App. E).

2 PURPOSE AND NEED FOR THE ACTION

2.1 Résumé

The action for which this Environmental Statement is being written is the issuance of operating licenses for CPSES Units 1 and 2. Each unit has a design electrical rating of 1150 MW; they are pressurized water reactors.

On December 18, 1979, NRC amended the construction permits for CPSES to reflect the addition of two new co-owners of CPSES (Amend. 3 to CPSES Construction Permit Nos. CPPR-126 and CPPR-127). In addition to the three original co-owners, Dallas Power and Light Company (DPL), Texas Electric Service Company (TESCO), and Texas Power and Light Company (TPL), the two new co-owners are Brazos Electric Power Cooperative (BEPC) and Texas Municipal Power Agency (TMPA), which acquired 3.8% and 6.2% ownership interest in CPSES, respectively. DPL transferred 10% of its original one-third ownership interest in CPSES. TUGCO remains as the lead applicant for CPSES.

When the FES-CP was issued in June 1974, TUGCO scheduled CPSES Units 1 and 2 for initial operation as baseload units in 1980 and 1982, respectively. Current scheduling calls for Units 1 and 2 to begin commercial operation in 1982 and 1984, respectively. The original dates for commercial operation of the units were predicated on an expected growth rate in electrical-energy use in the Texas Utilities Company System (TUCS) of 10.5%/yr between 1963 and 1972. The applicant had predicted that the average annual rate of growth (AARG) of electrical-energy use would be 9.7% between 1974 and 1980 and 7.6% between 1980 and 1984. The actual AARG for 1974 to 1980 was 5.9%, and is projected to be 5.5% for 1981 to 1986 (ER-OL, Sec. 1.1.1). The applicant also indicates, and the staff agrees, that this decreasing trend in demand for electrical energy will continue.

The staff has studied the decline in expected growth rate of electrical-energy use, and finds that it is not unique to the TUCS service area; it is representative of a national trend, attributable in part to higher prices for electricity, conservation, and slower economic growth than predictions for the 1980s, which were made in the late 1970s, had assumed (Ref. 1).

In this section, the staff has evaluated the purpose and need for operation of the CPSES units within the context of (1) overall system production costs for generating electricity, (2) availability of alternative fuels, and (3) reliability of the power supply for the TUCS service area.

2.2 Production Costs

The CPSES units were constructed to provide a diversity of fuel types and an economical source of baseload energy. Because the substantial capital costs and environmental costs associated with construction* have already been incurred,

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*Environmental costs associated with operation of CPSES are discussed in subsequent sections of this environmental statement.

the only economic factors that are relevant for consideration now are system fuel costs and operation and maintenance (O&M) costs, because these expenses will be affected by whether or not the units operate. A comparison of system production costs with and without the CPSES units available to the system shows savings to the service area if operating licenses are issued and operating plans proceed as scheduled.

The TUCS system is currently entirely dependent on fossil fuels for generating electricity for its customers. The past, present, and predicted distribution of TUCS fuel use is shown in Table 2.1. In 1981, fuel use is about evenly split between gas/oil and coal/lignite. The gas/oil units are designed for gas but can use oil with some reduction in unit generating efficiency.

The increase in use of coal and lignite, primarily to reduce the TUCS dependence on gas, is evident from the data in Table 2.1. Whenever oil is used as a standby fuel (when gas is not available), not only would there be reduced efficiency of electricity production, but a dramatic increase in fuel cost; in 1981, oil is about twice as expensive as natural gas on a thermal basis (Ref. 1) and this difference in price, favoring gas, is estimated by the staff and Data Resources, Inc. (DRI) (Ref. 2) to persist until 1990 at least.

Lignite is the other (than gas) major fuel in present use by the TUCS system. Currently, lignite provides fuel for about one-third of the generating capability of TUCS, and one-half of the thermal capacity of the system (Ref. 2). Coal will become important to the TUCS system in the late 1980s. Lignite prices have escalated at an average rate of 13.7%/yr from 1977 to 1980. The price of coal has gone up 25%/yr over the same period (Ref. 1). The staff estimates that lignite prices will continue to rise at a rate of 14.3%/yr for the decade of 1980 to 1990, and that this same rate will apply to coal. The absolute price of lignite will remain lower than that of coal because of its lower thermal-production quality; i.e., its thermal content per unit weight is about two-thirds that of coal.

Because TUCS is heavily dependent on gas (i.e., about 50%, with oil as standby only), and because available and firm supplies of gas are not adequate to meet all future needs, the staff agrees with the estimates of future fuel use presented by the applicant in Table 2.1. Gas constitutes a consistently smaller part of total fuel use through 1990 as lignite gradually becomes the predominant fossil fuel and nuclear generation becomes important by 1982 or 1983. The applicant states that by 1990 it will have fully exploited the lignite deposits of central and eastern Texas (ER-OL, Amend. 1, response to staff question 29). Further fossil-fuel expansion beyond 1990 will have to be based on coal. For these reasons, the staff has concluded that the replacement of any energy not produced by CPSES Units 1 and 2 through 1990 would have to come from lignite and gas in about a 50:50 proportion. Whereas oil could be used for 5% to 10% of TUCS system requirements (Ref. 3), the applicant indicates that gas will be the preferred fuel until 1990, when the Fuel Use Act of 1978 prohibits the use of gas as a primary energy source for new generating plants, and limits its use in existing plants (Ref. 3).

In the staff's analysis of projected production costs, according to an economic-dispatch logic, the annual projected fuel costs for the TUCS system are estimated on the basis of a specified mix (Table 2.1) of generating capacity and projected energy requirements (ER-OL, Amend. 1). Analyses were performed for

Table 2.1. Percentage Distribution of TUCS Actual and Projected Fuel Use†[1]

Year	Gas and Oil†[2]	Lignite and Coal	Nuclear Fuel
		Actual	
1970	100.0		
1971	100.0		
1972	94.0	6.0	
1973	85.1	14.9	
1974	84.3	15.7	
1975	75.3	24.7	
1976	68.8	31.2	
1977	67.7	32.3	
1978	59.3	40.7	
1979	50.8	49.2	
		Projected	
1980	49.4	50.6	
1981	49.3	49.8	0.9
1982†[3]	48.1	47.8	4.1
1983	46.9	44.7	8.4
1984†[4]	43.2	43.5	13.3
1985	35.0	49.7	15.2
1986	34.0	50.3	15.7
1990†[5]	30	54	16

†[1] Adapted from the ER-OL (Amend. 1, Table 1.1-12).

†[2] Primary fuel is gas; oil is standby.

†[3] Unit 1 commercial operation.

†[4] Unit 2 commercial operation.

†[5] Staff estimate.

1981 through 1986, with and without the CPSES units in service. It was assumed that the units would show a measurable contribution to production in 1982. The results of these production-cost analyses are shown in Table 2.2. The values reported there represent the staff's estimate of the annual savings in system fuel costs by having the CPSES units online in accordance with the applicant's projected schedule versus costs that will be incurred if the units are not allowed to operate. The savings estimated for 1981 to 1983 are attributable only to Unit 1; the 1984, 1985, and 1986 values reflect the fuel-cost savings that would be realized with both units online. The analyses assume that if the CPSES units were in operation in these initial years, they would have performed at an average capacity factor of about 65%. The analyses also assume that the energy that would have been generated by these units will be replaced by gas-fired generation (50%) and lignite-fired generation (50%). If the applicant's official forecast is realized, some supplemental energy from outside the TUCS system would be required in 1984 to 1986. This energy is assumed by the staff to cost as much as the gas-generated energy from the TUCS system. The applicant estimates savings for 1985 to be $309 million (ER-OL, Amend. 1, response to staff question 17); the staff estimate (see Table 2.2) is $383 million for that year. The staff believes the numbers to be in reasonable agreement and that the difference is due to a slightly higher fuel-cost differential in the staff estimate. The staff estimate for the cost of nuclear fuel in 1985 (Table 2.2) is 9 mill/kWh, whereas the applicant uses 6.2 mill/kWh; gas-cost estimates are 60 mill/kWh by the staff and 55 mill/kWh by the applicant. The difference between these gas and nuclear-fuel values is greater for the staff's estimate than for the applicant's; hence, the greater savings estimated by the staff.

A production-cost analysis should also include the differential in variable O&M costs between the CPSES units and the units that would provide the replacement energy. However, these cost items are small in relation to the fuel-cost differential and would alter the ultimate cost differential slightly. The applicant estimates system O&M units in 1985 to be 3.5 mill/kWh with the CPSES units and 3.9 mill/kWh without them (ER-OL, Amend. 1, response to staff question 17). This would produce another $30 million in savings, or about 10% of the savings due to fuel alone.

In addition, a decision to operate the CPSES units will necessitate a decommissioning expense once the units are retired from service. The staff discusses the different decommissioning methods available and their estimated costs in Section 5.9. For large PWR units (such as CPSES Units 1 and 2) the decommissioning cost per unit is estimated to be $33 million (in 1978 dollars).

In the FES-CP (June 1974) both applicant and staff estimated production costs of electrical energy that are much lower than the current estimates presented here. The staff believes the lower cost estimate was due to underestimates of the effect of the OPEC oil embargo and subsequent general fuel-price increases, and the dramatic escalation of all fuel prices that resulted. The effects of inflation were also underestimated by both staff and applicant at the time the FES-CP was written (1972-1974).

In conclusion, the staff agrees with the applicant's assessment of potential savings due to the operation of CPSES. These savings would not be significantly altered if the demand for electricity grows at a lower rate than assumed, because

Table 2.2. TUCS Projected Annual Fuel Costs

Category	1979	1980	1981	1982	1983	1984	1985	1986
	Year							
Total energy generated†[1] (10^9 kWh)	58.3	63.3	67.8	71.7	75.4	79.2	83.6	87.1
Increase over previous year (%)	0.2	8.6	7.1	5.8	5.2	5.0	5.6	4.2
Distribution by fuel type†[2] (%)								
Gas and oil	50.8	49.4	49.3	48.1	46.9	43.2	35.0	34.0
Lignite	49.2	50.6	49.8	47.8	44.7	43.5	49.7	50.3
Nuclear fuel			0.9	4.1	8.4	13.3	15.2	15.7
Energy generated by fuel type†[3] (10^9 kWh)								
Gas and oil	29.6	31.3	33.6	34.5	35.4	34.2	29.3	29.6
Lignite	28.7	32.0	34.0	34.3	33.7	34.5	41.6	43.8
Nuclear fuel			0.6	2.9	6.3	10.5	12.7	13.7
Fuel price†[4] ($\$/10^6$ Btu)								
Gas and oil	1.57	2.08	2.50	2.96	3.64	4.51	5.59	6.94
Lignite	0.67	0.78	0.92	1.07	1.22	1.40	1.63	1.86
Nuclear fuel	0.46	0.55	0.60	0.66	0.72	0.77	0.83	0.90
Cost of fuel†[5] ($ million)								
Gas and oil	502	703	907	1103	1392	1666	1769	2219
Lignite	198	257	322	378	423	497	698	839
Nuclear fuel			3	20	48	86	112	131
Total	700	960	1232	1501	1863	2249	2579	3189
Gas and lignite (50:50) replacing nuclear fuel†[6] (10^9 kWh)			0.6	2.9	6.3	10.5	12.7	13.7
Cost of fuel ($ million)								
Gas and lignite (50:50)			11	63	166	335	495	651
Nuclear fuel			3	20	48	86	112	131
Savings using nuclear fuel			8	43	118	249	383	520
Total fuel cost†[7] (mill/kWh)								
With CPSES			18	21	25	28	31	37
Without CPSES			18	21	26	32	35	42

†[1] From the ER-OL (Amend. 1, Sec. 1.1).

†[2] From Table 2.1.

†[3] The product of total energy generated and distribution by fuel type.

†[4] From "Monthly Report on the Uranium Market, November 1980," Report No. 147, Nuclear Exchange Corporation, 1980.

†[5] The product of energy generated by fuel type, fuel price, and plant heat rate of the fuel. Plant heat rates in Btu/kWh are 10,800 for a gas-fueled plant, 10,300 for a lignite-fueled plant, and 10,660 for a nuclear-fueled plant.

†[6] It is assumed that gas and lignite, on a 50:50 basis, would replace the CPSES capability.

†[7] The quotient of cost of fuel and total energy generated.

TUCS marginal energy source would continue to be gas. Table 2.2 shows savings only through 1986; in actuality, fuel-cost savings would continue as long as CPSES is to be licensed to operate--about 30 years.

2.3 Diversity of Fuel Supply

Regardless of the relative economics of nuclear energy versus energy from other sources, it is to the advantage of a public utility to have diverse sources of power available. Any number of problems could arise regarding the availability of fuel to generate electricity. If imported oil were not available, if further limits were placed on the use of natural gas as a boiler fuel, if coal piles were to freeze, or if shortages of enrichment facilities were to develop, too much reliance on one or two fuels--especially for baseload operation--could necessitate cutbacks to the power-supply grid. Currently, about 50% of TUCS's generating capacity is fueled by either natural gas or oil (Table 2.1). With CPSES in operation in 1985, this dependence on gas and oil will be reduced to 35%, and TUCS would be better prepared to meet unexpected changes in the supply of gas. The staff concludes that operation of CPSES will improve the diversity of fuel supply for the service area and is an important factor in support of issuing an operating license.

2.4 System Reliability Analysis

Between 1965 and 1973, TUCS's electrical-energy output and peak-load demand grew at AARGs of 10.2% and 9.5%, respectively. During 1973 through 1980, these rates have slowed considerably, and are about the same as the growth experienced in the United States as a whole (Ref. 4).

Current projections by the applicant for the TUCS system call for AARGs of 4.6% for peak-load demand (ER-OL, Amend. 1, Table 1.1-9) and 5.5% for net-energy-for-area load from 1981 to 1986 (ER-OL, Amend. 1, Table 1.1-1).

Table 2.3 shows TUCS and Electric Reliability Council of Texas (ERCOT) reserve margins, both historical and projected with and without the CPSES units in operation, through 1986. The peak-load-responsibility values reported here reflect TUCS's official forecast for system-maximum hourly load. System capacity reflects capacity owned by TUCS.

TUCS has identified a 15% reserve margin as necessary to maintain minimum acceptable reliability for membership in ERCOT and for its own system (ER-OL, Amend. 1, Sec. 1.1). This standard is consistent with the 15% to 25% reserve margin recommended by the Federal Energy Regulatory Commission. Thus, based on TUCS current load forecast and capacity plans (as shown in Table 2.3), if the CPSES units are not added as scheduled, both TUCS and ERCOT reserve margins will be close to the minimum requirements in 1984 through 1986.

A regional econometric forecasting model has been developed by DRI (Ref. 2). This model suggests that the growth of demand for electrical energy in Texas, Arkansas, and Louisiana will probably be less than the growth projected by TUCS; the model results project an AARG of 3.8% for 1980 to 1986 versus 5.5% as projected by TUCS. The model also projects reserve margins for the region that range from 17% in 1980 to 24% in 1986 with all planned units coming online as scheduled by 1986.

Table 2.3. Capacity Resources, Peak-Hour Demands, and Reserve Margins for TUCS and ERCOT†[1]

Year	Resources (MW) ERCOT†[3]	Resources (MW) TUCS†[4]	Peak-Hour Demand†[2] (MW) ERCOT	Peak-Hour Demand†[2] (MW) TUCS	Reserve Margin (MW) ERCOT	Reserve Margin (MW) TUCS	Reserve Margin (%) ERCOT	Reserve Margin (%) TUCS
				Actual				
1972	25,550	10,355	20,408	8,285	5,142	2,069	25.2	25.0
1973	26,475	10,929	21,687	8,670	4,788	2,259	22.1	26.1
1974	30,010	12,007	23,332	9,602	6,678	2,405	28.6	25.0
1975	32,055	13,352	23,525	9,505	8,530	3,847	36.3	40.5
1976	33,600	13,863	25,400	10,002	8,200	3,861	32.3	38.6
1977	36,440	14,919	26,819	10,525	9,621	4,394	35.9	41.8
1978	39,099	15,932	28,645	11,232	10,454	4,700	36.5	41.8
1979	39,623	17,432	28,556	10,880	11,067	6,552	38.8	60.2
1980	42,141	17,412	32,126	12,591	10,015	4,821	31.2	38.3
				Projected with Comanche Peak				
1981	42,086	17,957	33,306	13,130	8,780	4,827	26.4	36.8
1982	44,701	18,947	35,089	13,735	9,612	5,212	27.4	37.9
1983	45,273	18,925	36,873	14,365	8,400	4,560	22.8	31.7
1984	47,391	19,787	38,796	15,035	8,595	4,752	22.2	31.6
1985	49,013	21,002	40,744	15,755	8,269	5,247	20.3	33.3
1986	51,142	21,470	42,735	16,485	8,407	4,985	19.7	30.2
				Projected without Comanche Peak				
1981	42,086	17,957	33,306	13,130	8,780	4,827	26.4	36.8
1982	43,551	17,912	35,089	13,735	8,462	4,177	24.1	30.4
1983	44,123	17,890	36,873	14,365	7,250	3,525	19.7	24.5
1984	45,091	17,717	36,796	15,035	6,295	2,682	16.2	17.8
1985	46,713	18,932	40,744	15,755	5,969	3,177	14.7	20.2
1986	48,842	19,400	42,735	16,485	6,107	2,915	14.3	17.7

†[1] Adapted from the ER-OL (Amend. 1, Table 1.1-9).

†[2] Undiversified. Projections include interruptible demands.

†[3] Electric Reliability Council of Texas.

†[4] Texas Utilities Company System.

The staff's reliability assessment assumes that about 2500 MWe of new capacity, other than that from CPSES, will be added to the TUCS system in 1981 to 1986 as scheduled. It also assumes that about 1200 MWe of purchased power will be available in the peak-use season each year. The conclusions of the reliability assessment could be altered by unavoidable slippages in, or decisions to delay, any of these subsequent additions, or by the uncertainty associated with TUCS reliance on outside purchases for some needed power. Finally, it must be stressed that because the DRI econometric model is aggregated at the regional level and because the TUCS utilities serve only parts of the states within the region, the findings based on the DRI model are valid only if the growth rate in each of the service areas is the same as the growth rate for the respective region as a whole.

Based on the above considerations, the staff concludes that the CPSES units will contribute to maintaining desirable reliability levels. However, reliability is not found to be a primary consideration in the timing of the initial operation of these units.

2.5 Conclusions

The results of the staff's assessment of purpose and need for CPSES Units 1 and 2 support a decision to issue operating licenses for the units in accordance with the schedule proposed by the applicant. The fact of overriding importance is that the addition of these units to the TUCS system is expected to result in significant savings in system production costs. Furthermore, the operation of these units will decrease TUCS dependence on fuel supplies of uncertain availability and will increase system reliability.

References

1. "Monthly Report on the Uranium Market, November 1980." Report No. 147, Nuclear Exchange Corporation, Menlo Park, CA, 1980.

2. "Energy Review." Vol. 4, No. 2, Data Resources, Inc., Lexington, MA, Spring 1980.

3. "SEC Form 10K Annual Report 1979." Texas Utilities Company.

4. "Statistical Abstract of the United States, 1979."

3 ALTERNATIVES TO THE PROPOSED ACTION

3.1 Résumé

During the construction-permit (CP) review stage, the staff analyzed alternative sites, plant designs, and methods of power generation, including the alternative of not adding production capacity. The staff concluded, based on its analysis of these alternatives, as well as on a cost-benefit analysis, that additional capacity was needed, that a nuclear-fueled plant would be an environmentally acceptable means of providing the capacity, and that CPSES Units 1 and 2, at a specified site and of a specified design, were acceptable from both economic and environmental perspectives. Since that time, construction of CPSES has been nearly completed; and many of the economic and environmental costs associated with the construction of the station have already been incurred and must be viewed as "sunk costs" in any prospective assessment.

The staff believes the only reasonable alternative to the proposed action of granting an operating license for CPSES available for consideration at the operating license stage is denying the license for operation of the facility and thereby not permitting the constructed nuclear facility to be added to the applicant's generating system. Alternatives such as construction at alternative sites, extensive station modification, or construction of facilities utilizing different energy sources would each require additional construction activity with its accompanying economic and environmental costs, whereas operation of the already constructed plant would not create these costs. Therefore, unless major safety or environmental concerns resulting from operating the plant are revealed that were not evident and considered during the CP review, these alternatives are unreasonable as compared to operating the already constructed plant. No such concerns have been revealed with regard to operation of CPSES.

With respect to the proposed action of operating the facility, it was shown in Section 2 that the addition of CPSES to the TUCS systems is expected to result in savings in system production costs of about $150 million per year for each of the two units of CPSES. Further, as stated in Chapter 2, operation of these units will provide diversity of fuel sources, thereby decreasing TUCS dependence on fuel supplies of uncertain availability (gas, oil, and lignite) and will contribute to increased system reliability. The environmental impacts of operation are reassessed in Section 5 of this statement. As discussed in Section 5.16.3, as a result of this reassessment, the staff has been able to forecast more accurately the effects of operation of CPSES and has determined that the station will operate with acceptable environmental impact.

The alternative of not operating the facility will require the utility to substitute approximately 12 billion kWh per year of electrical energy that would have been provided by CPSES with other sources of energy which have a greater economic cost and have an equal or greater environmental cost. As indicated above, the additional economic cost has been estimated at approximately $150 million per year for each of the two units.

After weighing the above described options, the staff concludes the preferable choice is operation of CPSES.

4 AFFECTED ENVIRONMENT

4.1 Résumé

This résumé highlights changes in the design of the facility and new information on the local environment gained since the FES-CP was issued in 1974.

Minor changes in design of the circulating-water system are described in Section 4.2.2.

After the FES-CP was issued, the applicant modified the liquid-, gaseous-, and solid-radwaste-treatment systems as described in the Final Safety Analysis Report and evaluated in the staff's Safety Evaluation Report. New liquid and gaseous source terms based on more recent operating data applicable to the station during normal operation, and anticipated operational occurrences, have been provided in Section 4.2.3.

There have been many changes in design and operation of the nonradioactive water treatment and waste systems, including construction of a surface water treatment facility (Sec. 4.3.2), and changes in the types and amounts of chemicals used in the systems and in their methods of disposal (Sec. 4.2.4).

The staff revisited CPSES in August 1980 to determine what changes had occurred at the site and in the surrounding area since the preconstruction review in 1974 that would alter the staff's evaluation of the impact of station operation on the environment. The staff has also reviewed the new documentation (such as the ER-OL) supplied by the applicant. Land use on the site has changed as a result of construction of the station. Major changes involve the conversion of rural and agricultural areas to station use; e.g., installation of permanent structures, construction facilities, warehouses, parking lots, roads, cooling pond, railroad spur, and transmission-line rights-of-way (Sec. 4.3.1).

The water-use discussion has been updated (Sec. 4.3.2). Water-quality data collected since the issuance of the FES-CP have been incorporated to provide a more complete description of water quality and local groundwater resources.

The meteorology and air quality discussion (Sec. 4.3.3) has been updated to include new information for the region and the site.

Additional background information relating to the terrestrial and aquatic biota within the site environs is provided in Section 4.3.4.

Section 4.3.5 contains new information on the historic and prehistoric resources of the site and nearby areas.

Expected changes in the local economy due to operation of CPSES and new demographic information from the 1980 census are discussed in Section 4.3.6.

4.2 Project Descriptions

4.2.1 External Appearance and Station Layout

There have been no significant changes in the design or layout of CPSES since the FES-CP was issued in June 1974 that would alter the external appearance of the station or layout of the major structures and facilities. Sections 3.1 (External Appearance) and 3.2 (Reactor, Steam-Electric System, and Fuel Inventory) and Figure 3.1.1 of the FES-CP remain valid. The station and its relationship to the surrounding region are shown in the following figures of the FES-CP:

Figure 2.1.2 (area within 16 km of the reactor location)
Figure 2.1.4 (exclusion area)
Figure 3.4.1 (Squaw Creek Reservoir and circulating-water system)
Figure 3.8.1 (transmission lines)

4.2.2 Station Cooling System

4.2.2.1 General Description

The station cooling system at CPSES consists of two major components: the circulating-water system and the service-water system. The general plan of the cooling system is shown in the FES-CP (Fig. 3.4.2). The circulating water will be withdrawn from Squaw Creek Reservoir (SCR) through an intake structure containing eight water pumps; it will be pumped through the condenser and various heat exchangers to the discharge tunnels and then be returned to SCR through a submerged discharge structure. A dam was built across an arm of the reservoir to form a separate water compartment called a safe-shutdown impoundment (SSI).

The purpose of this impoundment is to provide cooling water for dissipating reactor afterheat and to allow an orderly shutdown of the plant in the unlikely event of failure of the main dam retaining SCR. For all operating conditions, the station service water will be taken from the SSI through an intake structure containing five pumps. The water will be pumped through various safety-related cooling systems and then returned to the SSI through a discharge-chute structure.

Since the issuance of the FES-CP in 1974, the applicant has modified the design of various structures associated with the station cooling system. In the following sections, major modifications of the cooling system are described to update the description of the previous designs given in Section 3.4 of the FES-CP. The impact of these design modifications on the thermal-plume distributions in SCR is discussed in Section 5.3.3.

4.2.2.2 Circulating-Water System

A schematic diagram of the modified circulating-water system (CWS) for the station is shown in Figure 4.1. A description of the flow characteristics at various locations in the CWS is given in Table 4.1. The values presented in the table are for periods with a maximum circulating-water flow rate of 70 m^3/s (one unit operating at full power):

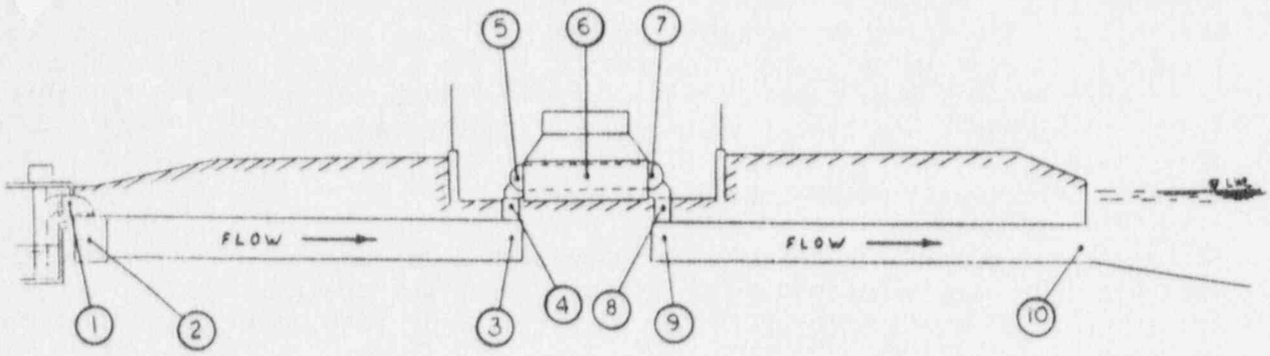

Figure 4.1. Circulating-Water-System Profile (numbers refer to locations listed in the accompanying table). (Modified from ER-OL, Amend. 1, Fig. 3.4-14.)

Table 4.1. Conditions of Flow in the CPSES Circulating-Water System†[1]

Location†[2]	Flow Area per Unit (ft^2)†[3]	Flow Rate per Unit (gpm)†[4]	Velocity (ft/s)†[5]	Static Pressure at Duct Centerline (ft of water)†[6]	Temperature (°F)†[7]	Time at Condition (s)
1. Circulating-water-pump discharge pipe	63.7	275,000	9.6	30	95	6
2. Inlet-duct entrance	250	1,100,000	9.8	30	95	73
3. Inlet duct below waterbox	250	1,100,000	9.8	55	95	73
4. Condenser waterbox and inlet pipes	78.7	256,250	7.2	30	95	3
5. Condenser-tube inlet	-	1,025,000	7.0	13	95	7
6. Condenser tubes	-	1,025,000	7.0	12	95	7
7. Condenser-tube outlet	-	1,025,000	7.0	0	110	7
8. Condenser waterbox and discharge pipes	78.7	256,250	7.2	12	110	3
9. Outlet duct below waterbox	250	1,100,000	9.8	35	110	100
10. Outlet-duct discharge	250	1,100,000	9.8	15	110	100

†[1] Modified from ER-OL, Amendment 1, Table 3.4-5.

†[2] Numbers refer to locations depicted in the accompanying figure.

†[3] To convert to m^2, multiply by 0.09290.

†[4] To convert to m^3/s, multiply by 6.309×10^{-5}.

†[5] To convert to m/s, multiply by 0.3048.

†[6] To convert to kPa, multiply by 2.98898.

†[7] To convert to °C, use formula: °C = 5(°F-32)/9.

One of the design changes in the CWS is the use of a separate discharge tunnel for each unit, rather than a combined single tunnel for two units, to convey the heated water from the condenser to the discharge canal. The tops of the present discharge tunnels are submerged about 5 m below the low water level in SCR. However, the flow characteristics such as velocity and static pressure inside the present and previous tunnels remain the same.

4.2.2.3 Circulating-Water Discharge Canal

The newly designed circulating-water discharge canal is shown in Figure 4.2. The canal has been made deeper and narrower than the previous design, but with cross-sectional areas at corresponding locations in the canal remaining about the same.

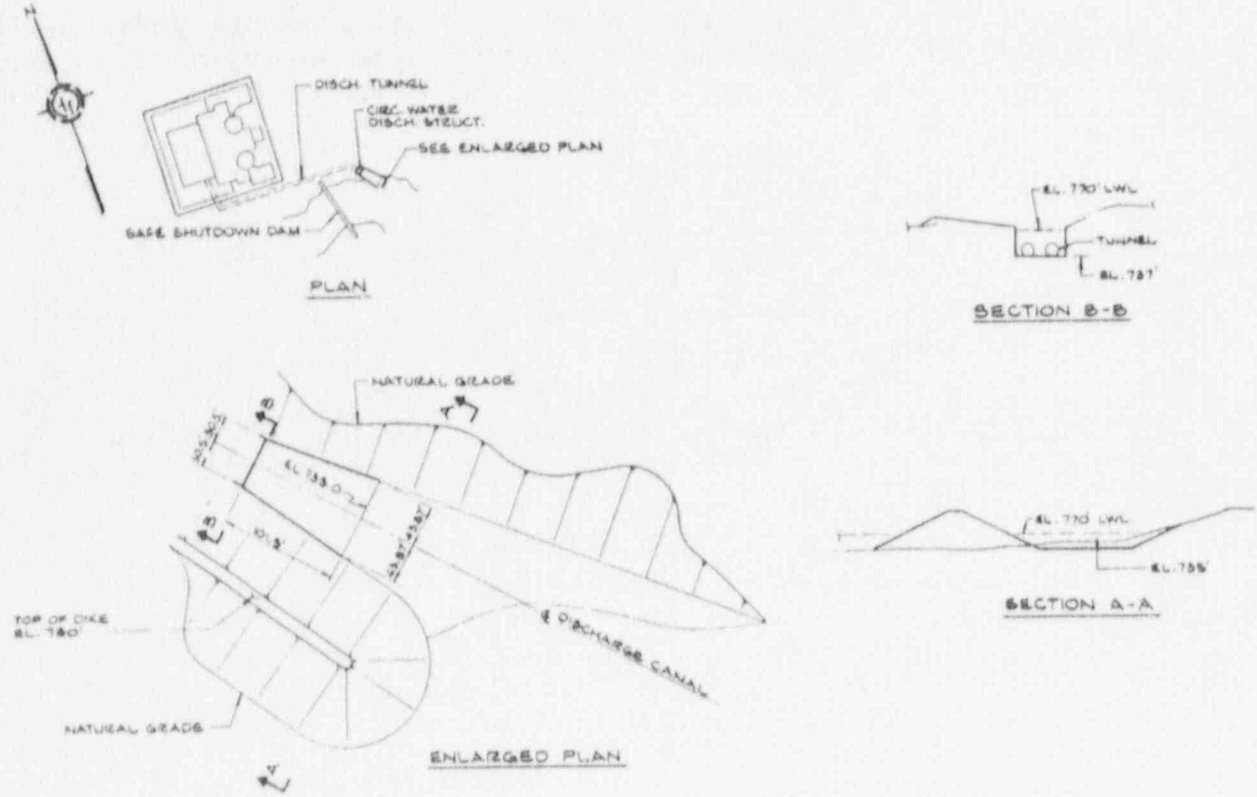

Figure 4.2. Circulating-Water Discharge Canal. (ER-OL, Amend. 1, Fig. 3.4-5.)

The flow velocity in the discharge canal is affected by the rate of discharge and by the water-surface level in the SCR. Assuming the maximum circulating-water flow rate of 140 m^3/s (both units operating) and a low-water level of 235 m MSL in SCR, the cross-sectionally averaged discharge flow velocity will be 0.5 m/s at the downstream end of the concrete-lined discharge canal.

4.2.3 <u>Radioactive-Waste-Management Systems</u>

10 CFR §50.34a (Section 50.34a of Title 10 of the Code of Federal Regulations) requires an applicant for a permit to construct a nuclear power reactor to

include a description of the preliminary design of equipment to be installed for keeping levels of radioactive materials in effluents to unrestricted areas "as low as is reasonably achievable." The phrase "as low as is reasonably achievable" takes into account the state of technology and the economics of improvement in relation to benefits to the public health and safety and other societal and socioeconomic considerations and in relation to the utilization of nuclear energy in the public interest. Appendix I to 10 CFR Part 50 provides numerical guidance on design objectives for light-water-cooled nuclear power reactors to meet the requirement that radioactive materials in effluents released to unrestricted areas be kept as low as is reasonably achievable.

To comply with the requirements of 10 CFR Part 50.34a, the applicant has elected to meet the requirements of the Annex to Appendix I to 10 CFR Part 50, dated September 4, 1975, in lieu of performing a cost-benefit analysis as required by Section II.D of Appendix I. The applicant has provided final designs of radwaste systems and effluent-control measures for keeping levels of radioactive materials in effluents to unrestricted areas as low as is reasonably achievable within the requirements of Appendix I and the Annex to Appendix I. In addition, the applicant has provided an estimate of the quantity of each principal radionuclide expected to be released annually to unrestricted areas in liquid and gaseous effluents produced during normal operation, including anticipated operational occurrences.

The staff's detailed evaluation of the radwaste systems and the capability of these systems to meet the requirements of Appendix I are presented in Chapter 11 of the Safety Evaluation Report. Also, the quantities of radioactive material calculated by the staff to be released from the facility are presented there, and in Section 5.8 of this Environmental Statement, along with the calculated doses to individuals and to the population that will result from these effluent quantities.

Technical Specifications in the operating license will require that the applicant: (1) establish release rates for radioactive material in liquid and gaseous effluents and, (2) provide for the routine monitoring and measurement of all principal release points to assure that the facility operates in conformance with the requirements of Appendix I to 10 CFR Part 50.

4.2.4 Nonradioactive-Waste Systems

Since publication of the FES-CP, the applicant has modified the CPSES water treatment systems and has revised the estimates of the amounts and types of nonradioactive chemicals to be used. With respect to cooling system chemicals (Sec. 4.2.4.1 below), there has been a major increase in the amount of hydrazine to be used and in addition, morpholine will now be used and cyclohexylamine will not be used. Concerning water treatment (Sec. 4.2.4.2 below), (1) there has been a major decrease in the amount of sodium hydroxide to be used, (2) a minor increase in the amount of sulfuric acid to be used, and (3) coagulant and polymer (coagulant aid), sodium hexametaphosphate, formaldehydes, potassium chromate and Calgon-CS (corrosion inhibitor) will now be used. With respect to closed loop cooling systems (Sec. 4.2.4.4 below), sodium phosphate will not be used. In addition, detergents will not be used during CPSES operation.

4.2.4.1 Cooling-System Chemicals

Hydrazine and morpholine are used in the reactor-coolant system; they are released from condenser-feedwater drains in the turbine building and discharged to the evaporation pond. These chemicals are added to make up for losses from blowdown, chemical reaction, and decomposition. Because blowdown is recycled through demineralizers, some hydrazine and morpholine will be removed by ion exchange. Hydrazine, used as an oxygen scavenger, is released at concentrations of 0.05 to 0.10 mg/L. Hydrazine reacts with dissolved oxygen producing nitrogen and water; this reaction limits unreacted hydrazine discharges from the system (Ref. 1). Morpholine, used for pH control, is released from feedwater drains at a maximum concentration of 10 mg/L.

Chemicals used in the primary water system (the pressure or water loop) are boric acid and lithium hydroxide. These chemicals are either recirculated continuously in the primary water system or collected on ion-exchange resins and disposed of offsite at a licensed disposal facility as solid waste.

Biocides

The circulating-water and service-water systems of CPSES will be treated by the shock-chlorination method. At periodic intervals, chlorine will be injected into the circulating-water system to prevent the growth of algae and bacterial slime on the surfaces of the circulating-water tunnel and the condensers. The chlorine dosage will be adjusted to restrict the total residual chlorine (TRC) concentration to a maximum of 0.5 mg/L. Effluent limitations for free available chlorine (FAC) are 0.2 mg/L average and 0.5 mg/L maximum (NPDES permit, App. E of this Environmental Statement). The daily chlorine use for the circulating-water system is subject to a chlorination minimization program as discussed below. Daily chlorine use for the service-water system is not subject to this program and is projected to be used at a rate of 640 kg/day.

To define the minimum amount of chlorine needed for biofouling control in the circulating-water system, the applicant has designed a chlorine-minimization plan to achieve the lowest chlorine discharges from the station. Implementation of the plan, approved by the United States Environmental Protection Agency (USEPA) Region VI, will begin during Unit 1 startup and take place over the first 18 months of operation (Refs. 2 and 3). A baseline will be established to assure clean and efficient condensers. Three chlorine-screening trial periods will then be undertaken to determine the proper chlorine dosage and schedule. Once the dosage and schedule have been established, the corresponding effluent limitations will replace existing limitations given in the NPDES permit. The maximum chlorine dosage during the minimization plan is 0.4 mg/L for 30 minutes twice each operating day, and will occur during baseline studies. The daily chlorine use for the circulating water system is projected to be at a rate of 750 kg/day. A similar minimization program will be instituted during Unit 2 startup.

4.2.4.2 Water-Treatment Wastes

Waste from the makeup-water-treatment systems consists of clarifier sludge, which is sent to the evaporation pond. Clarified-sludge waste contains coagulant, polymer coagulant aid, and settled solids. The applicant has not selected the specific type and dosage of coagulant and polymer coagulant aid.

Makeup-demineralizer waste consists of dilute solutions (1%) of sodium sulfate and excess regenerant solution (sodium hydroxide and sulfuric acid), which is sent to the evaporation pond, and spent ion-exchange resin, which is solidified for offsite burial. Powdex resin (a disposable ion-exchange resin) is used for condensate polishing. Backwash in the polishing vessel produces a thick slurry of spent powdex resin. Condensate-polishing waste is normally sent to the evaporation pond; but, if radioactive, it is transferred to the radioactive-waste-solidification system (Sec. 4.2.3).

Sodium hexametaphosphate is used as an antiscaling agent in the reverse-osmosis (RO) unit in the makeup-water-treatment system. During RO operation, sodium hexametaphosphate waste is discharged continuously to the circulating-water system at a rate of 6.3×10^{-3} m^3/s at a concentration of 20 mg/L. The average concentration in the circulating-water system will be less than 1 mg/L. Formaldehyde is injected into the RO unit to preserve the membrane during RO shutdown. Formaldehyde waste is discharged to the evaporation pond at a concentration of about 1 mg/L.

Sodium hypochlorite will be added to the potable-water supply to maintain a chlorine residual in accordance with Texas Department of Health regulations. Potable-water-use facilities drain to the sanitary-waste-treatment plant (Sec. 4.2.4.8).

4.2.4.3 Auxiliary-Boiler Blowdown

During station startup, the auxiliary-boiler water is deaerated using sodium sulfite; this process oxidizes the sulfite, forming sulfate. Boiler blowdown contains 2400 mg/L of sodium sulfate, which is discharged to the evaporation pond at a maximum rate of 4.3 kg/d, 30 d/yr.

4.2.4.4 Closed Loop Cooling-Water Systems

Two corrosion inhibitors, potassium chromate and Calgon-CS, are released from the closed-loop cooling system. During system maintenance, the coolant containing potassium chromate is collected in drums for disposal offsite at a licensed disposal facility. Calgon corrosion inhibitor-CS, a solution of 72% sodium nitrate and 28% borax, is discharged to the evaporation pond.

4.2.4.5 Condenser Waste

As described in the FES-CP (pp. 3-15 and 3-16), makeup water will be pumped into SCR from Lake Granbury and blowdown from the reservoir will be returned to Lake Granbury. The design capacity of the makeup-water and blowdown lines is sufficient to limit the dissolved-solids concentration in SCR to about twice the average level in Lake Granbury.

Corrosion of condenser tubes will release some copper into SCR. Because there is a change in the corrosion potential of the heat exchanger tubes over the life of the plant, there will be a decrease in copper concentration discharged into SCR. Based on new information on copper loadings supplied by the applicant (ER-OL, Amend. 1, response to staff question 62), the staff estimates that discharges into SCR will result in an initial copper concentration of 20 µg/L, leveling off to 2 µg/L. This compares with an existing concentration of about 1 µg/L in Lake Granbury (ER-OL, Table 2.4-19).

4.2.4.6 Evaporation Pond

Since the issuance of the FES-CP, (1) estimates of the amounts and types of chemicals to be discharged into the evaporation pond have been changed and (2) the evaporation-pond liner has been selected.

The evaporation pond, consisting of two independent sections, is used for most chemical-waste disposal (Table 4.2) during CPSES operation for the projected life of the plant (ER-OL, Sec. 3.6.2.3). Each section will have an area of 2.4 ha and a depth of 1.8 m, for a total volume of 86,000 m^3. The average discharge to the evaporation pond is 39,000 m^3/yr, carrying 74,000 kg/yr of chemical wastes. The average net evaporation in this area is about 0.8 m/yr, which is adequate. The applicant's Resource Conservation and Recovery Act (RCRA) compliance review indicates that all materials discharged to the evaporation pond could be disposed of in a manner complying with RCRA regulations (ER-OL, Amend. 1, response to staff question 58). If additional capacity becomes necessary, the sludge can be removed to an offsite landfill in accordance with RCRA requirements at that time (ER-OL, Amend. 1, response to staff question 59). The evaporation-pond bottom and sides have been lined with an impervious clay liner to prevent groundwater contamination.

4.2.4.7 Blowdown from Squaw Creek Reservoir to Lake Granbury

The description of the characteristics of blowdown from SCR to Lake Granbury (FES-CP, Sec. 3.6.1) remains valid.

4.2.4.8 Sanitary Wastes

Sanitary wastes presently are treated onsite by two extended-aeration units, each with a rated capacity of 114 m^3/d. The effluent is chlorinated for disinfection and odor control prior to release to the circulating-water discharge canal; the chlorine residual in the effluent is 1.0 mg/L (Ref. 4). During normal operation, the average waste flow rate is 19 m^3/d with a peak flow rate of 72 m^3/d during refueling. Because the loading is well below the combined capacity of 228 m^3/d, the applicant intends to remove one of the extended-aeration units from service once the higher capacity required by the construction work force is no longer needed. The five-day biochemical oxygen demand (BOD_5) and total-suspended-solids concentrations in the treated effluent are not expected to exceed 45 mg/L. Sanitary-waste sludge is pumped from the treatment plant and trucked offsite to a licensed disposal facility.

The treatment plant has been designed to operate in accordance with the standards of EPA and the Texas Department of Water Resources. The operator holds a certificate of competence issued by the Texas State Department of Health. Effluent limitations for treated sanitary wastes were set in the applicant's NPDES permit from USEPA Region VI, and in the permit from the Texas Water Commission for the disposal of wastes.

4.2.4.9 Combustion Effluents

The description of CPSES combustion effluents (FES-CP, pp. 3-41 and 3-42) remains valid.

Table 4.2. Projected Amounts of Chemicals Used and Discharged During CPSES Operation†[1]

Chemical	Amount (kg/d)		Disposal Method
	Used	Discharged	
Hydrazine	7	0.002	Evaporation pond
Morpholine	70	1.1	Evaporation pond
Boric acid	variable	14 to 18	Offsite disposal
Lithium hydroxide	variable	0	Offsite disposal
Polymer (coagulant aid)†[2]	3.2	†[3]	Evaporation pond
Clarifier sludge†[2]	†[4]	32	Evaporation pond
Ion-exchange resin	†[4]	9.1	Offsite disposal
Sulfuric acid	290	58	Evaporation pond
Sodium hydroxide	120	25	Evaporation pond
Powdex resin†[5]	82	82	Evaporation pond
Sodium hexametaphosphate	4.5	4.5	Squaw Creek Reservoir
Formaldehyde	0.1	0.1	Evaporation pond
Sodium hypochlorite	20	9.1	Sanitary wastes
Sodium sulfite†[6]/sulfate	3.6	4.3	Evaporation pond
Potassium chromate	0.03	0.03	Offsite disposal
Calgon-CS†[7]	0.01	0.01	Evaporation pond
Chlorine	1380	1380†[8]	Squaw Creek Reservoir

†[1] From the ER-OL, Section 3.6.

†[2] The applicant has not yet selected the type and dosage of coagulant and coagulant aid.

†[3] Included in clarifer sludge.

†[4] Information not provided by the applicant.

†[5] Disposable powdered ion-exchange resin.

†[6] Used only 30 days per year.

†[7] 72% sodium nitrate, 28% borax.

†[8] Maximum amount discharged per day.

4.2.5 Power-Transmission Systems

The CPSES transmission lines are described in the ER-CP, in the FES-CP (Sec. 3.8), and in the ER-OL (Sec. 3.9). Discussions of transmission-line rights-of-way (ROW), land use, and impacts are in Sections 4.3.1, 5.2, and 5.5.1 of this environmental statement. The transmission lines are divided into two corridors, and the total length of the ROW is 22.6 km.

All transmission lines associated with CPSES as described in the FES-CP have been constructed with the exception of an additional tie into the southwest, which will be made from the CPSES switchyard in 1983 or later when system loads require a transmission reinforcement.

Four transmission lines were required to connect CPSES with the Texas Utilities Company System. Two parallel transmission lines tie into the DeCordova Steam Electric Station switchyard. The other two are short segments forming a loop to connect CPSES to the Weatherford, Parker, and Venus 345-kV transmission lines. There were no special problems caused by the terrain or topography of the region in construction of these transmission lines. The lines cross the Brazos River twice, the spur railroad line on the site, and one major highway in a sparsely settled region of the countryside. A line parallels an infrequently traveled farm road for a very short distance.

Right(s)-of-way (ROW) lands were selected to minimize requirements for construction of access roads and extensive clearing of vegetation. The number of structures has been kept to a minimum, using lattice-type galvanized-steel towers for the 345-kV lines and wooden poles for the 138-kV circuits.

The area used for the CPSES transmission lines is almost 185 ha, and the ROW totals 24 km. The CPSES site has almost 95 ha of ROW. The ROW encompass woodland, open range, pasture, cropland, and residential and industrial lands.

The standard easement provides for continued use of land for ranching and general agricultural purposes. Transmission corridors are to remain in, or be allowed to return to, the state of use before construction was begun.

Clearance and maintenance practices of the transmission-line ROW have been designed to protect the environment and to maintain an esthetically pleasing effect. These practices have been addressed in the ER-CP, FES-CP, and ER-OL. In the ER-OL, Section 3.9.3 indicates that herbicides were, and may continue to be, used along the ROW. Use of herbicides was limited because experience indicated that spraying and chemical treatment did not control the growth of vegetation. Control of vegetation along the ROW will be accomplished by pruning once every three years. A few stems that cannot be mowed were treated with a specific and individual application of TORDON 101R EPA #464-510. There are no restrictions for the use of this herbicide and no state permits are required, according to the applicant. The herbicide GUARDSMAN 2413 EPA #1706-125-AA-550 is not being used inside fenced areas of the switchyard. Future application will be with currently EPA-approved herbicides only. No pesticides are used in the switchyard or ROW. The Texas Electric Service Company, Fort Worth Transmission Division, is responsible for the application of these chemicals (ER-OL, Amend. 1, response to staff question 73).

4.3 Project-Related Environmental Description

4.3.1 Land

The staff revisited the CPSES site in August 1980 to observe the terrain and to assess the environmental changes and impacts of construction. The total area of the site is 3105 ha, but only 1483 ha are required for the power station and reservoir. Prior to construction, land-use categories consisted of agriculture, cattle grazing, and mixed woodland.

The major changes in land use since the FES-CP was published were the construction of a permanent CPSES facility, parking lots, roads, railroad spur, transmission line ROW, the Squaw Creek Dam, and the filling of Squaw Creek Reservoir (SCR). A 6-inch gas line, 26-inch crude-oil line, and two 36-inch gas lines cross the site. The two 36-inch gas lines are anchored and submerged where they cross the reservoir.

The CPSES facility is nearly completed. The site is described in the ER-OL (Sec. 2.1). Topsoil, saved during the clearing phase of construction, will be respread on the appropriate areas of the site peninsula to provide suitable soil for revegetation, with emphasis placed on native species. Grasses have been planted around evaporation ponds and the service-water discharge canal to impede erosion (ER-OL, Amend. 1, response to staff question 75).

The entire railroad spur is 17.6 km long and occupies a 21- to 40-m wide ROW. This amounts to 41.7 ha, 32 ha of which is offsite and beyond the limits of the project property. The access road to the plant site is 3.4 km long and affects 7.7 ha of rangeland. The areas occupied by the railroad-spur, access-road, and transmission-line ROWs were either woodland, open range, pasture, or cropland.

A 48-inch makeup-water or diversion pipeline from the reservoir to Lake Granbury is almost 8 km long, and the 36-inch return-water pipeline from the reservoir to Lake Granbury is about 14 km long. The pipeline ROW is also either woodland, open range, pasture, or cropland. Land use is described in greater detail in the ER-CP, FES-CP, and ER-OL.

4.3.2 Water

4.3.2.1 Surface Water

The surface-water descriptions presented in Sections 2.2.3.2 and 2.5.1 of the FES-CP are still valid, as supplemented by the following discussion. In addition, Section 5.3.2 of this Environmental Statement contains a discussion of the hydrologic effects of alterations in the floodplain, as required by Executive Order 11988, "Floodplain Management" (Ref 5).

The U.S. Geological Survey (USGS) established a stream gaging station on Squaw Creek in October 1973. At the time the FES-CP was published in June 1974, streamflow records from this gage were not available. Average monthly-runoff records for the 1974-1980 water years are shown in Table 4.3. The average monthly runoff during the six-year period shown in the table was about 630,000 m^3 (510 acre-ft).

Table 4.3. Runoff Data, Squaw Creek near Glen Rose, Texas (acre-ft)†[1]

Water Year	Month											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1974	619	116	111	73	40	42	24	93	51	22	11	105
1975	2190	1190	413	333	3000	488	4220	505	472	168	65	311
1976	80	38	52	43	23	44	1704	2950	330	717	50	493
1977	399	301	587	372	486	651	330	217	189	57	37	57
1978	150	232	145	157	137	99	106	147	76	98	99	131
1979	133	147	257	356	210	405	273	3500	2030	239	309	261
1980†[2]	249	217	236	--†[3]	--	--	227	373	347	180	315	228
Avg	546	320	237	222	649	288	983	1098	499	212	128	227

†[1] To convert to m^3, multiply by 1233.5.

†[2] Data for water year 1980 is provisional, subject to verification.

†[3] Denotes data not available.

4.3.2.2 Groundwater

The groundwater descriptions presented in Sections 2.2.3.1 and 2.5.2 of the FES-CP are still valid, with the following additions:

Two production wells (PW-1 and PW-2) and three observation wells (OB-1, OB-2, and OB-4) have been constructed onsite. Locations of these wells are shown in Figure 4.3. Observation well OB-3 was an existing well on the station property. All of these wells tap water from the Twin Mountains Formation. Information on groundwater usage is provided in Section 5.3.1.2.

At the construction-permit stage, the NRC required that during construction the applicant evaluate alternative actions to mitigate potential adverse effects to the groundwater resources of the region that could result from the station's groundwater use. As a result of the evaluation, which was performed after issuance of the construction permits, the applicant constructed a surface-water-treatment facility onsite. A description of the use of the facility is presented in Section 5.3.1.1.

4.3.3 Meteorology and Air Quality

The regional climatology is described in Section 2.6 of the FES-CP. More recent data on the local meteorology and severe weather affecting the site are now available, and are summarized below.

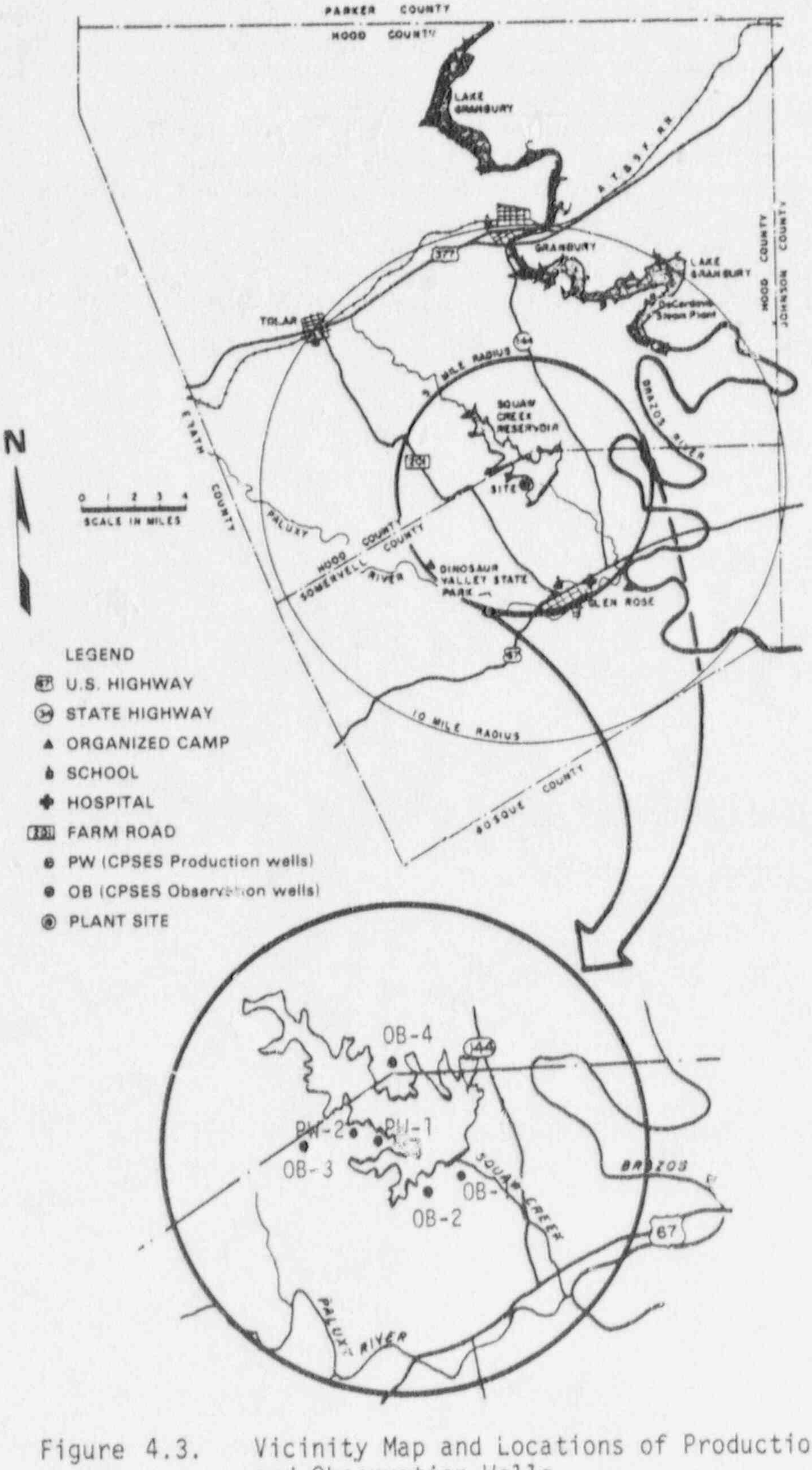

Figure 4.3. Vicinity Map and Locations of Production and Observation Wells.

4.3.3.1 Local Meteorology

Onsite meteorological data for three additional years (May 1973 to May 1976) have been submitted by the applicant. The temperature data indicate that the monthly mean temperature at the site ranges from 7°C in January to about 27°C in July and August. This is consistent with what other local data sources indicate (as reported in the FES-CP). The absolute-minimum temperature for the four-year period at the site was -14°C; the maximum was 38°C.

Wind data from the site for the four-year period indicate a predominance of south to southeasterly winds (40% of the time). The mean wind speed for the onsite data was 3.7 m/s, with 0.9% calms. A wind rose of the onsite data is presented in Figure 4.4.

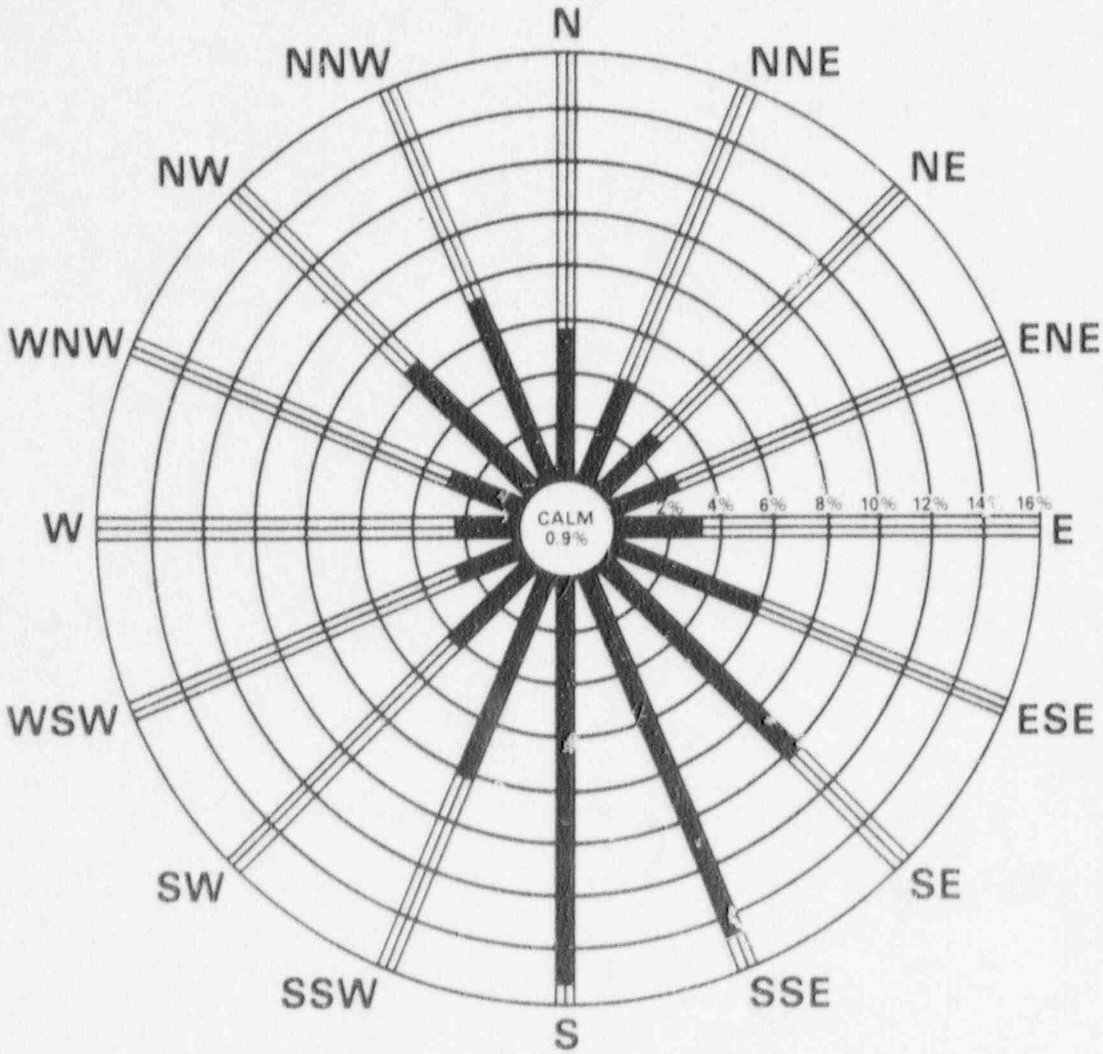

Figure 4.4. Comanche Peak Wind Rose, 15 May 1972 to 14 May 1976. (Length of black bar indicates the percentage of time that the wind comes from the indicated direction.)

Stable atmospheric conditions occurred over 75% of the four-year period. Unstable conditions accounted for less than 6% of the total valid hours reported.

4.3.3.2 Severe Weather

For the period 1950-1979, there were 252 reported tornado occurrences within about 93 km of the CPSES site. This is a mean annual frequency of 8.4. Tornadoes occurred most frequently during May, with 82 of the 252 reported tornadoes. Texas was affected by strong winds and heavy rainfall due to about 15 tropical cyclones between 1964 and 1979. Only five of these cyclones were of hurricane strength. The storm data for the period 1968-1979 indicate 91 damaging wind-storms within a 1° latitude-longitude square containing the site. The majority of these storms are estimated to have had wind speeds in excess of 35 m/s.

4.3.3.3 Air Quality

Air-quality data for 1979, collected by the Texas Air Control Board in Fort Worth, Arlington, and Waxahachie (Ellis County), Texas, indicate the primary National Ambient Air Quality Standards (NAAQS) for sulfur dioxide (SO_2), oxides of nitrogen, carbon monoxide (CO), and total suspended particulates (TSP) are being achieved in the vicinity of the site; the NAAQS values are not being met for ozone and nonmethane hydrocarbons (Refs. 6 and 7). SO_2 levels are very low, whereas TSP levels in Fort Worth and Arlington are near the primary NAAQS values.

4.3.4 Ecology

4.3.4.1 Terrestrial

Monitoring

The ecological communities are described in detail in the ER-CP, FES-CP (Sec. 2.7), and ER-OL. Environmental monitoring began in 1972, continued through 1979, and was summarized annually.

Invertebrates were sampled in 1975, 1977, and 1979. A complete detailed report of sites, methods, and results was published in the ER-OL and a summary was presented in a report to the applicant (Ref. 8). Surveys for amphibians and reptiles were begun in August 1972 (Ref. 9) and data were reported in the FES-CP and ER-OL, and were summarized in the report of the five-year monitoring study (Ref. 8).

Observations and surveys of birds were conducted from August 1972 through 1974 (Ref. 9). A summary of observations from 1975 through 1979 suggests gradual increases in species richness, but none are statistically significant (Ref. 8). Seven species not reported in 1972-1974 (Ref. 9) were observed in the spring of 1975 (ER-OL, p. 2.2-11). The numbers of bird species in the riparian and upland juniper habitats had declined significantly. Although the cause of the decline is not known for certain, it may be attributed to loss of habitat due to the filling of SCR (Ref. 8). The mourning dove (Zenaidura macroura) and bobwhite (Colinus virginianus), are the two major game birds observed in the CPSES environs.

Both Hood and Somervell Counties lie along migration routes, and some migratory game birds have been observed in the CPSES site area. Sandhill cranes, geese, and ducks were observed during 1972-1974 (Ref. 9).

Mammals are considered to be important to the ecosystem. Habitats, food requirements, and numbers of individuals observed are listed in Ref. 9, the ER-CP, and the FES-CP.

Endangered Species

None of the Federally listed Texas endangered-plant species are known to occur within 320 km of Hood or Somervell Counties (Ref. 10).

The Texas Parks and Wildlife Department considers three reptiles--Harter's water snake (Natrix harteri), Brazos water snake (Nerodia harteri harteri), and Texas horned lizard (Phrynosoma cornutum)--as endangered species. It also cites the Louisiana milk snake (Lampropeltis triangulum amaura) as a probable endangered species for Hood and Somervell Counties (Ref. 10).

Several migratory birds observed in Hood and Somervell Counties are listed by the State of Texas as endangered or threatened (Ref. 10). The endangered species are: osprey (Pandian haliaetus carolinensis), southern bald eagle (Haliaeetus l. leucocephalus), and the golden cheeked warbler (Dendroica chrysoporia). The possible threatened migratory birds are: white-faced ibis (Plegadis chihi), swallowtailed kite (Elanoides f. forficatus), wood stork (Mycteria americana), arctic peregrine falcon (Falco peregrinus tundrius), whooping crane (Grus americana) and interior least tern (Sterna albifrons athalassos).

No mammals are listed as endangered for the State of Texas or Hood and Somervell Counties (Refs. 10 and 11). The U.S. Fish and Wildlife Service has stated that there are no endangered or threatened species, listed or proposed, that would be affected by CPSES operation (Ref. 12).

4.3.4.2 Aquatic

The principal aquatic environments in the area affected by construction of CPSES include SCR, lower Squaw Creek (below the dam), Lake Granbury, and the Paluxy River from its confluence with Squaw Creek and the Brazos River below Lake Granbury, as shown in Figure 4.5. This figure also shows the locations of aquatic-monitoring activities. Since the issuance of the FES-CP, additional data on the aquatic ecology of the area have been collected. These data are summarized here; more-detailed information appears in the ER-OL (Sec. 2.2.2) and Ref. 8.

Squaw Creek Reservoir

SCR is a cooling lake formed by impoundment of Squaw Creek, and has an area of 1325 ha and a capacity of about 190 million m^3 at an elevation of 236 m MSL; maximum depth is about 41 m (FES-CP, Fig. 3.4.4, p. 3-14). Impoundment was begun in February 1977 with closure of the dam, and filling was completed in May 1979. More than 95% of the water was obtained from Lake Granbury (FES-CP, p. 4-26); therefore, the original biota and chemical characteristics of the

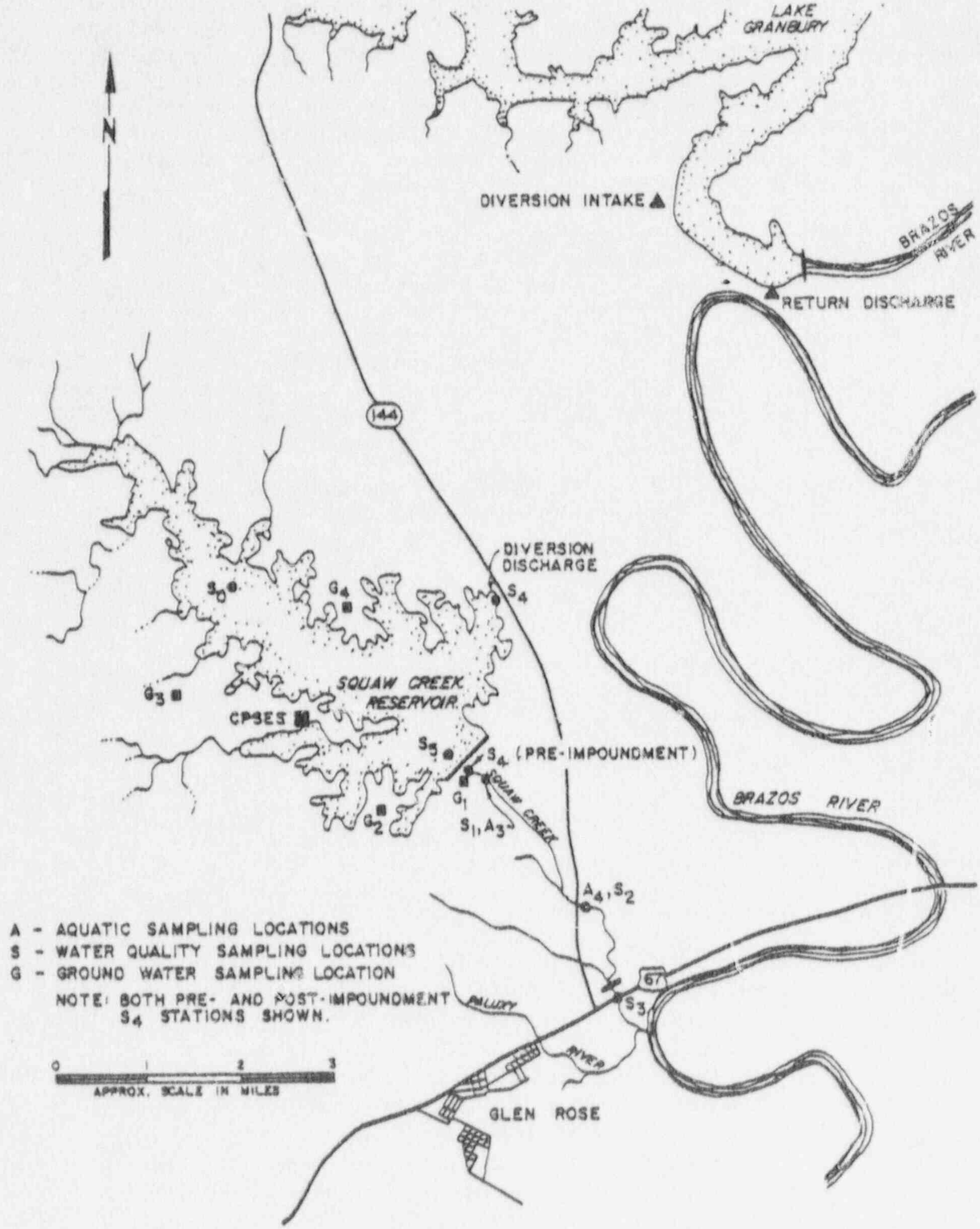

Figure 4.5. Sampling Locations for Aquatic Ecology, Water Quality, and Groundwater.

water in SCR resembled those of Lake Granbury. Until the station becomes operational, the Texas Parks and Wildlife Department has responsibility for monitoring the aquatic biota and other resources in SCR. Since impoundment began, the Texas Parks and Wildlife Department (Ref. 10) has monitored the fish population of SCR once. The applicant will monitor the aquatic biota and selected other resources of SCR once the station is in operation (ER-OL, Amend. 1, response to staff question 65). The purpose of that monitoring will be to provide confirmatory data on the impact of CPSES operation on aquatic biota and selected other resources of SCR.

The Texas Parks and Wildlife Department began stocking SCR in spring 1979 with walleye, white bass, striped bass, and smallmouth bass. In addition, smallmouth bass (25 mm long) were added in May 1980. These activities apparently were part of the Department's program to develop potential recreational areas. On April 24, 1979, just before stocking was begun, the fish population was surveyed. The data collected in the survey are summarized in Table 4.4. These data show a relatively small proportion of rough fish, but this probably was temporary because the reproductive potential of rough fish such as shad is very high.

Table 4.4. Fish Samples Obtained by Electroshocking in Squaw Creek Reservoir on April 24, 1979†[1]

Species	Number	Total Weight (lb)†[2]
Threadfin shad	1	0.1
Gizzard shad	6	1.7
Gray redhorse	2	3.3
Black bullhead	254	73.7
Yellow bullhead	2	0.7
White bass	27	24.8
Largemouth bass	15	6.9
Green sunfish	1	0.3
Bluegill	5	0.7

†[1] Office memorandum with attachments from K. Sellers to B. Bounds, Texas Parks and Wildlife Dept., 3 May 1979.

†[2] To convert to kg, multiply by 0.4536.

Lower Squaw Creek

Biological surveys of lower Squaw Creek (below the dam site) were conducted for five years (1975-1979) after construction began (Ref. 8). The detailed information obtained from these surveys is provided in the ER-OL (Sec. 2.2.2.3). Aquatic samplings of plankton, macroinvertebrates, and fish were conducted during winter, spring, and summer to provide baseline information during the construction phase and to determine changes after impoundment of Squaw Creek. Sampling stations were located just below the dam (A3) and at the Highway 144 bridge (A4) near Glen Rose (see Fig. 4.5).

Lake Granbury

The new information discussed below is related to makeup water intake and blowdown discharge effects on the biota of Lake Granbury.

Aquatic vegetation is generally sparse on the west side of Lake Granbury in the area of the makeup-water pumping station and blowdown discharge from SCR; submerged plants in this area include stonewort (Chara sp.), pond weed (Potamogeton sp.), and milfoil (Myriophyllum sp.). Extensive lists of plankton species were reported in 1974 and 1976 (Refs. 13 and 14). Generally the diversity was greatest in winter and early spring and least in summer. The green alga Actinastrum gracielum was dominant at all seasons throughout the water column, whereas zooplankton taxa were limited primarily to a few species of rotifers, cladocerans, and copepods, characteristic of saline-alkaline waters (ER-CP, p. 2.7-56). Species diversity of benthic macroinvertebrates were fairly uniform throughout the reservoir from January to June, except for the midge larva Chaoborus punctipennis, which made up 95% of the January collection during the 1976 survey (Ref. 15).

The species of fish captured during a six-month study in Lake Granbury (January-June 1974) correspond closely to the fish population of the Brazos River (ER-OL, p. 2.2-55). Results of a juvenile-fish study showed that fry and fingerlings were more numerous along the east side of Lake Granbury (Ref. 15), whereas the habitat along the west side of the lake, where the makeup-water intake and blowdown outlet are located, was less suitable to support juvenile fish (Refs. 13 and 14). The bottom mud, ooze, and fine sand provide an unsuitable habitat for spawning of most common fish species found in the lake.

In the 1978 larval-fish study of Lake Granbury, conducted by the applicant to determine the density at three collection stations in the area of the makeup-water diversion for SCR, two species of shad (Dorosoma cepedianum and D. petenense) made up 85% of the larvae collected (Ref. 15). There were no statistically significant differences in the densities of larval fish among the three stations, from which the applicant concludes that the area of the diversion does not provide unique spawning and nursery habitats (ER-OL, p. 2.2-57).

Paluxy and Brazos Rivers

Information on aquatic biota is available only from the surveys conducted since construction of CPSES was initiated, and was not included in the FES-CP. Both submergent and emergent aquatic vegetation found in the Paluxy River resembled those found in Squaw Creek, whereas aquatic vegetation is essentially absent in the Brazos River. Complete species lists for both rivers are given in the 1974 study (Ref. 13).

The fish populations reported in the 1974 study of the Brazos and Paluxy Rivers include almost all the species reported for Lake Granbury and Squaw Creek (Ref. 13). No additional fish species were reported in the ER-OL.

Endangered Species

U.S. Fish and Wildlife Service lists of endangered species for Hood and Somervell Counties contain no aquatic-invertebrate species, nor is any threatened or endangered fish species known to occur in the CPSES area (Ref. 11). Four fish species potentially to be found in SCR have been listed as limited or depleted: blue sucker (Cycleptus elongatus), suckermouth minnow (Phenacobius mirabilis), gray redhorse (Moxostoma congestum), and big scale logperch (Percina macrolepida) (Ref. 16, as quoted in Ref. 11). Of these species, only the gray redhorse was collected in the SCR area (in 1976 and 1977) during the 1975-1979 aquatic-monitoring studies (Ref. 8). Potential habitat for these species is confined to limited areas in this region. The range of all four species extends into this region of Texas, but the blue sucker is uncommon and its capture is unlikely.

The Brazos water snake (Nerodia harteri harteri) is listed as "endangered" by the Texas Parks and Wildlife Department and by the Texas Organization for Endangered Species, but not by the U.S. Fish and Wildlife Service, and may potentially be found in Hood and Somervell Counties (Ref. 10). The U.S. Fish and Wildlife Service has stated that there are no endangered or threatened species, listed or proposed, that would be affected by CPSES operation (Ref. 12).

4.3.5 Historic and Prehistoric Sites

4.3.5.1 Regional Profile

The general region surrounding the plant site is reported to have numerous sites of prehistoric, historic, and ethnohistoric importance (Refs. 17 and 18). This region is included as part of the Southern Plains cultural subarea (Ref. 19), which contains four chronological periods that range from 9000 B.C. until the end of the Historic Period (Refs. 17, 20, and 21). Each period is characterized by select artifacts, site types, and associated cultural patterns (Refs. 17, 20, 21, and 22). By the beginning of the Christian era, many parts of central Texas were abandoned and then later filled by invading groups from the plains and east Texas (Ref. 22).

By the end of the 19th century, homesteads were being established along Squaw Creek as an agricultural and stock-raising economy developed, and the community of Glen Rose grew up in the vicinity of a mill (Ref. 17). It was during this era that the May family purchased land in 1877 along Squaw Creek and began to build the rock house, today known as the May House (Ref. 17). Additions were made to this house and family members built other structures and established a cemetery in the immediate vicinity (Ref. 17). Some of these structures were still being used at the time the station property was purchased.

4.3.5.2 Sites of Federal, State, and Local Concern

A complete inventory of prehistoric, historic, and ethnohistoric cultural resources has not been made for Hood and Somervell Counties, although cultural resources from this area are included in Federal, state, and local registers. The Historic Period homes and buildings that have been evaluated and published in the "National Register of Historic Places" are from Hood County, as of February 1979 (Ref. 23). They are the "Hood County Courthouse Historic District" and the "Wright-Henderson-Duncan House," both in the town of Granbury. This area is also geologically unique because local limestone strata are known to contain the preserved remains of dinosaur tracks of several species (Refs. 17 and 18). The Texas Parks and Wildlife Department maintains Dinosaur Valley State Park for the display of dinosaur tracks and information on the geology-ecology of this era. This park is about 8 km from the station property and is listed in the "National Registry of Natural Landmarks" (ER-CP, Fig. 2.2-5).

State historical markers, sites, and places of interest that are within an 8-km radius of the station site have been identified and listed by the applicant. Among nine sites in the area are Indian battlegrounds, historic buildings, and dinosaur-track locations (ER-CP, Table 2.3-1). The staff has verified the applicant's identification and listing.

Numerous prehistoric sites have also been reported in the areas surrounding the station (Refs. 17 and 18). These sites were identified during surveys of areas that were being developed for water projects, and site descriptions and locations are recorded in local and state archeological files.

4.3.5.3 The Station Site

A complete and systematic survey had been made of the station property to inventory and evaluate cultural resources, and mitigate impacts on them, prior to station and lake construction (Ref. 17). The survey method consisted of walkover by a field crew spaced along 30- to 50-m transect lines (ER-OL, Amend. 1, response to staff question 49). At the time this survey was made, the area had been plowed or contained dry vegetation that had been burned off giving the survey crews good surface exposure of shallow soils.

Fifty-two cultural-resource-site locations are reported to be on the station property (Ref. 17). Ten sites are reported to have historic and Anglo-American components, whereas the other 42 appear to be prehistoric and consist of lithic debris and midden deposits. One additional site has prehistoric materials and is also the location of a historic structure (Ref. 17).

The staff has verified that the current status of the cultural resources is as follows: All prehistoric sites have been throughly explored and their loss mitigated by various methods including excavation and surface pickup during the 1972 and 1974 investigations (ER-OL, Amend. 1, response to staff question 50). All prehistoric sites that remain on the station property are now under the reservoir (Ref. 24), and those sites that were located outside this area were protected from indirect impacts by complete surface pickup and, thus, no longer exist. Cultural materials and records from the survey and excavation phases of this project are permanently cared for at Southern Methodist University, and selected items are being displayed at a public museum in Glen Rose.

However, several historic sites remain on the station property. The May House is well preserved, with historic and architectural importance. It is potentially eligible for inclusion in the "National Register of Historic Places" (Ref. 24) (Sec. 5.6). The existence of other structures of the historic era, such as barns, has been described, recorded, and published (Ref. 17). The Hopewell Cemetery, located on the station boundary, contains gravestones from as early as 1874 and is still in use today. This cemetery is a good example of a late-19th-century cemetery that has not been vandalized or despoiled (Ref. 17).

4.3.6 Socioeconomics

4.3.6.1 Demography

Section 2.2.1 of the FES-CP noted that the population of the State of Texas had grown faster between 1960 and 1970 than that of the United States as a whole (16.9% vs. 13.3%). According to final 1980 U.S. census figures, population growth of Texas from 1970 to 1980 again exceeded U.S. overall growth (27.5% vs. 11.4%). In the 19 counties within 80 km of CPSES, there was a net gain of 19.3% (ER-OL, Table 2.1-1). The two counties in the immediate vicinity of CPSES, Hood and Somervell, increased in population by 165.9% and 46.8%, respectively. Thus it is clear that population has grown in the vicinity during the period of construction (FES-CP, Table 2.2.2). The population living in the area is much greater now than in 1970; thus, there are many more people requiring electricity and incurring environmental impacts that may result from plant operation.

Hood and Somervell Counties had the smallest populations of the 19 counties within 80 km of CPSES in 1970, but have had the largest numbers of relocated CPSES workers and their families living there through most of the construction period (ER-OL, Table 8.1-7). At the peak of construction, in mid-1975, construction workers and their families numbered 1047 in Hood County and 1100 in Somervell County, or 7% and 21% of the total population in Hood and Somervell Counties, respectively. After 1976 the rate of population growth slowed down considerably in Hood County, and population actually declined in Somervell County.

These population changes coincide with the completion of the major portion of the construction phase of CPSES and strongly suggest that many of the relocated workers and their dependents no longer reside in Hood and Somervell Counties. In Hood County, whatever effect the departure of relocated workers might have had is obscured by the continued growth of the county population, although such growth was slower after 1976.

Data supplied by the applicant indicate that even after the workers are no longer employed at CPSES, a percentage of the former CPSES workers and their families continue to live in Hood and Somervell Counties. The applicant estimated that, in July 1976, 52% of such former CPSES workers continued to live in the counties after ending their CPSES employment (ER-OL, Sec. 2.1). If this pattern has persisted, former CPSES workers and their families have contributed about 5% and 42% to the 1970-1980 rate of population growth of Hood and Somervell Counties, respectively.

4.3.6.2 Recreational Uses

SCR is a desirable recreational and water resource in an area where such resources are scarce. However, SCR differs from Lake Granbury, another nearby recreational water resource, even though the volume of water in SCR is about the same as that of Lake Granbury. Lake Granbury is about 20 km long, is narrow and sinuous, and provides easy access to many residential sites with relatively unobstructed lakefront-view lots. In contrast, SCR is about one-third the length of Lake Granbury. Also, unlike Lake Granbury, access to SCR is controlled, because it is within the CPSES site boundary and much of SCR is within the CPSES exclusion area. No private landowners have direct access to SCR (ER-OL, Amend. 1, response to staff question 45).

According to the applicant and the State of Texas, recreational plans for SCR have not been finalized. The applicant anticipates that "...a portion of the property along the eastern shoreline of the reservoir will be made available to a governmental or regulatory agency for development into a public recreational facility" (ER-OL, Amend. 1, response to staff question 69). However, in accordance with NRC regulations concerning exclusion area control access to and use of portions of the reservoir may be restricted.

4.3.6.3 Governmental Organization

County government in both Hood and Somervell Counties is administered by four elected commissioners and an elected county judge. The judge is president of the commissioners' court and chief administrative officer of the county.

Taxes are assessed by local school districts and governmental bodies having jurisdiction only in the county in which the taxed facilities are located. There is no provision in Texas state law for county governments to divert tax revenues paid to them by CPSES facilities to unincorporated areas of the counties. Texas law also prohibits one taxing jurisdiction from transferring tax revenues to another (ER-OL, p. 8.1-11). Accordingly, Glen Rose School District and Somervell County receive the majority of the taxes paid by the applicant (ER-OL, Amend. 1, response to staff question 44), despite the proximity of the station to Hood County. Some taxes are paid by the applicant to the State of Texas.

4.3.6.4 Economy

Much of the income in Hood and Somervell Counties is obtained from raising cattle and farming. Outside this area, most income is generated by employment in the Dallas-Fort Worth metropolitan area. During construction, CPSES provided a major contribution to the income of the local area, primarily through payroll and secondarily through local procurement of construction related materials and equipment such as sand, gravel, cement, reinforcing steel, lumber, fuels, and earth-moving equipment (ER-OL, Amend. 1, p. 8.1-7). During operation, CPSES is expected to be the single largest employer in Hood and Somervell Counties. The applicant projected a total employment of 187 full-time personnel by 1983 (ER-OL, Sec. 8.1.2.2). Based on recent staff experience with other stations, the staff projects a total employment of 450 to 500 full-time personnel for CPSES operation.

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5 ENVIRONMENTAL CONSEQUENCES OF, AND MITIGATING ACTIONS FOR, THE PROPOSED ACTION

5.1 Résumé

As a result of new information gained since the FES-CP was issued in June 1974, increased understanding of environmental issues and new impact assessment methodologies, the staff has reevaluated the environmental impacts of operation of the Comanche Peak Steam Electric Station (CPSES).

As part of the staff's reevaluation, the staff has also considered means to mitigate any adverse environmental impacts. A summary of the staff's revised evaluations of the impacts of station operation on the environment is presented below.

As part of the staff's reevaluation, the following sections have been updated or revised: 5.3 (Water Use and Hydrology), 5.4 (Meteorology and Air Quality), 5.5 (Ecology), 5.6 (Historic and Prehistoric Sites), 5.7 (Socioeconomics), 5.8 (Radiological Impacts), 5.9 (Decommissioning), 5.10 (Emergency Planning), 5.11 (Measures and Controls to Limit Adverse Impacts), and 5.16 (Benefit-Cost Summary).

The staff expects that the use of groundwater resources to supply potable and makeup water (to the demineralized- and makeup-water-treatment systems) will result in more rapid lowering of the water table, and recommends the use of surface water from SCR instead of groundwater (Sec. 5.3.1). New information on floodplain management is presented in Section 5.3.2.

Section 5.3.3 has been revised to consider changes made in the circulating-water-discharge structure.

A revised analysis of expected changes in water quality based on new information on chemical treatment is presented in Section 5.3.4. During the first years of 1 and 2 unit operation at CPSES, the applicant will conduct a chlorine minimization study. During the study, residual chlorine concentrations released to SCR from CPSES will be limited to 0.5 mg/l maximum.

Section 5.4 has been revised to reflect new information on air-quality impacts of station operation and on an analysis of fogging and icing caused by the heated reservoir.

Because there have been no changes in intake design, the staff continues to question effects of the fast flow rates of the circulating-water intake (Sec. 5.5.2). A fish return at the intake has been proposed as the best method of mitigating impingement losses if these are shown to be unacceptably high during initial operation of the station.

With respect to a structure on the site, known as the "May House," the NRC is preparing, in consultation with the Texas State Historic Preservation Officer, a request that a Determination of Eligibility for inclusion in the National

Register of Historic Places be made by the Keeper of the National Register, National Park Service, Department of the Interior (Sec. 5.6).

New information on the socioeconomic impacts of station operation is given in Section 5.7.

Information in Section 5.8.1 has been revised to reflect updated knowledge of radiological impacts of normal operation gained since the FES-CP was issued.

Section 5.8.2 has been revised to reflect updated assessments of environmental impacts of accidents.

Section 5.8.3 includes the latest information on the health effects of the uranium fuel cycle.

Section 5.9 has been updated to include revised estimates of the dollar and environmental costs of decommissioning.

A new section (5.10, Emergency Planning) has been added to reflect new or revised NRC procedures and requirements.

Sections 5.11 and 5.11.2 have been added to discuss changes in plant design and operation to lessen adverse environmental impacts of station operation.

Environmental monitoring programs for CPSES are presented in Section 5.11.3.

A new benefit-cost summary has been prepared (Section 5.16).

5.2 Land Use

Most of the CPSES construction has been completed and the applicant states that the surrounding area will be landscaped. As stated previously, SCR is filled and may become a recreational lake. The access road, railroad spur, pipelines, and transmission lines have been constructed. Most of the ROW has been restored to normal agricultural use.

In the FES-CP (Sec. 5.1), the staff evaluated impacts of operation on land use. With the exception of the uncertainty as to whether SCR will be used for recreational purposes, there is no new information regarding impacts of operation on land use.

5.3 Water Use and Hydrology

5.3.1 Water-Use Impacts

5.3.1.1 Surface Water

The following discussion supplements the description of impacts on surface-water use that appears in the FES-CP (Sec. 5.2.1).

Surface water will be used to supplement groundwater supplies. A reverse-osmosis surface-water-treatment facility with a capacity of 1.14 m^3/min has been constructed onsite. This facility will take water from SCR at the circulating-water intake structure, treat it, and make it available for demineralizer and other uses. It will also be possible to supplement the potable-water supply during periods of high demand. The interaction between this surface-water supply and the groundwater supply is described below.

5.3.1.2 Groundwater

Groundwater levels in north-central Texas have declined steadily in this century and are continuing to decline at rates of 1.5 to 3.0 m/yr (Ref. 1). As discussed below, declines have been somewhat less in Hood and Somervell Counties.

Between 1970 and 1974, groundwater levels measured by the Texas Water Development Board (TWDB) in the two surrounding counties of Hood and Somervell (see Fig. 4.3), showed an average rate of decline of 0.73 m/yr. From 1974 (when pumping began at CPSES) until 1978, the average rate of groundwater decline increased to 1.49 m/yr. However, not all of this increase was due to CPSES pumpage alone. In Hood County, annual municipal and industrial pumpage more than doubled from 1971 to 1975 (Ref. 1). Pumpage is continuing to increase, especially by the City of Granbury, which is located about 16 km north of CPSES. Granbury's annual pumpage increased 60% from 1975 to 1978 (Ref. 1). This trend is also evident in Somervell County. During the same period, the City of Glen Rose, which is located about 8 km south-southwest of CPSES, increased its pumpage rate by about 84% (Ref. 1). These increased pumpage rates have led to an acceleration in the decline of groundwater levels.

To satisfy water demands during construction of the CPSES, significant pumpage of groundwater has occurred. From 1974 to 1978, pumpage from two onsite production wells averaged about 0.59 m^3/min (Ref. 1). From 1975 to May 1979, 1,373,565 m^3 of groundwater were withdrawn by the CPSES. A summary of water use for the years 1975 to 1979 is presented in Table 5.1.

Table 5.1. Summary of Pumpage During CPSES Construction (m^3)

Year	Pumping Well No. 1	Pumping Well No. 2	Total
1975	213,530	67,468	280,998
1976	145,787	174,538	320,325
1977	138,050	130,238	268,288
1978	201,543	162,517	364,060
1979 (Jan-May)	81,938	57,956	139,894
Total	780,848	592,717	1,373,565

At the staff's request, the applicant has been monitoring groundwater levels in the four observation wells onsite since 1975. From 1975 to 1979, the levels declined at an average rate of 2.2 m/yr, as shown in Table 5.2.

Table 5.2. Groundwater-Level Decline in the CPSES Observation Wells

Well	Observation Period	Decline (m)	Rate (m/yr)
OB-1	Apr 75 to May 79	9.08	2.22
OB-2	Apr 75 to May 79	7.22	1.77
OB-3	Jan 75 to Sep 79	7.53	1.62
OB-4	Jun 75 to May 79	12.59	3.23
Average:			2.2

Total pumpage in Somervell County in 1978 was 814,797 m^3 (Ref. 1). During 1978 the CPSES pumped 364,060 m^3, or 45% of the total pumpage. The City of Glen Rose pumped 431,335 m^3 during this time, or 53% of the total. Together, the CPSES and Glen Rose accounted for 98% of the groundwater pumped in Somervell County in 1978. The TWDB estimates that complete postconstruction cessation of pumpage at CPSES would probably only lead to a short-term recovery of water level in the immediate vicinity of the station. However, water-level declines would eventually continue at the regional rate as influenced by other centers of high pumpage, particularly the Cities of Glen Rose and Granbury (Ref. 1).

Operational pumpage at the station is estimated by the applicant to be about 0.48 m^3/min on an average annual basis. The peak station requirement has been estimated by the applicant to be 1.25 m^3/min for short periods. A summary of pumping and drawdown data presented by the applicant in the ER-OL (Sec. 3.3) is presented in Table 5.3.

Table 5.3. Applicant's Summary of Operational Pumping Data†[1]

Pumping Rate (m^3/min)	Duration	Estimated Drawdown at Property Boundary†[2] (m)
0.48	40 years	2.2†[3]
1.25	1 day	1.0†[4]
1.25	3 days	2.2†[4]

†[1] From ER-OL.

†[2] About 1.65 km from the pumped wells.

†[3] Although no estimate was provided by the applicant, its drawdown-distance curves show that at a pumping rate of 0.38 m^3/min, the drawdown would be 2.2 m; at 0.48 m^3/min, it would be greater than 2.2 m (ER-OL, Fig. 2.4-6).

†[4] These estimates differ somewhat from those of the staff.

The applicant has concluded that potentiometric levels (those that would exist in the absence of withdrawals) in the Twin Mountains Formation will be depressed locally due to pumping from production wells, but that there will be no adverse effects from this pumping on the station or on existing offsite wells. The effect of drawdown due to operational pumpage will be minimized by supplemental water supply from the reverse-osmosis surface-water-treatment facility. The applicant has not provided any specifications to define the conditions under which treated surface water will be used to supplement or replace groundwater. An assessment was made for various combinations of treated-surface-water and groundwater usage to identify impacts on the regional groundwater resource.

The maximum drawdown due to station operation would occur if the total demand were met by using groundwater. There would be no drawdown due to station operation if the total demand were satisfied by using treated surface water. During actual station operation, the resulting drawdown will be somewhere between these two extremes. Table 5.4 is a summary of the staff's estimates of drawdown due to using only groundwater or only treated surface water. Also included in the table are several combinations of surface-water and groundwater usage.

Table 5.4. Staff's Summary of Operational Pumping Data for Different Combinations of Groundwater and Treated Surface Water

	Water Demand (m^3/min)			Estimated Drawdown (m)	
Duration	Total	From Ground-Water	From Treated Surface Water	At Property Boundary†[1]	At Nearest Offsite Well†[2]
40 years	0.48	0	0.48	0	0
	0.48	0.11	0.37	0.9	0.8
	0.48	0.19	0.29	1.5	1.3
	0.48	0.48	0	3.7	3.4
1 day	1.25	0.11†[3]	1.14†[3]	0.1	0.1
	1.25	1.25	0	1.1	0.6
3 days	1.25	0.11†[3]	1.14†[3]	0.2	0.1
	1.25	1.25	0	2.0	1.3

†[1] About 1.65 km from the pumped wells.

†[2] About 2.4 km from the pumped wells.

†[3] The maximum capacity of the reverse-osmosis surface-water-treatment facility is 1.14 m^3/min. During periods when peak demand is at a maximum of 1.25 m^3/min, at least 0.11 m^3/min must be supplied from groundwater.

As shown in Table 5.4, pumping groundwater at an average rate of 0.48 m^3/min for 40 years would result in a 3.4-m decline in the groundwater level at the nearest offsite well. Due to regional pumpage there would also be an additional decline, the magnitude of which is not known. However, prior to CPSES pumpage, regional water levels declined about 0.73 m/yr. If this trend continues, water levels due to regional pumpage only (no pumpage by CPSES) would decline 29 m during the 40-year station life.

It is the staff's conclusion that the groundwater-level decline due to the CPSES usage of groundwater as a sole source of water for demineralizer and other uses would not be excessive, possibly only about 10% of the combined decline. However, it would aggravate an already serious regional groundwater-level decline. For this reason, the staff recommends that a condition be imposed in the operating license restricting use of groundwater by CPSES to potable and sanitary purposes and to supplementing the supply of treated surface water during short periods of peak demand when station requirements exceed the capacity of the reverse-osmosis surface-water-treatment plant. Such a restriction on groundwater usage would significantly reduce the impact of CPSES operation on groundwater levels.

5.3.2. Hydrologic Alterations and Floodplain Effects

The CPSES will partially encroach on the floodplain of Squaw Creek. Therefore, an evaluation of the impact on the floodplain was made in accordance with Executive Order 11988 on floodplain management. Station structures located in the floodplain were substantially complete at the time the Executive Order was signed by the president in May 1977. Therefore, it is the staff's conclusion that consideration of alternative locations for those structures identified as being in the floodplain is neither required nor practicable.

Lake Granbury, on the Brazos River, is a source and point of diversion of cooling water for the station. Squaw Creek dam has been constructed onsite to provide storage for water diverted from Lake Granbury. In addition, the safe-shutdown impoundment (SSI) dam has been constructed on an arm of SCR to provide storage for emergency cooling water. Squaw Creek dam is located on Squaw Creek, an intermittent stream that flows into the Paluxy River, which, in turn, flows into the Brazos River downstream of Lake Granbury.

For Lake Granbury, the 1%-chance (100-year) flood level is at 211 m MSL. The floor of the makeup-pump station, located on Lake Granbury, is at 213.4 m MSL; therefore, it will not be affected by the 100-year flood at Lake Granbury.

The 100-year flood level for SCR is 238.0 m MSL. This flood level is 8.9 m below the station grade of 246.9 m MSL; thus, no structures located at that elevation would be affected. The 100-year flood level for the SSI is also about 238 m MSL. Again, no major structures located at station grade would be affected.

Portions of the intake and discharge structures are, by design, located below elevation 238.0 m MSL. These structures have been designed to withstand the flooding effects of a probable-maximum flood (PMF), which is a more severe event than the 100-year flood. The PMF reaches an elevation of 240.7 m MSL, 2.7 m higher than the 100-year flood level. However, due to their design, we conclude that the intake and discharge structures located in SCR will not be affected by flooding caused by the 100-year flood or the PMF.

Construction of Squaw Creek dam and the SSI dam has altered flood flows and levels in Squaw Creek. SCR will reduce the 100-year flood flow below the dam by about 65%; thus, flooding downstream would be reduced (ER-OL Sec. 12.1.1.4).

The applicant has purchased in fee, or has otherwise acquired, flood easements on all property upstream of SCR to an elevation of 240.8 m MSL (ER-OL, Sec. 12.1.1.4). Inasmuch as the 100-year flood level in SCR is at 238.0 m, or 2.8 m below the property-acquisition level, no flooding would occur on property not controlled by the applicant.

Station structures other than the dams in the floodplain will have negligible effect on postconstruction water levels during a flood event. This conclusion is based on the small cross-sectional area of the structures in relation to the area of flow available in the reservoirs. Thus, flood levels will be relatively unaffected by these small flow obstructions.

5.3.3 Thermal-Discharge Impacts

The applicant has performed analyses of the thermal-plume distribution in SCR resulting from heated-water release by the CPSES during operation, and of thermal plume impacts on Lake Granbury. The hydrothermal analyses were reviewed and commented on by the staff, with its evaluation and conclusion presented in the FES-CP (Sec. 5.3). However, since the issuance of the FES-CP in June 1974, the applicant has modified the circulating-water discharge-structure design as described in Section 4.2.2. The impact of this modification to the thermal-plume distribution in SCR is discussed below.

The circulating-water discharge structure at CPSES was designed to produce a low-velocity surface discharge that would yield minimal entrainment of ambient water while providing effective surface heat loss. Theoretical and experimental studies of heated surface discharges have shown that the temperature and shape of the heated discharge is directly related to the densimetric Froude number (jet inertial force/jet buoyancy force), F_0, at the outlet and the aspect ratio (depth/width), A, of the discharge channel (Ref. 2). In general, the results of the studies indicated that the flow entrainment increases with increasing F_0 and A. This, in turn, would mean that the vertical spreading of the jet would increase and the lateral spreading would decrease with increasing F_0 and A.

The circulating water discharge canal has been made deeper and narrower than in the previous design but with cross-sectional areas at corresponding locations in the canal remaining about the same (Sec. 4.2.2). For a given discharge flow and water level in SCR, the present canal design would have a smaller F_0 but a larger A. As previously discussed, these changes would have a certain degree of impact on temperature distribution. The extent of the impact was evaluated by the staff for a maximum circulating-water flow rate of 140 m^3/s and a low water level of 235 m MSL in the SCR. Based on the theoretical calculations and experimental data obtained in the studies of heated surface discharges (Ref. 2), it is believed that the changes in parameters F_0 and A would produce opposing effects on the temperature distribution in SCR. As a result, the difference in expected thermal impacts were found to be insignificant. In addition, the impacts due to the changes in F_0 and A will be limited to the near-field region where the temperature distribution is influenced primarily by conditions at or near the point of discharge. Therefore, the staff concludes that the modifications of the circulating-water discharge canal at the CPSES would result in insignificant changes in the behavior of the thermal plume in SCR and that the applicant's and the staff's hydrothermal analyses, as presented in the FES-CP, remain sound and valid.

In addition to the main reservoir (SCR) used for circulating-water cooling purposes, the applicant has also constructed a safe-shutdown impoundment (SSI), which holds water for emergency cooling and service-water cooling. This secondary reservoir, as described in Section 4.2.2, is separated from the main body of SCR by a rockfill dam. An open "equalization" channel was excavated to connect the SSI with the main reservoir. The floor of the channel is about 15 cm below the low water level in SCR. The applicant has indicated that under normal operating conditions a bleed flow of 0.82 m^3/s will be directed into the service-water intake structure, thereby creating a blowdown flow of about the same amount from the SSI to SCR through the equalization channel.

The use of the SSI to dissipate heat rejected from the station service-water system during normal operation is functionally similar to the use of SCR for circulating-water cooling. Therefore, a hydrothermal analysis of the SSI is required to assess its heat-rejection capabilities and to determine the possibility of hydraulic short-circuiting between the service-water intake and discharge structures. In response to a staff request, the applicant performed a thermal-plume analysis for the SSI in May 1980 under both emergency and normal cooling conditions (Ref. 3). A constant normal heat load of 1.1 million joules per hour (MJ/h) was considered to be transferred to service water flowing at 2.15 m^3/s. This heat addition would raise the water temperature about 3.4°C above the intake-water temperature.

The results of simulating the SSI performance for station normal-operating conditions during a severe meteorological period (1974) indicate that the maximum normal intake temperature will be about 39°C. It is also expected from the results shown that, during these meteorological conditions, the surface-water temperature in the SSI would vary from about 40°C to 35°C. The high water temperature in the SSI is due partly to the excess temperature of the makeup water that was recirculated from SCR to the service-water intake structure in the SSI. The applicant further simulated the temperature variations in the SSI for the most-severe emergency conditions and concluded that the heat-rejection capabilities of the SSI would be sufficient. The staff has reviewed the applicant's analyses and believes that the calculations based on the model represent conservative estimates of the maximum thermal effects to be expected from discharge of heated outflow into the SSI.

The staff further examined the potential effects on water temperature in the SSI due to a possible thermal-wedge intrusion of the warm water in the Panther Branch arm of SCR through the equalization channel. The analysis was made for an SCR elevation of 236 m MSL, a net flow out of the SSI of 0.82 m^3/s, and a water-temperature difference of 1.7°C between SCR and the SSI. Under these conditions, the analysis indicated that the thermal wedge just barely reaches the SSI end of the equalization channel as a thin layer of warm water. Therefore, the SSI temperature would not be affected by SCR. Moreover, the applicant indicated that the normal operating water level of the SSI and the Panther Branch would be 235.5 m rather than 236 m MSL. This lower water level would reduce the channel cross section, which would increase the SSI outflow velocity, thereby decreasing the depth and hence the horizontal pressure gradient due to density at the mouth of the channel. These changes would help to reduce the thermal-wedge length intruding into the equalization channel. However, for extreme low-flow conditions from the SSI, or a larger temperature difference between SCR and the SSI, a thermal wedge may extend into the SSI. The effect on temperature would depend on the amount of heat convected into the SSI by the wedge. Because the wedge would appear only as a thin layer, the intruded heat from SCR would be a small fraction of the normal service-water heat and would probably be quickly dissipated to the atmosphere. Therefore, the staff concludes that the thermal-wedge intrusion, if any, would not have significant effect on the water temperature in the SSI.

5.3.4 Water-Quality Impacts

The description of CPSES operation as it relates to compliance with water-quality standards presented in the FES-CP (Sec. 5.2), remains valid. The water quality impacts resulting from the changes described in Sec. 4.2.4 are discussed below.

5.3.4.1 Squaw Creek Reservoir

As described in Section 4.2.4, wastes discharged into SCR during CPSES operation are chlorides, residual chlorine, sodium hexametaphosphate, copper salts, and treated sanitary wastes.

The applicant will perform a chlorine-minimization study during the first year of operation of each unit. Based on a simulation of chlorine residuals expected under operating conditions, the applicant is committed to restricting chlorine in the discharged circulating water to a maximum total residual chlorine (TRC) concentration of 0.5 mg/L during the minimization study (Refs. 4 and 5). This level will satisfy the Federal effluent-limitations (NPDES permit, App. E of this environmental statement).

Sodium hexametaphosphate will be released into the circulating-water system from the reverse-osmosis unit. The resulting concentration in the circulating water is calculated by the staff to be less than 1 μg/L. Further dilution in SCR will result in undetectable levels.

Based on copper loading estimates provided by the applicant (Sec. 4.2.4.5), the staff estimates the concentration of copper in SCR for a short period following startup to be 16 μg/L; and for subsequent operation, a steady state concentration to be 2 μg/L, based on complete mixing in the entire reservoir. However, as shown in the FES-CP (Fig. 3.4.1), much of the reservoir will not be used for mixing. Most of the mixing occurs in the area between the circulating-water discharge and intake structures. For this reason, higher concentrations are expected in the mixing area. The EPA criterion for protection of freshwater aquatic life for total recoverable copper is 5.6 μg/L (24-hour average) and, based on the minimum hardness value expected for the water in SCR, should not exceed 72 μg/L at any time (Ref. 6). Based on the above, the staff concludes that the estimated steady-state copper concentration will meet the EPA criterion for total recoverable copper at the point where blowdown from SCR enters Lake Granbury.

Sanitary wastes are treated by extended aeration and chlorinated for disinfection. The process should reduce BOD_5 and suspended-solids concentrations by 80% to 90%. Prior to discharge to SCR, the effluent (19 m^3/d) will be diluted by the circulating flow (12 million m^3/d). Thus, the load of BOD_5 and suspended solids should not be measurable.

5.3.4.2 Lake Granbury

The description of impacts related to blowdown from SCR to Lake Granbury, presented in the FES-CP (Sec. 3.6.1.1 and Sec. 5.3), remains valid.

5.3.4.3 Lower Squaw Creek

The applicant is committed to maintaining a continuous flow of 0.04 m^3/s in Squaw Creek below the reservoir. The flow will be maintained by diverting a portion of the flow from the Lake Granbury makeup line for SCR. Prior to construction of Squaw Creek dam, streamflow was intermittent. The continuous releases during CPSES operation will reduce erosion and scouring associated with floods. A comparison of the chemical analyses from lower Squaw Creek and Lake Granbury indicates that there should be no detectable water-quality impact from diversion of flow to lower Squaw Creek (ER-CP, Sec. 4.1.2.4 and App. D).

5.3.4.4 Groundwater

The evaporation-pond bottom and sides are lined with a relatively impervious clay; the permeability is about 1 nm/s (ER-OL, Amend. 1, response to staff question 57). Infiltration into the bedrock aquifers is further impeded by the low permeability of the rock and soils in the site area (ER-OL, Sec. 2.4). Thus, if the integrity of the liner is maintained, the impact on groundwater quality due to CPSES operation will be negligible.

5.4 Meteorology and Air Quality

5.4.1 Fog and Ice

Air passing over SCR under most meteorological conditions will be warmer, more humid, and less stable than surrounding air. In periods of very cool weather, part of the moisture evaporated from SCR will immediately recondense as steam fog over and close to the edge of the reservoir. Observations at cooling ponds in winter indicate that this steam fog is thin, wispy, and in constant turbulent motion, and that it becomes less dense and quickly reevaporates as it moves inland (Ref. 7). During periods of below-freezing temperatures, part of the moisture will freeze onto vegetation, poles, wires, and other elevated objects as light, friable, very low-density rime ice (Ref. 7). The staff expects frequent fogging over the warmer parts of SCR and some low-density icing of trees and other elevated objects within 100 to 200 m of the water's edge in winter. No dense fog or icing is expected to occur on offsite roads.

The effect of the warm water in SCR on local offsite air temperatures and humidity will be very small (Ref. 7).

5.4.2 Emissions and Dust

Combustion-exhaust gases will be discharged to the atmosphere during operation and testing of four 9-MW (12,000-hp) diesel-driven emergency generators and one fire pump (ER-OL, Sec. 3.7.4 and FES-CP Table 3.7.1). Testing procedures for each diesel engine are carried out once per month for a two-hour period. The Texas Air Control Board has determined that the emissions from these engines are exempted from permit procedures under Standard Exemption No. 5 (Ref. 8).

Another source of air pollution during station operation will be fugitive dust from vehicle movement. The applicant will pave (or has paved) all parking lots and all roads having more than 100 vehicle traversals daily, in compliance with applicable State of Texas standards (ER-OL, Amend. 1, response to staff question 5).

The staff agrees with the Texas Air Control Board that CPSES operation will be in compliance with applicable Federal and state air-quality standards (Ref. 8).

5.5 Ecology

5.5.1 Terrestrial

The terrestrial impacts of construction and operation of the CPSES have been considered in the FES-CP (Sec. 5.5.1) and the ER-OL. No recommendations addressing mitigation of terrestrial impacts were made as a result of the construction-phase monitoring.

The staff, based on information in the terrestrial monitoring annual reports prepared by the applicant and other sources such as the site visit, concludes that the analysis of impacts of operation of CPSES on the terrestrial ecology presented in Section 5.5.1 of the FES-CP remain valid.

The staff has reviewed the information on the effect of CPSES operation on endangered species (Section 4.3.4.1) and concludes that the operation of CPSES will not impact endangered species in Hood and Somervell Counties. This conclusion is in agreement with that reached by the U.S. Fish and Wildlife Service.

The staff has examined the information on the impact of CPSES operation on the terrestrial ecology of the transmission line rights-of-way and concludes that the analysis in Section 5.1.2 of the FES-CP remains valid.

5.5.2 Aquatic

Operation of CPSES will affect SCR and Lake Granbury directly, and may have indirect effects on lower Squaw Creek and the Brazos and Paluxy Rivers as a result of the effects on SCR and Lake Granbury. A summary of the water exchange between SCR and Lake Granbury is presented in Section 4.2.2 and in the ER-OL (Sec. 5.1). The potential environmental impacts of CPSES operation on aquatic biota in SCR and Lake Granbury are discussed below.

5.5.2.1 Total Dissolved Solids

The predicted level of total dissolved solids (TDS) in SCR of 2400 mg/L is stated by the applicant to be within the range tolerated by Texas fish populations (ER-OL, Sec. 5.1). For example, state fish hatcheries derive water from Lake Possum Kingdom and Diversion Reservoir, which at times have had TDS concentrations in excess of 3500 mg/L. Despite this high level of TDS, successful spawning and growth of native species of game fish were reported to have occurred (ER-OL, Sec. 5.1). Therefore, the staff concurs that the predicted level of TDS should not adversely affect fish in SCR and Lake Granbury. The staff has calculated that copper released to SCR as a result of station operation would average 2 μg/L (Sec. 5.3.4.1). This is in agreement with the applicant's figures (ER-OL, Amend. 1, response to staff question 62). The staff concludes that these levels do not present a problem inasmuch as preconstruction concentration was found to be as high as 4 μg/L (FES-CP, Sec. 3.6.1.1).

5.5.2.2. Discharge Effects

The thermal impact of the discharged circulating water was discussed in the FES-CP (Sec. 5.5.2.1 and Table 5.3.6) and the description of the thermal impact remains valid.

The potential impact on the plankton population in SCR of makeup water diverted from Lake Granbury, described in the ER-CP (Secs. 5.1.4.1. and 5.1.4.2) and the FES-CP (Sec. 5.5.1), remains valid.

5.5.2.3 Impingement and Entrainment

In the FES-CP, the staff questioned the potential effects of impingement and entrainment on fish populations in SCR as a result of the relatively high circulating-water intake velocity. The applicant responded on July 28, 1978 in a report that evaluated the expected effect and the alternatives for mitigating the damage, based on information from various Texas reservoirs operated in connection with other power plants (Ref. 9). Although no details were given on the intake structures or the flow rates for any of these plants, the report states that rough fish (primarily shad) could be expected to make up about 85% of impinged fish and that the majority of impinged fish will be in a moribund condition or dead. Similar results were reported in 24 of 32 Texas power plants at which sampling was conducted for at least one year. This high impingement loss was believed to have occurred during conditions of low water temperature (below 15°C), to which shad are especially susceptible. The applicant's report stated that equilibrium loss resulting from low-temperature (cold) stress rendered the shad unable to avoid impingement. The staff concludes that a relatively high impingement loss may not significantly affect the population of shad in SCR, considering the explosive reproductive potential of these species. Although reported fish-impingement studies (Ref. 9) suggest that shad is the predominant fish at risk, newly stocked game fish may become increasingly dominant and at risk as the reservoir population ages.

There has been no change in the intake design since the FES-CP was issued. Therefore, the staff again questions the effect of the relatively high intake velocities at the circulating-water intake screens, as given in Table 5.5. The values of 0.28-0.31 m/s at the trash racks, depending on water level, are considered high; present EPA-recommended rates are at or below 0.15 m/s. The volume of flow when the two units are operating (140 m^3/s) is also high. In addition to the intake-structure design and the rapid flow rates, the amount of impingement will be related to the number of fish in the intake area. The circulating-water intake is located in a cove in SCR into which fish might congregate, but it is only one of many similar coves along this region of the shore and for this reason is not expected to contain a unique population of fish or other biota.

Table 5.5. Velocities in the Circulating-Water Intake Structure†1†2

	Flow Velocity (m/s)	
Location	Water Surface 235 m	Water Surface 236 m
Through trash racks	0.31	0.28
Screen approach	0.33	0.30
Through traveling screens	0.75	0.66

†1 Adapted from the ER-OL (Table 3.4-2).

†2 Constant parameters: 100% load factor, eight pumps in operation, and 8.3°C temperature rise through the condenser.

The NPDES permit (App. E), issued by EPA, requires a monitoring program that will provide data to be used to determine the impact of the circulating water intake structure during CPSES operation. This program is being implemented under the provisions of Section 316(b) of the Clean Water Act, which requires that the location, design, construction, and capacity of cooling water intake structures reflect the best available technology for minimizing environmental impact. This monitoring program will begin after the second unit at the site becomes operational. The plan includes impingement sampling performed for a 24-hour period on a weekly basis for an entire year and ichthyoplankton entrainment sampling for a 24-hour period on a weekly basis during the months of February through July (Refs. 10 and 11). In the absence of changes in intake design since the FES-CP issuance, and of information on fish populations in SCR during operation, the staff concludes that evaluation of the aquatic impact of station water withdrawal must await results of the monitoring studies of the NPDES permit, as outlined above. Monitoring of impingement rates after startup will determine the game-fish losses, and with adequate population sampling in SCR, the significance of these losses can be determined.

5.5.2.4 Makeup Water Diversion

In the FES-CP, the staff recommended a larval-fish sampling study near the area of the diversion intake (makeup water) in Lake Granbury to determine whether the area provides important spawning or nursery sites for fish. The applicant conducted this study in 1978 over a period of maximum spawning for most fish in Lake Granbury. Weekly samples, taken between April 17, 1978 and June 28, 1978, indicated little spawning activity in the area of the diversion intake (Ref. 12), presumably due to the unfavorable bottom habitat (predominantly mud). On the basis of this information, the staff concludes that the diversion intake will not adversely affect fish populations in Lake Granbury

5.6 Historic and Prehistoric Sites

Operational impacts on cultural resources and the grounds surrounding them may be direct or indirect. At this time, the staff has not identified any direct impacts of station operation on historic properties. However, indirect impacts on historic properties may occur such as the unauthorized collection of parts of the structures, vandalism, and weathering and aging of unmaintained structures.

The State of Texas required that the applicant prepare quality drawings and photographic records of the May House prior to restoration, adaptation, or disposal (Ref. 13). To mitigate the potential impacts on the May House and any other historic buildings that remain on the site, the applicant should, in consultation with the Texas State Historic Preservation Officer, provide for a monitoring and protection program of this structure and any other historic buildings that remain on the site. With respect to the May House, the NRC staff, in consultation with the Texas State Historic Preservation Officer, intends to submit a request to the keeper of the National Register of Historic Places, National Park Service, U.S. Department of the Interior, for a Determination of Eligibility for inclusion of the May House in the National Register of Historic Places. Until this determination is made, the applicant should protect the structure as though it were included in the National Register of Historic Places.

5.7 Socioeconomics

5.7.1 Local Economy

When fully operating, CPSES expects to employ 187 full-time operation workers, nearly three times the number originally projected (Section 5.5.2, FES-CP; Table 8.1-17, ER-OL). Despite this increase, from 1978 to 1982 the CPSES payroll will have decreased 75% because of the termination of a much larger number of construction workers as construction is completed (Table 8.1-16, ER-OL). The CPSES payroll will therefore represent a much smaller percentage of the local economy than at the peak of construction. The effects of the reduction of the construction work force and payroll is likely to be felt most in Hood and Somervell Counties because relatively large numbers of the CPSES construction workers and their families have been living in those counties (see Sec. 4.3.6.1). This resident construction work force was about equally distributed between the two counties. About 70 of the 187 operation workers are expected by the applicant to settle in these counties (Table 8.1-17, ER-OL). Assuming the same distribution of the resident operation work force between the two counties as for the resident construction work force, then CPSES payroll income for operation workers residing in each will be about $0.9 million/yr compared to about $12.5 million at the peak of construction in 1976 (Tables 8.1-16 and 8.1-17, ER-OL). As indicated in Section 4.3.6, the staff projects the number of full-time operation workers to be about 2½ times greater than the applicant projects; therefore, the impacts on the economy will vary accordingly. Clearly, the economies of both counties will lose a considerable amount of CPSES payroll income as the transition from plant construction to operation is completed. This loss should be mitigated to some extent by the gradual nature of the transition (Tables 8.1-16 and 8.1-17, ER-OL), the substantial CPSES property tax benefits to accrue to Somervell County (see Sec. 5.7.2), the continuing population and economic growth in Hood County, and the proximity of the two counties to the Dallas-Fort Worth metropolitan area, which has been experiencing rapid population growth and economic development in recent decades (see Sec. 4.3.6.1).

5.7.2 Tax Benefits

Section 8.1.2.3 of the ER-OL discusses the substantial property taxes to be paid on the station when it is fully operating and also discusses the much more modest Federal income taxes, state and local sales taxes, and local property taxes eventually to be paid by CPSES full-time operating personnel. It is clear from data presented in the ER-OL (Sec. 8.1) that the preponderant share of the property taxes paid on the station (93%) is likely to accrue to Somervell County and its Glen Rose School District. Hood County and its Granbury and Tolar school districts, hospital district, library, and road fund are likely to receive about 4%, and the State of Texas about 3%, of these CPSES property tax payments. However, Hood and Somervell Counties should benefit about equally from local sales taxes if, as was the case during CPSES construction, about an equal number of operating workers and their families live in each county (Table 8.1-7, ER-OL). Hood should benefit somewhat more than Somervell from property taxes paid by CPSES operating workers because its property tax rate is about 60% higher than Somervell's (ER-OL, Sec. 8.1).

In effect, Somervell County is apt to experience a tax windfall during the life of CPSES because it will receive the larger share of the property tax payments on the station. The tax payment to Hood County and the State of Texas are likely to be quite small.

5.7.3 Recreational Impacts

Although recreational activities at SCR will be controlled and limited, the reservoir should add to the recreational resources available in Hood and Somervell Counties. An aquatic habitat is to be established in the reservoir (Sec. 8.1.2.4.2, ER-OL) and public viewing of the lake will be possible at the visitors' overlook (Fig. 2.1.2, ER-OL). It is likely that additional public access to the lake will be provided through rights-of-way permitted by the applicant for transient public accommodations.

5.7.4 Community Services and Institutions

Inasmuch as the CPSES operating work force is expected to be much smaller than the construction work force (Tables 8.1-16 and 8.1-17, ER-OL) there should be much less demand in the CPSES region for housing, fire and police protection, education, water, sewerage, and other community services during station operation than at the peak of construction. The operating workers and their families should be able to benefit from the great variety of services and facilities, both public and private, available in the Dallas-Fort Worth metropolitan area, including a good supply of different types of housing.

The availability of community services is likely to be somewhat more limited in Hood and Somervell Counties than in the CPSES region generally, but services should be adquate for the needs of the relatively few operation workers and families that are expected to live in the two counties (see Sec. 5.7.1). If, as estimated by TUGCO in 1976, about half the construction workers and their families who move to these counties for CPSES employment leave after termination of employment (ER-OL, Sec. 2.1) as construction gradually ends, there should be enough housing available to meet the needs of the operation workers and their families at least initially. Because of its very large share of CPSES property taxes, Somervell County should not have difficulty expanding its public services, if needed (see Sec. 5.7.2). Texas law bars a county from sharing its tax revenues with unincorporated areas in the county or with other counties, so Somervell County cannot share its windfall CPSES property taxes with Hood County. The staff concludes that the operation of CPSES is not likely to adversely affect community services and institutions in the area.

5.8 Radiological Impacts

5.8.1 Normal Operation

5.8.1.1 Exposure Pathways

The enviromental pathways considered in this section are shown in Figure 5.1. The specific pathways evaluated were:

1. Direct radiation from the plant
2. Gaseous effluents
    a. Immersion in the gaseous plume
    b. Inhalation of iodines and particulates
    c. Ingestion of iodines and particulates through the milk-cow, goat, meat-animal, and vegetation pathways
    d. Radiation from iodines and particulates deposited on the ground
3. Liquid effluents
    a. Drinking water
    b. Ingestion of fish
    c. Shoreline activities, boating, and swimming in water containing radioactive effluents

Only those pathways associated with gaseous effluents that were reported to exist at a single location were combined to calculate the total exposure to a maximally exposed individual. Pathways associated with liquid effluents were combined without regard to location but were assumed to be associated with a maximally exposed individual other than the individual associated with gaseous-effluent pathways.

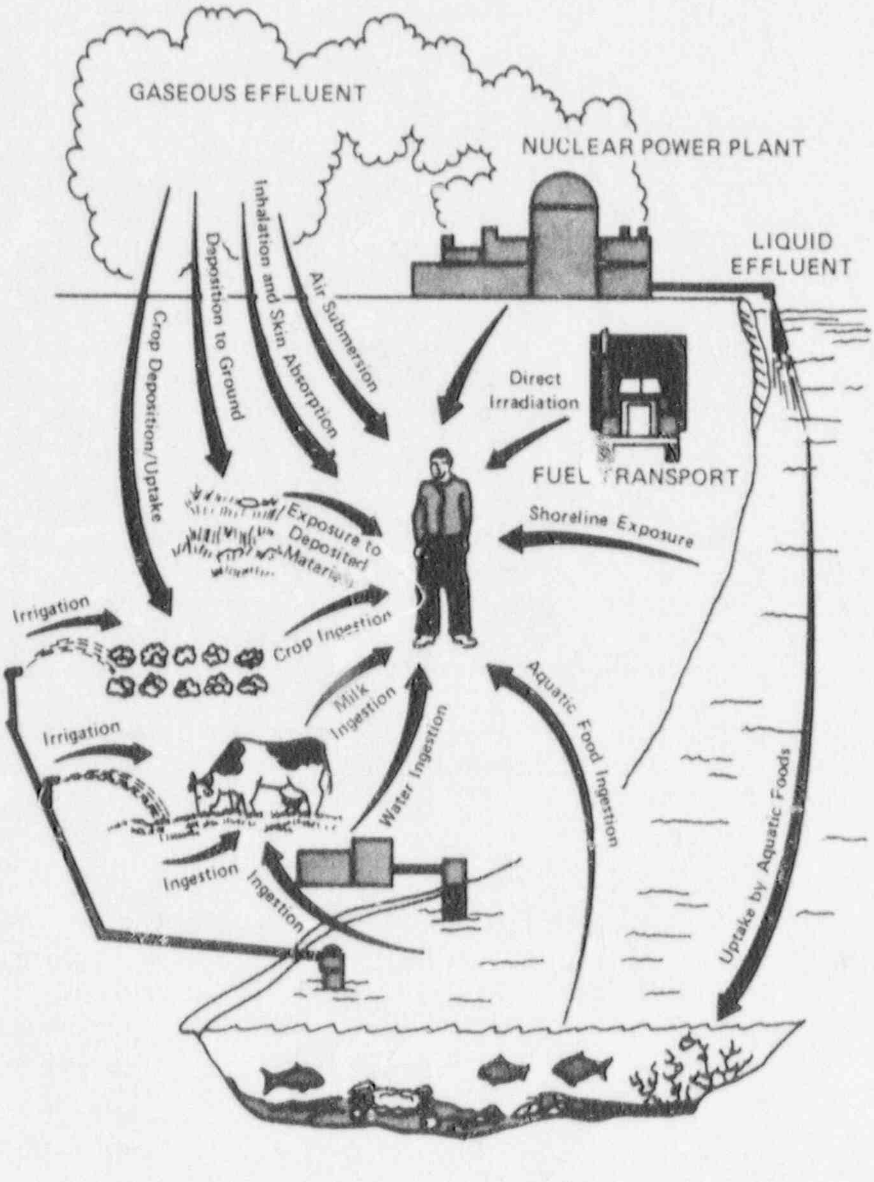

Figure 5.1. Exposure Pathways to Man.

The models and considerations for environmental pathways leading to estimates of radiation doses to individuals near the station and to the population within an 80-km radius of the station, resulting from station operation, are discussed in detail in Regulatory Guide 1.109. Use of these models, with additional assumptions for environmental pathways leading to exposure to populations outside the 80-km radius, is described in Appendix B.

5.8.1.2 Dose Commitments

General Population

The quantities of radioactive material that may be released annually from the station are estimated based on the description of the radwaste systems given in the ER-OL (Sec. 3.5) and the Final Safety Analysis Report using the calculational model and parameters described in NUREG-0017 (Ref. 14). The applicant's site and environmental data provided in the ER-OL and in subsequent answers to staff questions (ER-OL, Amend. 1) are used extensively in the dose calculations. Using these quantities of radioactive materials released and exposure-pathway information, the dose commitments to individuals and the population are estimated. Population doses are based on the projected population distribution in the year 2020.

The dose commitments given in this environmental statement represent the total dose received over a period of 50 years following the intake of radioactivity for one year under the conditions existing 15 years after the station begins operation. For younger age groups, changes in organ mass with age after the initial intake of radioactivity are accounted for in a stepwise manner.

In the analysis of all effluent radionuclides released from the station, tritium, carbon-14, and strontium were found to account for essentially all total-body dose commitments to individuals and the population within 80 km of the station.

Dose Commitments from Radioactive Releases to the Atmosphere

Radioactive effluents released to the atmosphere from CPSES will result in small radiation doses to individuals and populations. The NRC staff estimates of the expected gaseous and particulate releases listed in Table 5.6, and the site meteorological considerations discussed in Section 4.3.3 and summarized in Table 5.7, were used to estimate radiation doses to individuals and populations. The results of the calculations are discussed below.

Radiation Dose Commitments to Individuals. Individual receptor locations and pathway locations considered for the maximum individual are listed in Table 5.8. The estimated dose commitments to the maximum individual from radioiodine and particulate releases at selected offsite locations, and the maximum annual beta and gamma air doses and maximum total-body and skin doses to an individual at the maximum site boundary, are presented in Tables 5.9, 5.10, and 5.11. The maximum individual is assumed to consume well-above-average quantities of the foods considered (see Table E-5 in Regulatory Guide 1.109).

Radiation Dose Commitments to Populations. The estimated annual radiation-dose commitments to the population within 80 km of CPSES from gaseous and particulate releases are shown in Tables 5.10 and 5.11. Beyond 80 km the doses were evaluated using average population densities and food-production values as

Table 5.6 Calculated Releases of Radioactive Materials in Gaseous Effluents from CPSES Units 1 and 2 (Ci/yr per reactor)

	Unit Vent		Turbine-Bldg Vent	
Nuclides	Continuous	Periodic†[1]	Continuous	Total
Ar-41	25	†[2]	†[2]	25
Kr-83m	†[3]	†[3]	†[3]	†[3]
Kr-85m	3	2	†[3]	5
Kr-85	†[3]	260	†[3]	260
Kr-87	1	†[3]	†[3]	1
Kr-88	7	2	†[3]	9
Kr-89	†[3]	†[3]	†[3]	†[3]
Xe-131m	†[3]	11	†[3]	11
Xe-133m	3	19	†[3]	22
Xe-133	180	1900	†[3]	2100
Xe-135m	†[3]	†[3]	†[3]	†[3]
Xe-135	10	10	†[3]	20
Xe-137	†[3]	†[3]	†[3]	†[3]
Xe-138	†[3]	†[3]	†[3]	†[3]
Total, noble gases				2400
Co-60	1.8(-4)†[4]	4.5(-3)	†[2]	4.7(-3)
Co-58	6.0(-5)	1.5(-3)	†[2]	1.6(-3)
Fe-59	6.0(-4)	1.5(-2)	†[2]	1.6(-2)
Mn-54	2.7(-4)	7.0(-3)	†[2]	7.3(-3)
Cs-137	1.3(-5)	3.3(-4)	†[2]	3.4(-4)
Cs-134	2.4(-6)	6.0(-5)	†[2]	6.2(-5)
Sr-90	1.8(-4)	4.5(-3)	†[2]	4.7(-3)
Sr-89	3.0(-4)	7.5(-3)	†[2]	7.8(-3)
Total, particulates				4.3(-2)
I-131	7.2(-3)	2.0(-4)	1.6(-4)	7.6(-3)
I-133	1.0(-2)	2.4(-4)	2.3(-4)	1.1(-2)
C-14	8	†[2]	†[2]	8
H-3	1100	†[2]	†[2]	1100

†[1] Periodic increase in releases 24 times per year for 2 hours duration.

†[2] Less than 1% of total for nuclide.

†[3] Less than 1.0 Ci/yr.

†[4] Exponential notation: 1.8(-4) = 1.8×10^{-4}.

Table 5.7 Summary of Atmospheric Dispersion Factors and Deposition Values for Maximum Site Boundary and Receptor Locations near CPSES†[1]

Location †[2]	χ/Q (s/m^3)†[3]	Relative Deposition (m^{-2})
Site boundary (NNW, 1.29 mi)†[4]	3.64(-6)†[5]	
Nearest residence (W, 1.55 mi)	8.64(-7)	2.07(-9)
Nearest garden (W, 1.55 mi)	8.64(-7)	2.07(-9)
Nearest milk cow (WNW, 1.89 mi)	7.91(-7)	2.33(-9)
Nearest milk goat (N, 3.37 mi)	3.32(-7)	1.52(-9)
Nearest meat animal (ESE, 2.12 mi)	4.11(-7)	8.61(-10)

†[1] Values are corrected for radioactive decay and cloud depletion from deposition, where appropriate, in accordance with Regulatory Guide 1.111, Rev. 1, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light Water Reactors," July 1977.

†[2] "Nearest" refers to that type of location where the highest radiation dose is expected to occur from all appropriate pathways.

†[3] Annual average atmospheric relative concentrations (χ/Q) were computed using the onsite meteorological data for May 15, 1972 to May 15, 1976. The analysis was done with a constant mean wind-direction model according to the guidance provided in Regulatory Guide 1.111.

†[4] To convert to km, multiply by 1.6093.

†[5] Exponential notation: $3.64(-6) = 3.64 \times 10^{-6}$.

Table 5.8 Receptor and Pathway Locations Considered for Selecting Maximum-Individual Dose Commitments

Location	Sector	Distance (mi)†[1]
Site boundary†[2]	NNW	1.29
Residence	W	1.55
Garden	W	1.55
Milk cow	WNW	1.89
Milk goat	N	3.37
Meat animal	ESE	2.12

†[1] To convert to km, multiply by 1.6093.

†[2] Beta and gamma air doses and total-body and skin doses from noble gases are determined at the site boundary.

Table 5.9 Annual Dose Commitments to a Maximum Individual near CPSES

Location†[1]	Pathway	Dose (mrem/yr per unit)						
		Total Body	Skin	Thyroid	Bone	Liver	Kidney	Lung
Noble Gases in Gaseous Effluents								
Site boundary†[2] (NNW, 1.29 mi)†[3]	Direct radiation from plume†[4]	0.075	0.19					
Iodine and Particulates in Gaseous Effluents								
Nearest site boundary (NNW, 1.29 mi)	Ground deposit	0.057		0.057	0.057			
	Inhalation	0.17		0.18	0.051			
	Total	0.23(T)†[5]		0.24(T)	0.11(T)			
Nearest garden and residence (W, 1.55 mi)	Ground deposit	0.008		0.008	0.008			
	Inhalation	0.046		0.045	0.013			
	Vegetable consumption	0.43		0.33	1.3			
	Total	0.48(C)		0.38(C)	1.3(C)			
Nearest milk cow (WNW, 1.89 mi)	Ground deposit	0.0089		0.0089	0.0089			
	Inhalation	0.038		0.042	0.012			
	Vegetable consumption	0.42		0.31	1.3			
	Cow-milk consumption	0.14		0.21	0.43			
	Total	0.61(C)		0.57(C)	1.8(C)			
Nearest milk goat (N, 3.37 mi)	Ground deposit	0.0058		0.0058	0.0058			
	Inhalation	0.017		0.011	0.0051			
	Vegetable consumption	0.21		--	0.70			
	Goat-milk consumption	0.093		0.29	0.22			
	Total	0.33(C)		0.31(I)	0.93(C)			
Nearest meat animal (ESE, 2.12 mi)	Ground deposit	0.0033		0.0033	0.0033			
	Inhalation	0.02		0.022	0.0063			
	Vegetable consumption	0.2		0.016	0.62			
	Meat consumption	0.018		0.018	0.063			
	Total	0.24(C)		0.059(C)	0.69(C)			
Liquid Effluents (adults)								
Nearest drinking water at SCR	Water ingestion	0.64		0.63	0.02	0.65	0.63	0.62
Nearest fish at SCR	Fish ingestion	1.23		0.02	1.02	1.65	0.58	0.20

†[1] "Nearest" refers to the location where the highest radiation dose to an individual from all applicable pathways has been estimated.

†[2] Refers to the site-boundary location where the highest radiation doses due to gaseous effluents have been estimated to occur.

†[3] To convert to km, multiply by 1.6093.

†[4] Gamma and beta air doses (mrad/yr per unit) at the site boundary are 0.12 and 0.28, respectively.

†[5] Doses are for the age group that results in the highest dose: T = teen, C = child, I = infant.

Table 5.10 Calculated Dose Commitments to a Maximum Individual and the Population from CPSES Operation†1

Maximum-Individual Doses

	Appendix I Design Objective	Calculated Dose
	Annual Dose per Reactor Unit	
Liquid effluents		
Dose to total body from all pathways	3 mrem	1.9 mrem
Dose to any organ from all pathways	10 mrem	2.3 mrem (liver)
Noble-gas effluents (at site boundary)		
Gamma dose in air	10 mrad	0.12 mrad
Beta dose in air	20 mrad	0.28 mrad
Dose to total body of an individual	5 mrem	0.08 mrem
Dose to skin of an individual	15 mrem	0.19 mrem
Radioiodine and particulates†2		
Dose to any organ from all pathways	15 mrem	1.8 mrem (bone, child)

Population Doses Within 80 km

	Total Body	Thyroid
	Annual Dose for Both Units (person-rem)	
Natural-background radiation†3	150,000	
Liquid effluents	41	70
Noble-gas effluents	0.38	0.38
Radioiodine and particulates	8.44	8.86

†1 Appendix I design objectives from Sections II.A, II.B, II.C, and II.D of Appendix I, 10 CFR Part 50; considers doses to maximum individual and population per reactor unit. From 40 FR 19442, 5 May 1975.

†2 Carbon-14 and tritium have been added to this category.

†3 "Natural Radiation Exposure in the United States," U.S. Environmental Protection Agency, ORP-SID-72-1, June 1972; using the average background dose for Texas of 74 mrem/yr, and year-2020 projected population of 2,080,000.

Table 5.11 Calculated Dose Commitments to a Maximum Individual and Activity Releases from Operation of CPSES Units 1 and 2†[1]

	Annual Dose per Site	
	RM-50-2 Design Objective	Calculated
Liquid effluents		
Dose to total body or any organ from all pathways	5 mrem	4.6 mrem
Activity-release estimate, excluding tritium (Ci/unit)	5	0.16
Noble-gas effluents (at site boundary)		
Gamma dose in air	10 mrad	0.24 mrad
Beta dose in air	20 mrad	0.56 mrad
Dose to total body of an individual	5 mrem	0.16 mrem
Radioiodine and particulates†[2]		
Dose to any organ from all pathways	15 mrem	3.6 mrem
I-131 activity release (Ci/unit)	1	0.062

†[1] Guides on design objectives proposed by the NRC staff on 20 February 1974. Considers doses to individuals from all units on site. From "Concluding Statement of Position of the Regulatory Staff," Docket No. RM-50-2, 20 February 1974, pp. 25-30, U.S. Atomic Energy Commission. Also published as Annex to Appendix I to 10 CFR Part 50.

†[2] Carbon-14 and tritium have been added to this category for the purpose of dose estimates, but not included in the "activity release" category.

discussed in Appendix B. Estimated dose commitments to the U.S. population are shown in Table 5.12. Background-radiation doses are provided for comparison. As shown in the table, the dose commitments from atmospheric releases from CPSES during normal operation represent a small increase in the normal population dose due to background-radiation sources.

Dose Commitments from Radioactive-Liquid Releases to the Hydrosphere.

Radioactive effluents released to the hydrosphere from CPSES during normal operation will result in small radiation doses to individuals and populations. Staff estimates of the expected liquid releases listed in Table 5.13, and the site hydrological considerations discussed in Section 4.3.2 and summarized in Table 5.14, were used to estimate radiation-dose commitments to individuals and populations. The results of the calculations are discussed below.

Radiation Dose Commitments to Individuals. The estimated dose commitments to the maximum individual from liquid releases at selected offsite locations are listed in Tables 5.9, 5.10, and 5.11. The maximum individual is assumed to consume well-above-average quantities of the foods considered and spend more time at the shoreline than the average person (see Table E-5 in Regulatory Guide 1.109).

Radiation Dose Commitments to Populations. The estimated annual radiation-dose commitments to the population within 80 km of CPSES from liquid releases are shown in Tables 5.10 and 5.11. Dose commitments beyond 80 km were based on the assumptions discussed in Appendix B. Estimated dose commitments to the U.S. population are shown in Table 5.12. Background-radiation doses are provided for comparison. As shown in the table, the dose commitments from liquid releases from CPSES during normal operation represent a small increase in the normal population dose due to background-radiation sources.

Dose Commitments from Direct Radiation

Radiation fields are produced within the station as a result of radioactivity contained within the reactor and its associated components. Direct radiation from sources within the station are due primarily to nitrogen-16, a radionuclide produced in the reactor core. Because the primary coolant of a pressurized water reactor (PWR) such as CPSES is contained in a heavily shielded area of the station, dose rates in the vicinity of PWRs are generally undetectable (less than 5 mrem/yr).

Low-level-radioactivity storage containers outside the station are estimated to contribute less than 0.01 mrem/yr at the site boundary.

Occupational Radiation Exposure

The dose to nuclear-plant workers varies from reactor to reactor and can be projected for environmental-impact purposes by using the experience to date with modern PWRs. Most of the dose to nuclear-plant workers is due to external exposure to radiation from radioactive materials outside the body rather than from internal exposure from inhaled or ingested radioactive materials. Recently licensed 1000-MWe PWRs are designed and operated in a manner consistent with new (post-1975) regulatory requirements and guidelines. These new requirements and guidelines place increased emphasis on maintaining occupational

Table 5.12 Annual Total-Body Population-Dose Commitments in the Year 2000

Category	U.S. Population-Dose Commitment
Natural-background radiation†1 (person-rem/yr)	26,249,400
Comanche Peak operation (person-rem/yr per site)	
Plant workers	2,600†2
General public	
Gaseous effluents	90
Liquid effluents†3	41
Transportation of fuel and waste	14

†1 Using the average U.S. background dose (100 mrem/yr) and year-2000 projected U.S. population from "Population Estimates and Projections," Series II, U.S. Dept. of Commerce, Bureau of the Census, Series P-25, No. 541, February 1975.

†2 Particular plants have experienced average lifetime annual doses as high as 1300 person-rem per unit ("Final Environmental Statement - Steam Generator Repair at Surry Power Station, Unit No. 1," NUREG-0692, U.S. Nuclear Regulatory Commission). The average reactor annual dose is 410 person-rem.

†3 80-km population dose.

Table 5.13 Calculated Releases of Radioactive Materials in Liquid Effluents from CPSES Units 1 and 2

Nuclide	Ci/yr per Unit
Corrosion and Activation Products	
Cr-51	0.00009
Mn-54	0.00005
Fe-55	0.00009
Fe-59	0.00005
Co-58	0.00096
Co-60	0.0004
Zr-95	0.00005
Nb-95	0.00007
Np-239	0.00002
Fission Products	
Br-83	0.00004
Rb-86	0.00002
Sr-89	0.00002
Mo-99	0.0015
Tc-99m	0.0014
Ru-106	0.00008
Ag-110m	0.00001
Te-127m	0.00001
Te-127	0.00002
Te-129m	0.00007
Te-129	0.00004
I-130	0.00011
Te-131m	0.00002
I-131	0.083
Te-132	0.00049
I-132	0.0031
I-133	[illegible]029
I-134	[illegible]0003
Cs-134	0.01
I-135	0.0063
Cs-136	0.0032
Cs-137	0.008
Ba-137m	0.0067
Ce-144	0.00017
All others	0.00005
Total, except tritium	0.16
Tritium	340

Table 5.14 Summary of Hydrologic Transport and Dispersion of Liquid Releases from CPSES†[1]

Location	Transit Time (hours)	Dilution Factor
ALARA Calculations		
Sport fishing (Squaw Creek Reservoir)	0.1	1.0
Shoreline recreation (Squaw Creek Reservoir)	0.1	1.0
Population-Dose Calculations		
Sport fishing (Squaw Creek Reservoir)	0.1	1.0
Sport and commercial fishing (Lake Granbury and Lake Whitney)	0.1	10.0
Recreational use: swimming and boating (Squaw Creek Reservoir)	0.1	1.0

†[1] See Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

exposure at nuclear power plants as low as is reasonably achievable (ALARA), and are outlined in 10 CFR Part 20, Standard Review Plan Chapter 12, and Regulatory Guide 8.8. The applicant's proposed implementation of these requirements and guidelines is reviewed by the staff at the construction-permit stage, the operating-license stage, and during actual operation. Approval of the proposed implementation of these requirements and guidelines is granted only after the review indicates that an ALARA program can actually be implemented. Based on the staff's review of the CPSES FSAR, it has been determined that the applicant is committed to design features and operating practices that will assure that individual occupational radiation doses can be maintained within the limits of 10 CFR Part 20 "Standards for Protection Against Radiation" and that individual and total station population doses will be as low as is reasonable achievable (Ref. 15).

Based on actual operating experience, it has been observed that occupational dose has varied considerably from plant to plant, and from year to year. Average individual- and collective-dose information is available from over 190 reactor-years of operation between 1974 and 1979. (The dose data for years prior to 1974 are primarily from reactors with average rated capacities below 500 MWe.) These data indicate that the average reactor annual dose at PWRs has been about 410 person-rem, with particular plants experiencing an average lifetime annual dose as high as 1300 person-rem (Ref. 16). These dose averages are based on widely varying yearly doses at PWRs. For example, annual collective doses for PWRs have ranged from 18 to 5262 person-rem per reactor, and the average annual dose per nuclear-plant worker has been about 0.8 rem (Ref. 17).

The wide range of annual doses (18 to 5262 person-rem) experienced at PWRs in the U.S. is dependent on a number of factors such as the amount of required routine and special maintenance and the degree of reactor operations and in-plant surveillance. Because these factors can vary in an unpredictable manner, it is impossible to determine in advance a specific year-to-year or average annual occupational radiation dose for a particular plant over its operating lifetime. The need to accept high doses can occur, even at plants with radiation-protection programs that have been developed to assure that occupational radiation doses will be kept at levels that are ALARA. Consequently, our occupational-dose estimates for environmental-impact purposes for CPSES are based on the conservative assumption that the station may have a higher-than-average level of special maintenance work. Based on the staff's review of the applicant's Final Safety Analysis Report as well as occupational-dose data from over 190 reactor-years of operation, it is projected that the occupational doses at CPSES could average as much as 1300 person-rem/yr per unit when averaged over the life of the station (Refs. 16 and 17). However, actual year-to-year doses may differ greatly from this average, depending on actual operating conditions.

Radiation Exposure to Construction Workers

During the period between the startup of Unit 1 and the completion of construction on Unit 2, the construction personnel working on the station will be exposed to sources of radiation from the operation of Unit 1. The applicant has estimated the integrated dose to construction personnel to be 298 person-rem (FSAR Section 12.4). The greater part of the radiation exposure (i.e., 85%) to the total construction force will be from contained sources inside buildings. The remainder of the exposure will be from outdoor work.

Transportation of Radioactive Material

The transportation of cold fuel to a reactor, of irradiated fuel from the reactor to a fuel reprocessing plant, and of solid radioactive waste from the reactor to burial grounds is within the scope of the NRC report entitled, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," WASH-1238, December 1972 and Suppl. 1, NUREG 75/038, April 1975. The estimated population-dose commitments associated with transportation of fuel and waste are listed in Tables 5.12 and 5.15. The assessment presented in Table 5.15 is based on the values given in Table S-4 of 10 CFR Part 51.

5.8.1.3 Radiological Impact on Man

The actual radiological impact associated with operation of CPSES will depend, in part, on the manner in which the radioactive-waste-treatment system is

Table 5.15. Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor†[1]

Normal Conditions of Transport			
Heat (per irradiated fuel cask in transit)			260 MJ/h
Weight (governed by Federal or state restrictions)			33,000 kg per truck; 90 Mg per cask per rail car
Traffic density			
Truck			Less than 1 per day
Rail			Less than 3 per month
Exposed Population	**Estimated Number of Persons Exposed**	**Range of Dose to Exposed Individuals†[2] (mrem per reactor year)**	**Cumulative Dose to Exposed Population (person-rem per reactor year)†[3]**
Transportation workers	200	0.01 to 300	4
General public			
Onlookers	1,100	0.003 to 1.3	3
Along route	600,000	0.0001 to 0.6	

Accidents in Transport	
	Environmental Risk
Radiological effects	Small†[4]
Common (nonradiological) causes	1 fatal injury in 100 reactor years; 1 nonfatal injury in 10 reactor years; $475 property damage per reactor year.

†[1] Data supporting this table are given in the Commission's "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," WASH-1238, December 1972 and Supp. I, NUREG 75/038, April 1975.

†[2] The Federal Radiation Council has recommended that the radiation doses from all sources of radiation other than natural background and medical exposures should be limited to 5000 millirems per year for individuals as a result of occupational exposure and should be limited to 500 millirems per year for individuals in the general population. The dose to individuals due to average natural-background radiation is about 130 millirems per year. [The value "130 millirems per year" given in this footnote is not in current use. About 100 millirems per year is the value currently used as the dose due to average natural-background radiation in the United States.]

†[3] Person-rem is an expression for the summation of whole-body doses to individuals in a group. Thus, if each member of a population group of 1000 people were to receive a dose of 0.001 rem (1 millirem), or if two people each were to receive a dose of 0.5 rem (500 millirems), the total cumulative dose in each case would be 1 person-rem.

†[4] Although the environmental risk of radiological effects stemming from transportation accidents cannot currently be numerically quantified, the risk remains small regardless of whether it is being applied to a single-reactor or multireactor site.

operated. Based on an evaluation of the potential performance of the radioactive waste system, the staff concludes that the system as proposed is capable of meeting the dose design objectives of 10 CFR Part 50, Appendix I, and those of RM-50-2 contained in the annex to Appendix I. The applicant chose to show compliance with the design objectives of RM-50-2 as an optional method of demonstrating compliance with the cost-benefit section of Appendix I, Section II.D. Tables 5.10 and 5.11 compare the calculated maximum individual doses with the dose design objectives. However, because station operation will be governed by operating-license technical specifications and because these specifications will be based on the dose design objectives of 10 CFR Part 50, Appendix I (Table 5.10), the actual radiological impact of station operation may result in doses close to the dose design objectives. Even if this situation exists the individual doses will still be very small when compared with natural-background doses (about 100 mrem/yr) or with the dose limits specified in 10 CFR Part 20. As a result, the staff concludes that there will be no measurable radiological impact on man from routine operation of the station.

Effective December 1, 1979 the applicant became subject to 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations," (EPA). These standards specify that the annual dose equivalent not exceed 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ of any member of the public as the result of exposures to planned discharges of radioactive materials, except radon and its daughters, to the general environment from uranium-fuel-cycle operations and radiation from these operations.

5.8.1.4 Radiological Impact on Biota Other than Man

Depending on the pathway and the radiation source, terrestrial and aquatic biota will receive doses about the same or somewhat higher than man will receive. Although guidelines have not been established for acceptable limits for radiation exposure to species other than man, it is generally agreed that the limits established for humans are also conservative for other species. Experience has shown that it is the maintenance of population stability that is crucial to the survival of a species, and species in most ecosystems suffer rather high mortality rates from natural causes. Although the existence of extremely radiosensitive biota is possible and although increased radiosensitivity in organisms may result from environmental interactions with other stresses (e.g. heat, biocides, etc.), no biota have yet been discovered that show a sensitivity (in terms of increased morbidity or mortality) to radiation exposures as low as those expected in the area surrounding CPSES. Furthermore, in all the nuclear plants for which an analysis of radiation exposure to biota other than man has been made, there have been no cases of exposures that can be considered significant in terms of harm to the species or that approach the exposure limits to members of the public permitted by 10 CFR Part 20 (Ref. 18). Inasmuch as the BEIR Report (Ref. 19) concluded that evidence to date indicates no other living organisms are very much more radiosensitive than man, no measurable radiological impact on populations of biota is expected as a result of the routine operation of this station.

5.8.1.5 Radiation-Induced Health Effects on Man

Radiological doses to the general public and to the station work force may result in:

1. Late somatic effects in the form of fatal and nonfatal cancer in various body organs--following age and organ-specific latency periods--of the exposed population, and

2. Fatal and nonfatal genetic disorders in the future generations of the exposed population.

Because of the random occurrence of these effects, calculations are based on population dose (person-rem). Absolute risk estimators of about 140 deaths from expression of latent cancer in various body organs per million total-body person-rem in the exposed population, and about 260 cases of all forms of genetic disorders per million total-body person-rem in the future generations of the exposed population, were derived from the 1972 BEIR report (Ref. 19) and WASH-1400. This derivation assumes a linear and nonthreshold dose/effect relationship at all sublethal dose levels. Using these risk estimators and 2745 person-rem as the annual population dose due to generating electricity at CPSES (Table 5.12), the staff calculates that there may occur 0.37 cancer death in the exposed population and 0.71 genetic disorder in all future generations of the exposed population for each year of station operation. Essentially all (97%) of the public radiation risk is borne by workers in the station, i.e., 0.34 cancer death and 0.69 genetic disorder. Assuming that the average annual dose commitment per nuclear worker at CPSES will be in the same range as that at other similarly sized PWRs, the staff estimates an average worker dose of about 1 rem/yr.

The estimated fatality-incidence rate of nuclear-plant workers due to occupational radiation exposure is compared with risks to other occupational groups in Table 5.16.

In terms of job-related fatalities, the occupational risk associated with the industry-wide average radiation dose (i.e. 14 potential premature deaths per 0.1 million man-year) is slightly larger than the average private-sector risk (i.e. 10 premature deaths per 0.1 million man-year). However, the risk to nuclear-plant workers from radiation exposure is lower than the risk for a number of other groups as described in Table 5.16. It should be pointed out that the fatality-incidence rate given in Table 5.16 for nuclear-plant workers is a conservative estimate (i.e. the actual risk may be much less than the estimate), whereas the rates for other groups are based on known instances of job-related fatalities. In addition, the rate for nuclear-plant workers includes only radiation-related fatalities. Based on the above comparisons, the staff concludes that the risk to the average nuclear-plant worker is within the range of risks associated with other occupations, and is acceptable.

The risks to the exposed population (i.e. 0.37 possible cancer death and 0.71 potential genetic disorder for each year of operation) due to radioactive effluents from the reactor are a very small fraction of the estimated occurrence of 3600 cancer deaths in the U.S. population (year-2000 basis) and 7000 genetic disorders in future generations of the U.S. population (year-2000

Table 5.16 Incidence of Job-Related Fatalities

Occupational Group	Fatality-Incidence Rate†[1] (premature deaths per 0.1 million man-year)
Underground metal miners	1275
Uranium miners	422
Asbestos-insulation workers†[2]	365
Smelter workers	194
Mining†[3]	61
Transportation and public utilities†[3]	24
Nuclear-plant worker (avg)†[4]	14 (potential)
Services†[3]	3
Total, private sector†[3]	10

†[1] "The President's Report on Occupational Safety and Health," May 1972.

†[2] Irving J. Selikoff and William J. Nicholson, "Deaths Among 17,800 Asbestos Insulation Workers in the United States and Canada, January 1, 1967 through January 1, 1977," National Institutes of Health, 1978.

†[3] "Occupational Injuries and Illnesses in the United States by Industry, 1975," Bureau of Labor Statistics, Bulletin 1981, 1978.

†[4] The fatality-incidence rate for nuclear-plant workers is based on an annual exposure of 1 rem to the average worker and includes estimates of radiation-related fatalities only.

basis) due to each year of exposure to natural-background radiation. Therefore, the staff concludes that the health impact to the general public due to routine operation of the station will be undetectable.

5.8.2 Station Accidents*

On June 13, 1980 the Commission published in the Federal Register a statement of interim policy regarding accident considerations (Ref. 20). This statement withdrew the proposed Annex to Appendix D of 10 CFR Part 50 and suspended the rulemaking proceedings associated with it. It also put forth the Commission's interim policy that: "...Environmental Impact Statements shall include considerations of the site-specific accident sequences that lead to releases of radiation and/or radioactive materials, including sequences that can result in inadequate cooling of reactor fuel and to melting of the reactor core. In this regard, attention shall be given both to the probability of occurrence of such releases and to the environmental consequences of such releases." This section presents an analysis of accidents, including those commonly referred to as Class 9 accidents.

The staff has considered the potential radiological impacts on the environment of possible accidents at the Comanche Peak Steam Electric Station Units 1 and 2 in accordance with the statement of interim policy. The following discussion reflects these considerations and conclusions.

The first section deals with general characteristics of nuclear power plant accidents including a brief summary of safety measures to minimize the probability of their occurrence and to mitigate their consequences if they should occur. Also described are the important properties of radioactive materials and the pathways by which they could be transported to become environmental hazards. Potential adverse health effects and impacts on society associated with actions to avoid such health effects are also identified.

Next, actual experience with nuclear power plant accidents and their observed health effects and other societal impacts are then described. This is followed by a summary review of safety features of the Comanche Peak Units 1 and 2 facilities and of the site that act to mitigate the consequences of accidents.

The results of calculations of the potential consequences of accidents that have been postulated in the design basis are then given. Also described are the results of calculations for the Comanche Peak site using probabilistic methods to estimate the possible impacts and the risks associated with severe accident sequences of exceedingly low probability of occurrence.

5.8.2.1 General Characteristics of Accidents

The term accident, as used in this section, refers to any unintentional event not addressed in Section 5.8.1 that results in a release of radioactive materials into the environment. The predominant focus, therefore, is on events that can

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*In this section, conversion exclusively to the metric system of units originally expressed in English Units has not been made. This is to retain the convenience of easy comparison of round numbers.

lead to releases substantially in excess of permissible limits for normal operation. Such limits are specified in the Commission's regulations at 10 CFR Part 20 and 10 CFR Part 50, Appendix I.

There are several features which combine to reduce the risk associated with accidents at nuclear power plants. Safety features in the design, construction, and operation comprising the first line of defense are to a very large extent devoted to the prevention of the release of these radioactive materials from their normal places of confinement within the plant. There are also a number of additional lines of defense that are designed to mitigate the consequences of failures in the first line. Descriptions of these features for Comanche Peak Units 1 and 2 may be found in the applicant's Final Safety Analysis Report (Ref. 21), and in the staff's forthcoming Safety Evaluation Report. The most important mitigative features are described in Section 5.8.2.3 Design Features.

These safety features are designed taking into consideration the specific locations of radioactive materials within the plant, their amounts, their nuclear, physical, and chemical properties, and their relative tendency to be transported into and for creating biological hazards in the environment.

Fission Product Characteristics

By far the largest inventory of radioactive material in a nuclear power plant is produced as a by-product of the fission process and is located in the uranium oxide fuel pellets in the the reactor core in the form of fission products. During periodic refueling shutdowns, the assemblies containing these fuel pellets are transferred to a spent fuel storage pool so that the second largest inventory of radioactive material is located in this storage area. Much smaller inventories of radioactive materials are also normally present in the water that circulates in the reactor coolant system and in the systems used to process gaseous and liquid radioactive wastes in the plant.

These radioactive materials exist in a variety of physical and chemical forms. Their potential for dispersion into the environment is dependent not only on mechanical forces that might physically transport them, but also upon their inherent properties, particularly their volatility. The majority of these materials exist as nonvolatile solids over a wide range of temperatures. Some, however, are relatively volatile solids and a few are gaseous in nature. These characteristics have a significant bearing upon the assessment of the environmental radiological impact of accidents.

The gaseous materials include radioactive forms of the chemically inert noble gases krypton and xenon. These have the highest potential for release into the atmosphere. If a reactor accident were to occur involving degradation of the fuel cladding, the release of substantial quantities of these radioactive gases from the fuel is a virtual certainty. Such accidents are very low frequency but credible events (cf. Sec. 5.8.2.2). It is for this reason that the safety analysis of each nuclear power plant analyzes a hypothetical design basis accident that postulates the release of the entire contained inventory of radioactive noble gases from the fuel into the containment system. If further released to the environment as a possible result of failure of safety features, the hazard to individuals from these noble gases would arise predominantly through the external gamma radiation from the airborne plume. The reactor containment system is designed to minimize this type of release.

Radioactive forms of iodine are formed in substantial quantities in the fuel by the fission process and in some chemical forms may be quite volatile. For this reason, they have traditionally been regarded as having a relatively high potential for release from the fuel. The chemical forms in which the fission product radioiodines are found are generally solid materials at room temperature, however, so that they have a strong tendency to condense (or "plate out") upon cooler surfaces. In addition, most of the iodine compounds are quite soluble in, or chemically reactive with, water. Although these properties do not prevent the release of radioiodines from degraded fuel, they do act to mitigate the release from containment systems that have large internal surface areas and that contain large quantities of water as a result of an accident. The same properties affect the behavior of radioiodines that may "escape" into the atmosphere. Thus, if rainfall occurs during a release, or if there is moisture on exposed surfaces, e.g., dew, the radioiodines will show a strong tendency to be absorbed by the moisture. Because of radioiodine's distinct radiological hazard, its potential for release to the atmosphere has also been reduced by the use of special filter systems and/or containment spray systems. If released to the environment, the principal radiological hazard associated with the radioiodines is ingestion into the human body and subsequent concentration in the thyroid gland.

Other radioactive materials formed during the operation of a nuclear power plant have lower volatilities and therefore, by comparison with the noble gases and iodine, a much smaller tendency to escape from degraded fuel unless the temperature of the fuel becomes quite high. By the same token, such materials, if they escape by volatilization from the fuel, tend to condense quite rapidly to solid form again when transported to a lower temperature region and/or dissolve in water when present. The former mechanism can have the result of producing some solid particles of sufficiently small size to be carried some distance by a moving stream of gas or air. If such particulate materials are dispersed into the atmosphere as a result of failure of the containment barrier, they will tend to be carried downwind and deposit on surface features by gravitational settling or by precipitation (fallout), where they will become "contamination" hazards in the environment.

All of these radioactive materials exhibit the property of radioactive decay with characteristic half-lives ranging from fractions of a second to many days or years (see Table 5.17). Many of them decay through sequence or chain of decay processes and all eventually become stable (nonradioactive) materials. The radiation emitted during these decay processes is the reason that they are hazardous materials.

Exposure Pathways

The radiation exposure (hazard) to individuals is determined by their proximity to the radioactive material, the duration of exposure, and factors that act to shield the individual from the radiation. Pathways for the transport of radiation and radioactive materials that lead to radiation exposure hazards to humans are generally the same for accidental as for "normal" releases. These are

Table 5.17 Activity of Radionuclides in a Comanche Peak Reactor Core at 3565 MWt

Radionuclide	Radioactive Inventory (million Ci)	Half-Life (days)
Noble Gases		
Kr-85	0.63	3,950
Kr-85m	27	0.183
Kr-87	52	0.0528
Kr-88	76	0.117
Xe-133	190	5.28
Xe-135	38	0.384
Iodines		
I-131	95	8.05
I-132	130	0.0958
I-133	190	0.875
I-134	210	0.0366
I-135	170	0.280
Alkali Metals		
Rb-86	0.029	18.7
Cs-134	8.3	750
Cs-136	3.3	13.0
Cs-137	5.2	11,000
Tellurium-Antimony		
Te-127	6.6	0.391
Te-127m	1.2	109
Te-129	34	0.048
Te-129m	5.9	34.0
Te-131m	14	1.25
Te-132	130	3.25
Sb-127	6.8	3.88
Sb-129	37	0.179
Alkaline Earths		
Sr-89	100	52.1
Sr-90	4.1	11,030
Sr-91	120	0.403
Ba-140	180	12.8
Cobalt and Noble Metals		
Co-58	0.87	71.0
Co-60	0.32	1,920
Mo-99	180	2.8
Tc-99m	160	0.25
Ru-103	120	39.5
Ru-105	80	0.185
Ru-106	28	366
Rh-105	55	1.50
Rare Earths, Refractory Oxides, and Transuranics		
Y-90	4.3	2.67
Y-91	130	59.0
Zr-95	170	5.2
Zr-97	170	0.71
Nb-95	170	35.0
La-140	180	1.67
Ce-141	170	32.3
Ce-143	150	1.38
Ce-144	95	284
Pr-143	150	13.7
Nd-147	67	11.1
Np-239	1,800	2.35
Pu-238	0.063	32,500
Pu-239	0.023	8.9×10^6
Pu-240	0.023	2.4×10^6
Pu-241	3.8	5,350
Am-241	0.0019	1.5×10^5
Cm-242	0.56	163
Cm-244	0.026	6,630

depicted in Figure 5.1. There are two additional possible pathways that could be significant for accidental releases that are not shown in that figure. One of these is the fallout onto open bodies of water of radioactivity initially carried in the air. The second would be unique to an accident that results in temperatures inside the reactor core sufficiently high to cause melting and subsequent penetration of the basemat underlying the reactor by the molten core debris. This creates the potential for the release of radioactive material into the hydrosphere through contact with groundwater. These pathways may lead to external exposure to radiation, and to internal exposures if radioactivity is inhaled, or ingested from contaminated food or water.

It is characteristic of these pathways that during the transport of radioactive material by wind or by water, the material tends to spread and disperse, like a plume of smoke from a smokestack, becoming less concentrated in larger volumes of air or water. The result of these natural processes is to lessen the intensity of exposure to individuals downwind or downstream of the point of release, but they also tend to increase the number of individuals who may be exposed. For a release into the atmosphere, the degree to which dispersion reduces the concentration in the plume at any downwind point is governed by the turbulence characteristics of the atmosphere which vary considerably with time and from place to place. This fact, taken in conjunction with the variability of wind direction and the presence or absence of precipitation, means that accident consequences are very much dependent upon the weather conditions existing at the time.

Health Effects

The cause and effect relationships between radiation exposure and adverse health effects are quite complex (Ref. 22, pp. 517-534, and Ref. 23), but they have been more exhaustively studied than any other environmental contaminant.

Whole-body radiation exposure resulting in a dose greater than about 25 rem over a short period of time (hours) is necessary before any physiological effects to an individual are clinically detectable. Doses about 10 to 20 times larger, also received over a relatively short period of time (hours to a few days), can be expected to cause some fatal injuries. At the severe but extremely low probability end of the accident spectrum, exposures of these magnitudes are theoretically possible for persons in the proximity of such accidents if measures are not or cannot be taken to provide protection, e.g., by sheltering or evacuation.

Lower levels of exposures may also constitute a health risk, but the ability to define a direct cause and effect relationship between any given health effect and a known exposure to radiation is difficult given the backdrop of the many other possible reasons why a particular effect is observed in a specific individual. For this reason, it is necessary to assess such effects on a statistical basis. Such effects include cancer in the exposed population and genetic changes in future generations after exposure of a prospective parent. Cancer in the exposed population may begin to develop only after a lapse of 2 to 15 years (latent period) from the time of exposure and then continue over a period of about 30 years (plateau period). However, in the case of exposure of fetuses (*in utero*), cancer may begin to develop at birth (no latent period) and end at age 10 (i.e., the plateau period is 10 years). The health consequences model currently being used is based on the 1972 BEIR Report of the National Academy of Sciences (Ref. 19).

Most authorities are in agreement that a reasonable and probably conservative estimate of the statistical relationship between low levels of radiation exposure to a large number of people is within the range of about 10 to 500 potential cancer deaths (although zero is not excluded by the data) per million person-rem. The range comes from the latest NAS BEIR III Report (1980) which also indicates a probable value of about 150. This value is virtually identical to the value of about 140 used in the current NRC health effects models. In addition, approximately 220 genetic changes per million person-rem would be projected by BEIR III over succeeding generations. That also compares well with the value of about 260 per million person-rem currently used by the NRC staff.

Health Effects Avoidance

Radiation hazards in the environment tend to disappear by the natural process of radioactive decay. Where the decay process is a slow one, however, and where the material becomes relatively fixed in its location as an environmental contaminant (e.g., in soil), the hazard can continue to exist for a relatively long period of time--months, years, or even decades. Thus, a possible consequential environmental societal impact of severe accidents is the avoidance of the health hazard rather than the health hazard itself, by restrictions on the use of the contaminated property or contaminated foodstuffs, milk, and drinking water. The potential economic impacts that this can cause are discussed below.

5.8.2.2 Accident Experience and Observed Impacts

The evidence of accident frequency and impacts in the past is a useful indicator of future probabilities and impacts. As of mid-1980, there were 69 commercial nuclear power reactor units licensed for operation in the United States at 48 sites with power generating capacities ranging from 50 to 1130 megawatts electric (MWe). (The Comanche Peak Units 1 and 2 are designed for 1159 MWe each.) The combined experience with these units represents approximately 500 reactor years of operation over an elapsed time of about 20 years. Accidents have occurred at several of these facilities (Refs. 24 and 25). Some of these have resulted in releases of radioactive material to the environment, ranging from very small fractions of a curie to a few million curies. None is known to have caused any radiation injury or fatality to any member of the public, any significant individual or collective public radiation exposure, or any significant contamination of the environment. This experience base is not large enough to permit a reliable quantitative statistical inference. It does, however, suggest that significant environmental impacts due to accidents are very unlikely to occur over time periods of a few decades.

Melting or severe degradation of reactor fuel has occurred in only one of these units, during the accident at Three Mile Island - Unit 2 (TMI-2) on March 28, 1979. In addition to the release of a few million curies of xenon-133, it has been estimated that approximately 15 curies of radioiodine was also released to the environment at TMI-2 (Ref. 26). This amount represents an extremely minute fraction of the total radioiodine inventory present in the reactor at the time of the accident. No other radioactive fission products were released in measurable quantity.

It has been estimated that the maximum cumulative offsite radiation dose to an individual was less than 100 millirem (Refs. 26 and 27). The total population exposure has been estimated to be in the range from about 1000 to 3000 person-rem. This exposure could produce between none and one additional fatal cancer over the lifetime of the population. The same population receives each year from natural background radiation about 240,000 person-rem and approximately a half-million cancers are expected to develop in this group over its lifetime, primarily from causes other than radiation (Refs. 26 and 27). Trace quantities (barely above the limit of detectability) of radioiodine were found in a few samples of milk produced in the area. No other food or water supplies were impacted.

Accidents at nuclear power plants have also caused occupational injuries and a few fatalities but none attributed to radiation exposure. Individual worker exposures have ranged up to about 4 rem as a direct consequence of accidents, but the collective worker exposure levels (person-rem) are a small fraction of the exposures experienced during normal routine operations that average about 410 person-rem per reactor year for PWRs.

Accidents have also occurred at other nuclear reactor facilities in the United States and in other countries (Refs. 24 and 25). Due to inherent differences in design, construction, operation, and purpose of most of these other facilities, their accident record has only indirect relevance to current nuclear power plants. Melting of reactor fuel occurred in at least seven of these accidents, including the one in 1966 at the Enrico Fermi Atomic Power Plant Unit 1. This was a sodium-cooled fast breeder demonstration reactor designed to generate 61 MWe. The damages were repaired and the reactor reached full power in four years following the accident. It operated successfully and completed its mission in 1973. This accident did not release any radioactivity to the environment.

A reactor accident in 1957 at Windscale, England released a significant quantity of radioiodine, approximately 20,000 curies, to the environment. This reactor, which was not operated to generate electricity, used air rather than water to cool the uranium fuel. During a special operation to heat the large amount of graphite in this reactor, the fuel overheated and radioiodine and noble gases were released directly to the atmosphere from a 405-foot stack. Milk produced in a 200-square mile area around the facility was impounded for up to 44 days. This kind of accident cannot occur in a water-cooled reactor like Comanche Peak, however.

5.8.2.3 Mitigation of Accident Consequences

Pursuant to the Atomic Energy Act of 1954, the Nuclear Regulatory Commission is conducting a safety evaluation of the application to operate Comanche Peak Units 1 and 2. Although this evaluation will contain more detailed information on plant design, the principal design features are presented in the following section.

Design Features

Comanche Peak Units 1 and 2 are essentially identical units. Each contains features designed to prevent accidental release of radioactive fission products from the fuel and to lessen the consequences should such a release occur. Many of the design and operating specifications of these features are derived from the analysis of postulated events known as design basis accidents. These accident preventive and mitigative features are collectively referred to as engineered safety features (ESF). The possibilities or probabilities of failure of these systems is incorporated in the assessments discussed in Section 5.8.2.4.

Each steel-lined concrete containment building is a passive mitigating system which is designed to minimize accidental radioactivity releases to the environment. Safety injection systems are incorporated to provide cooling water to the reactor core during an accident to prevent or minimize fuel damage. The containment spray system is designed to spray cool water into the containment atmosphere. The operation of the spray system after a loss-of-coolant accident (LOCA) would prevent containment system overpressure by quenching the steam generated as a result of reactor coolant flashing into the containment atmosphere. The spray water also contains an additive (sodium hydroxide) which will chemically react with any airborne radioiodine to remove it from the containment atmosphere and prevent its release to the environment.

The mechanical systems mentioned above are supplied with emergency power from onsite diesel generators in the event that normal offsite station power is interrupted.

The fuel handling area located in the fuel building also has accident mitigating systems. The ventilation system contains both charcoal and high efficiency particulate filters. This ventilation system is also designed to keep the area around the spent fuel pool below the prevailing barometric pressure during fuel handling operations so as to prevent exfiltration through building openings. If radioactivity were to be released from the building, it would be drawn through the ventilation system and most of the radioactive iodine and particulate fission products would be removed from the flow stream before exhausting to the environment.

There are features of the plant that are necessary for its power generation function that can also play a role in mitigating certain accident consequences. For example, the main condenser, although not classified as an ESF, can act to mitigate the consequences of accidents involving leakage from the primary to the secondary side of the steam generators (such as steam generator-tube ruptures).

If normal offsite power is maintained, the ability of the plant to send contaminated steam to the condenser instead of releasing it through the safety valves or atmospheric dump valves can significantly reduce the amount of radioactivity released to the environment. In this case, the fission product removal capability of the normally operating off-gas treatment system would come into play.

Much more extensive discussions of the safety features and characteristics of the Comanche Peak Steam Electric Station may be found in the applicant's Final

Safety Analysis Report. The staff evaluation of these features will be addressed in a forthcoming Safety Evaluation Report. In addition, the implementation of the lessons learned from the TMI-2 accident, in the form of improvements in design, and procedures and operator training, will significantly reduce the likelihood of a degraded core accident which could result in large releases of fission products to the containment. Specifically, the applicant is expected to follow the guidance on TMI-related matters specified in NUREG-0737. As noted in Section 5.8.2.4 Uncertainties, no credit has been taken for these actions and improvements in establishing the radiological risk of accidents in this environmental statement.

Site Features

In the process of considering the suitability of the site of Comanche Peak Units 1 and 2, pursuant to NRC's reactor site criteria in 10 CFR Part 100, consideration was given to certain factors that tend to minimize the risk and the potential impact of accidents. First, the site has an exclusion area as provided in 10 CFR Part 100. The exclusion area of the 3105-ha site has a minimum exclusion distance of 1545 m from the midpoint of the centerline between the containment buildings to the closest site boundary. The applicant owns all the surface rights within the exclusion area, but does not control all the subsurface mineral rights within this area. The authority of the applicant to determine all activities within the exclusion area, which is required by Part 100, is still under review by the staff, and the resolution of this item will be reported in the staff's forthcoming Safety Evaluation Report, or a supplement thereto.

Activities within the exclusion area that are unrelated to plant operation include a gas and an oil pipeline which traverse the exclusion area near the southwest boundary, recreational activities at a visitors' overlook area, possible recreational activities on the Squaw Creek Reservoir used for plant cooling, and possible mineral exploration. The staff has determined that, except for possible mineral exploration and extraction within the exclusion area, these activities will not interfere with normal plant operation, as required by Part 100. The staff is presently reviewing a proposal made by the applicant that would allow access for mineral exploration within the exclusion area except for the area within an 850-m radius of either containment building. The staff's evaluation and resolution of this matter will be reported in the forthcoming Safety Evaluation Report, or a supplement.

Second, beyond and surrounding the exclusion area is a low popuation zone (LPZ), also required by 10 CFR Part 100. This is a circular area with a radius of 6.5 km. Within this zone the applicant must assure that there is a reasonable probability that appropriate and effective measures could be taken on behalf of the residents and other members of the public in the event of a serious accident. In case of a radiological emergency, the applicant has made arrangements with agencies of the state and local governments to control all traffic on the railroad and roadways near the nuclear plant.

Third, Part 100 also requires that the nearest population center of about 25,000 or more persons be no closer than one and one-third times the outer radius of the LPZ. The purpose of this criterion is a recognition that since accidents of greater potential hazards than those commonly postulated as representing an upper limit are conceivable, although highly improbable, it was considered desirable to add the population center distance requirement to provide for protection against excessive exposure doses to people in large centers.

The resident population within the LPZ was 500 persons in 1976. The major communities within 16 km of the site are Glen Rose, located 6.9 km south-southeast, and Granbury, located 15.1 km north, which had 1970 populations of about 1500 and 2500 persons, respectively. The nearest population center is Cleburne, Texas, located 37 km east of the plant. Cleburne had a 1970 population of 16,015 persons, but is expected to reach a population of about 25,000 by the mid-1980s. The population center distance is more than one and one-third times the LPZ, as required by Part 100. The City of Fort Worth is located about 55 km northeast of the plant.

The safety evaluation of the Comanche Peak site has also included a review of potential external hazards, i.e., activities offsite that might adversely affect the operation of the plant and cause an accident. This review encompassed nearby industrial, transportation, and military facilities that might create explosive, missile, toxic gas, or similar hazards. The staff has concluded that the hazards from nearby industrial and military facilities, pipelines, air transportation, waterways, and railways are acceptably low. A more detailed discussion of the site features will be included in the Safety Evaluation Report.

Emergency Preparedness

Emergency preparedness plans including protective action measures for the Comanche Peak facility and environs are in an advanced, but not yet fully completed stage. In accordance with the provisions of 10 CFR Section 50.47, effective November 3, 1980, an operating license will not be issued to the applicant unless a finding is made by the NRC that the state of onsite and offsite emergency preparedness provides reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency. Among the standards that must be met by these plans are provisions for two Emergency Planning Zones (EPZ). A plume exposure pathway EPZ of about 16 km (10 mi) in radius and an ingestion exposure pathway EPZ of about 80 km (50 mi) in radius are required. Other standards include appropriate ranges of protective actions for each of these EPZs, provisions for dissemination to the public of basic emergency planning information, provisions for rapid notification of the public during a serious reactor emergency, and methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences in the EPZs of radiological emergency condition.

The NRC findings will be based upon a review of the Federal Emergency Management Agency findings and determinations as to whether state and local government emergency plans are adequate and capable of being implemented, and on the NRC assessment as to whether the applicant's onsite plans are adequate and capable of being implemented. Although the presence of adequate and tested emergency plans cannot prevent the occurrence of an accident, it is the judgment of the staff that they can and will substantially mitigate the consequences to the public should one occur.

5.8.2.4 Accident Risk and Impact Assessment

Design Basis Accidents

As a means of assuring that certain features of the Comanche Peak Units 1 and 2 plants meet acceptable design and performance criteria, both the applicant and the staff have analyzed the potential consequences of a number of postulated accidents. Some of these could lead to significant releases of radioactive materials to the environment, and calculations have been performed to estimate the potential radiological consequences to persons offsite. For each postulated initiating event, the potential radiological consequences cover a considerable range of values depending upon the particular course taken by the accident and the conditions, including wind direction and weather, prevalent during the accident.

In the safety analysis and evaluation of Comanche Peak Units 1 and 2, three categories of accidents have been considered by the applicant and the staff. These categories are based upon their probability of occurrence and include (a) incidents of moderate frequency, i.e., events that can reasonably be expected to occur during any year of operation, (b) infrequent accidents, i.e., events that might occur once during the lifetime of the plant, and (c) limiting faults, i.e., accidents not expected to occur but that have the potential for significant releases of radioactivity. The radiological consequences of incidents in the first category, also called anticipated operational occurrences, are discussed in Section 5.8.1. Initiating events postulated in the second and third categories for the Comanche Peak Units 1 and 2 are shown in Table 5.18. These are collectively designated design basis accidents in that specific design and operating features as described in Section 5.8.2.3 Design Features are provided to limit their potential radiological consequences. Approximate radiation doses that might be received by a person at the most adverse location along

Table 5.18. Approximate Radiation Doses from Design Basis Accidents at the Comanche Peak Steam Electric Station†1

	Dose at 2206 m†2 (rem)	
Design Basis Accidents	Thyroid	Whole Body
Infrequent Accidents		
Radioactive waste system failure	< 0.1	< 0.1
Steam generator tube rupture	13	< 1.0
Fuel handling accident	2.1	0.044
Limiting Faults		
Main steam line break	79	< 1.0
Large-break LOCA†3	85	1.2

†1 Duration of release less than 2 hours.

†2 The site boundary distance that yields the highest radiological dose following an accident.

†3 Loss-of-coolant accident.

the site boundary (2206 m from the plant) are also shown in the table, along with a characterization of the time duration of the releases.*

The staff has used conservative models for calculations to estimate the potential upper bounds for individual exposures summarized in Table 5.18 for the purpose of implementing the provisions of 10 CFR Part 100, "Reactor Site Criteria." For these calculations, pessimistic (conservative or worst case) assumptions are made as to the course taken by the accident and the prevailing conditions. These assumptions include much larger amounts of radioactive material released by the initiating events, additional single failures in equipment, operation of ESFs in a degraded mode,** and very poor meteorological dispersion conditions.

The results of these calculations show that, for these events, the limiting whole-body exposures are not expected to exceed 1.2 rem to any individual at the site boundary. They also show that radioiodine releases have the potential for offsite exposures ranging up to about 85 rem to the thyroid. For such an exposure to occur, an individual would have to be located at a point on the site boundary where the radioiodine concentration in the plume has its highest value and inhale at a breathing rate characteristic of a person jogging, for a period of two hours. The health risk to an individual receiving such a thyroid exposure is the potential appearance of benign or malignant thyroid nodules in about 3 out of 100 cases, and the development of a fatal cancer in about 1 out of 1000 cases.

Probabilistic Assessment of Severe Accidents

In this and the following three sections, there is a discussion of the probabilities and consequences of accidents of greater severity than the design basis accidents discussed in the previous section. They are considered less likely to occur, but their consequences could be severe, both for the plant itself and for the environment. These severe accidents can be distinguished from design basis accidents in two primary respects: they involve substantial physical deterioration of the fuel in the reactor core, including overheating to the point of melting, and they involve deterioration of the capability of the containment structure to perform its intended function of limiting the release of radioactive materials to the environment. Heretofore these accidents have frequently been called Class 9 accidents which, as a class, include all accidents involving sequences of failures more severe than those postulated for the design basis of the protective systems and engineered safety features. The consequences of such accidents could be severe.

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*Site boundary distance of 2206 m (which differs from minimum site boundary distance of 1545 m) is selected on the basis of site meteorology which yields the most adverse radiological dose.

**The containment system, however, is assumed to prevent leakage in excess of that which can be demonstrated by testing, as provided in 10 CFR Part 100.11(a).

The assessment methodology employed is that described in the Reactor Safety Study (RSS) which was published in 1975 (Ref. 28).* However, the sets of accident sequences that were found in the RSS to be the dominant contributors to the risk in the prototype PWR (Surry Unit 1) have recently been updated or "rebaselined" (Ref. 29). The rebaselining has been done largely to incorporate peer group comments (Ref. 30), and better data and analytical techniques resulting from research and development after the publication of the RSS. Entailed in the rebaselining effort was the evaluation of the individual dominant accident sequences as they are understood to evolve. The earlier technique of grouping a number of accident sequences into the encompassing Release Categories as was done in the RSS has been largely (but not completely) eliminated.

The Comanche Peak Units 1 and 2 are Westinghouse designed PWRs having similar design and operating characteristics to the Surry 1 facility used in the RSS as a prototype for PWRs. Therefore, the present assessment for Comanche Peak has used as its starting point the rebaselined accident sequences and release categories referred to above, and more fully described in Appendix D. Characteristics of the sequences (and release categories) used (all of which involve partial to complete melting of the reactor core) are shown in Table 5.19. Sequences initiated by natural phenomena such as tornadoes, floods, or seismic events and those that could be initiated by deliberate acts of sabotage are not included in these event sequences. The radiological consequences of such events would not be different in kind from those which have been treated. Moreover, it is the staff's judgment, based upon design requirements of 10 CFR Part 50, Appendix A, relating to effects of natural phenomena, and safeguards requirements of 10 CFR Part 73, that these events do not contribute significantly to risk.

Calculated probability per reactor year associated with each accident sequence (or release category) used is shown in the second column in Table 5.19. As in the RSS there are substantial uncertainties in these probabilities. This is due, in part, to difficulties associated with the quantification of human error and to inadequacies in the data base on failure rates of individual plant components that were used to calculate the probabilities (Ref. 30). (See Sec. 5.8.2.4 Uncertainties.) The probability of accident sequences from the Surry plant was used to give a perspective of the societal risk at Comanche Peak Units 1 and 2 because, although the probabilities of particular accident sequences may be substantially different for Comanche Peak, the overall effect of all sequences taken together is likely to be within the uncertainties (see Sec. 5.8.2.4 Uncertainties).

The magnitudes (curies) of radioactivity releases for each accident sequence or release category are obtained by multiplying the release fractions shown in Table 5.19 by the amounts that would be present in the core at the time of the hypothetical accident. These are shown in Table 5.17 for a Comanche Peak plant at the core thermal power of 3565 megawatts.

The potential radiological consequences of these releases have been calculated by the consequence model used in the RSS (Ref. 31) and adapted to apply to a specific site. The essential elements are shown in schematic form in Figure 5.2. Environmental parameters specific to the Comanche Peak site have been used and include the following:

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*Because this report has been the subject of considerable controversy, a discussion of the uncertainties surrounding it is provided in Section 5.8.2.4 Uncertainties.

Table 5.19. Summary of Atmospheric Releases in Hypothetical Accident Sequences in a PWR (Rebaselined)†[1]

Accident Sequence or Sequence Group†[3]	Probability per Reactor Year	Fraction of Core Inventory Released†[2]						
		Xe-Kr	I	Cs-Rb	Te-Sb	Ba-Sr	Ru†[4]	La†[5]
Event V	2.0(-6)†[6]	1.0	0.7	0.8	0.4	0.1	0.04	0.006
TMLB'	3.0(-6)	1.0	0.3	0.4	0.2	0.04	0.02	0.002
PWR 3	3.0(-6)	0.8	0.2	0.2	0.3	0.02	0.03	0.003
PWR 7	4.0(-5)	6(-3)	4(-5)	1(-5)	2(-5)	1(-6)	1(-6)	2(-7)

†[1] See Section 5.8.2.4 Uncertainties for a discussion of uncertainties in risk estimates.
†[2] Background on the isotope groups and release mechanisms is presented in Appendix VII, of "Reactor Safety Study," WASH-1400, NUREG-75/014, October 1975.
†[3] See Appendix D for a description of accident sequences and release categories.
†[4] Includes Ru, Rh, Co, Mo, Tc.
†[5] Includes Y, La, Zr, Nb, Ce, Pr, Nd, Np, Pu, Am, Cm.
†[6] Exponential notation: $2.0(-6) = 2.0 \times 10^{-6}$.

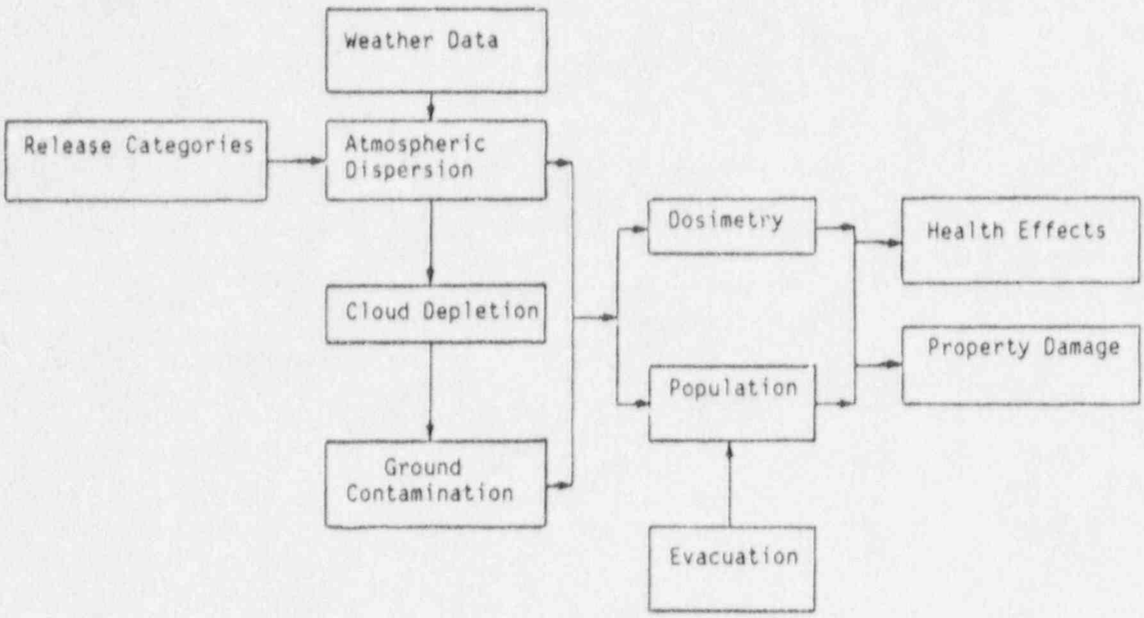

Figure 5.2. Schematic Outline of Consequence Model.

1. One full year of consecutive hourly averages of 1976 meteorological data from the site meteorological monitoring systems and the precipitation data obtained from National Weather Service records for the Dallas-Forth Worth Airport.

2. Projected population for the year 2000 extending throughout regions of 80 and 560 km (50 and 350 mi) radius from the site (the latter region includes parts of Mexico).

3. The habitable land fraction within the 560 km (350-mi) radius.

4. Land use statistics, on a state-wide basis, including farm land values, farm product values including dairy production, and growing season information, for the State of Texas and each surrounding state within the 560 km (350-mi) region.

5. Land use statistics including farm land values, farm product values including dairy production, and growing season information for the adjoining regions of Mexico, within 560 km (350 mi), based on comparison with the values for the nearby states of the U.S.

To obtain a probability distribution of consequences the calculations are performed assuming the occurrence of each accident release sequence at each of 91 different "start" times throughout a one-year period. Each calculation utilizes the site-specific hourly meteorological data and seasonal information for the time period following each "start" time. The consequence model also contains provisions for incorporating the consequence reduction benefits of evacuation and other protective actions. Early evacuation of people would considerably reduce the exposure from the radioactive cloud and the contaminated ground in the wake of the cloud passage. The evacuation model used (see App. F) has been revised from that used in the RSS for better site-specific application. The quantitative characteristics of the evacuation model used for the Comanche Peak site are best estimate values made by the staff and based upon evacuation time estimates prepared by the applicant. Actual evacuation effectiveness could be greater or less than that characterized but would not be expected to be very much less.

The other protective actions include: (a) either complete denial of use (interdiction), or permitting use only at a sufficiently later time after appropriate decontamination of food stuffs such as crops and milk, (b) decontamination of severely contaminated environment (land and property) when it is considered to be economically feasible to lower the levels of contamination to protective action guide (PAG) levels, and (c) denial of use (interdiction) of severely contaminated land and property for varying periods of time until the contamination levels reduce to such values by radioactive decay and weathering so that land and property can be economically decontaminated as in (b) above. These actions would reduce the radiological exposure to the people from the immediate and/or subsequent use of or living in the contaminated environment.

Early evacuation and other protective actions as mentioned above are considered as essential sequels to serious nuclear reactor accidents involving significant release of radioactivity to the atmosphere. Therefore, the results shown for Comanche Peak include the benefits of these protective actions.

There are also uncertainties in the estimates of consequences, and the error bounds may be as large as they are for the probabilities. It is the judgment of the staff, however, that it is more likely that the calculated results are overestimates of consequences rather than underestimates.

The results of the calculations using this consequence model are radiological doses to individuals and to populations, health effects that might result from these exposures, costs of implementing protective actions, and costs associated with property damage by radioactive contamination.

Dose and Health Impacts of Atmospheric Releases

The results of the calculations of dose and health impacts performed for the Comanche Peak facility and site are presented in the form of probability distributions in Figures 5.3 through 5.6 and are included in the impact summary Table 5.20. All of the four accident sequences and release categories shown in Table 5.19 contribute to the results, the consequences from each being weighted by its associated probability.

Figure 5.3 shows the probability distribution for the number of persons who might receive whole body doses equal to or greater than 200 rem and 25 rem, and thyroid doses equal to or greater than 300 rem from early exposure,* all on a per-reactor-year basis. The 200-rem whole-body dose figure corresponds approximately to a threshold value for which hospitalization would be indicated for the treatment of radiation injury. The 25-rem whole-body (which has been identified earlier as the lower limit for a clinically observable physiological effect) and 300-rem thyroid figures correspond to the Commission's guideline values for reactor siting in 10 CFR Part 100.

The figure shows in the left-hand portion that there are less than 8 chances in 1,000,000 per year (i.e., 8×10^{-6}) that one or more persons may receive doses equal to or greater than any of the doses specified. The fact that the three curves run almost parallel in horizontal lines initially shows that if one person were to receive such doses, the chances are about the same that several tens to hundreds would be so exposed. The chances of larger numbers of persons being exposed at those levels are seen to be considerably smaller. For example, the chances are about 1 in 100,000,000 (i.e., 10^{-8}) that 100,000 or more people might receive doses of 200 rem or greater. A majority of the exposures reflected in this figure would be expected to occur to persons within a 80 km (50-mi) radius of the plant. Virtually all would occur within a 160 km (100-mi) radius.

Figure 5.4 shows the probability distribution for the total population exposure in person-rem, i.e. the probability per reactor-year that the total population exposure will equal or exceed the values given. Most of the population exposure up to 50 million person-rem would occur within 80 km (50 mi) but the more severe releases (as in the first two accident sequences in Table 5.19) would result in exposure to persons beyond the 80-km (50-mi) range as shown.

*Early exposure to an individual includes external doses from the radioactive cloud and the contaminated ground, and the dose from internally deposited radionuclides from inhalation of contaminated air during the cloud passage. Other pathways of exposure are excluded.

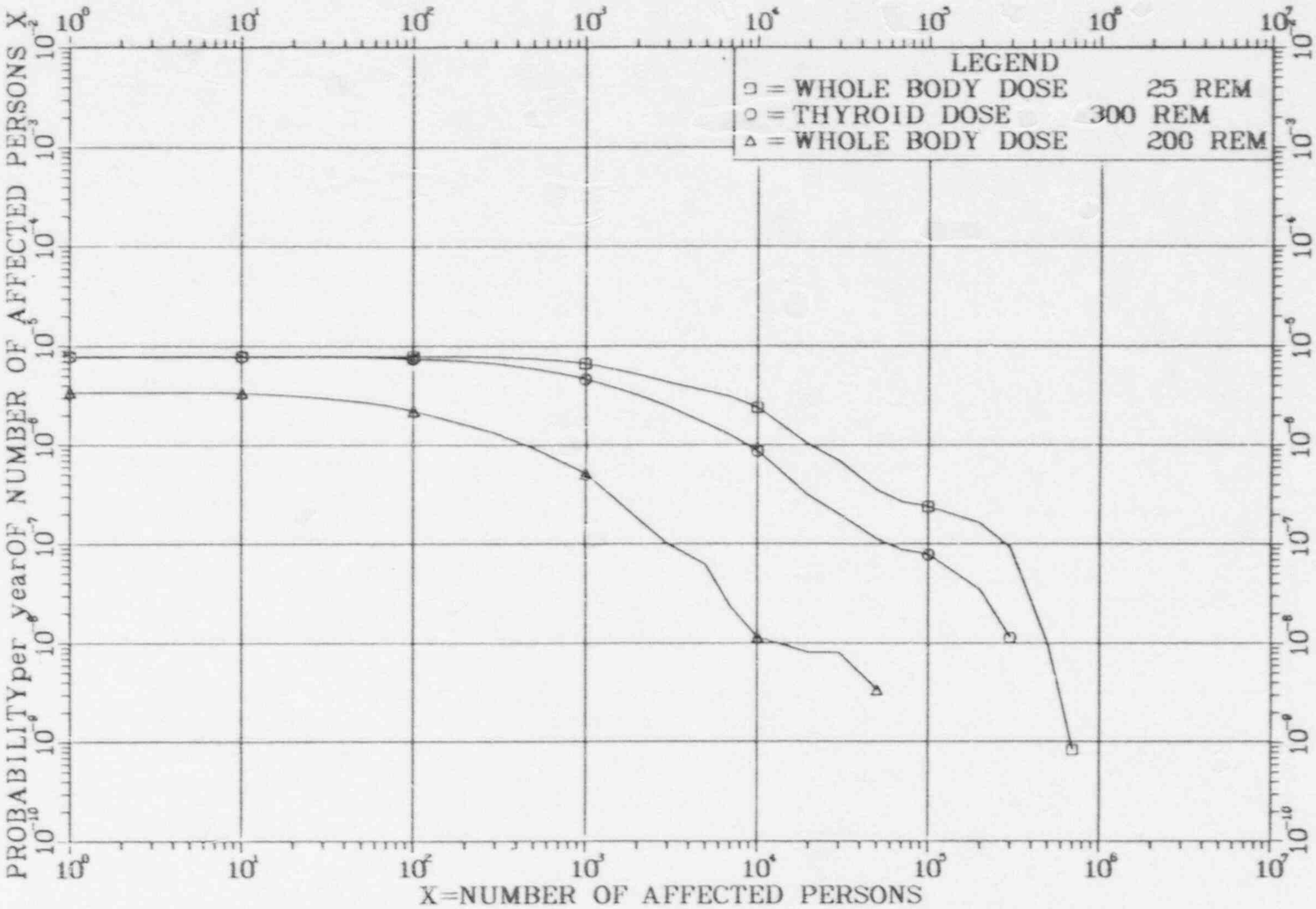

Figure 5.3. Probability Distributions of Individual Dose Impacts.

Note: See page 5-65 for discussion of uncertainties in risk estimates.

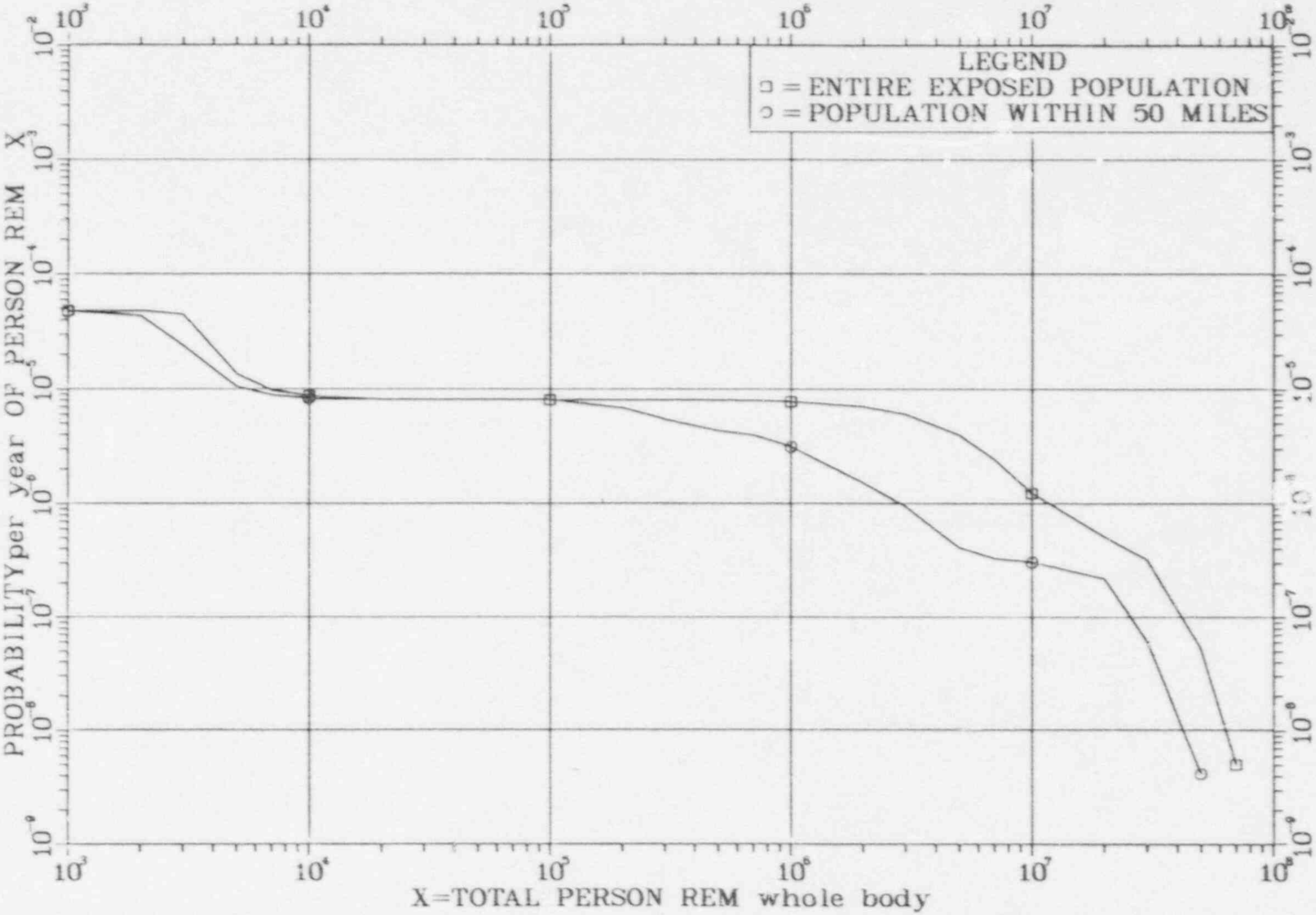

Figure 5.4. Probability Distributions of Population Exposures.

Notes: 1) See page 5-65 for discussion of uncertainties in risk estimates.
2) To convert miles to kilometers multiply by 1.6.

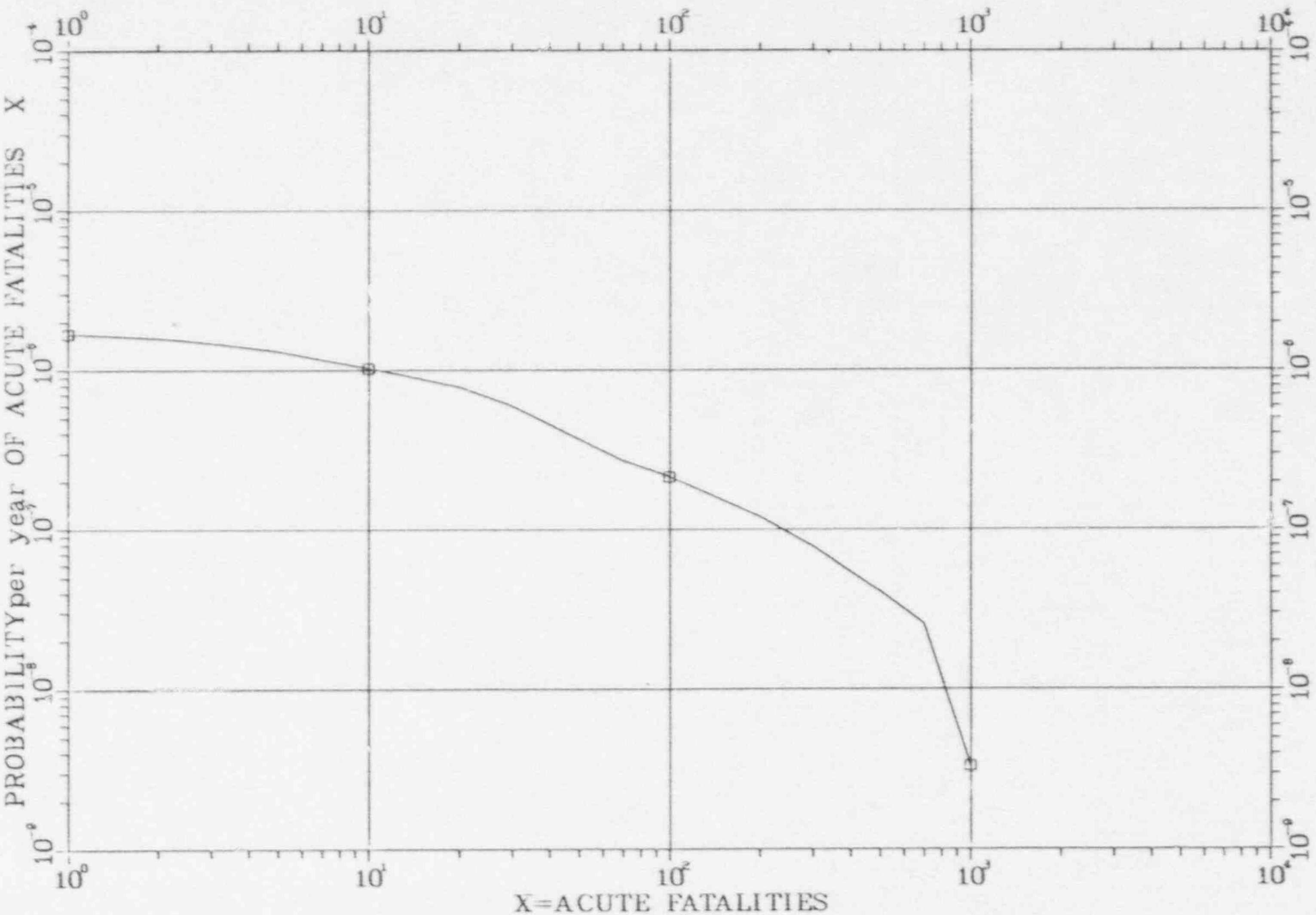

Figure 5.5. Probability Distribution of Acute Fatalities.

Note: See page 5-65 for discussion of uncertainties in risk estimates.

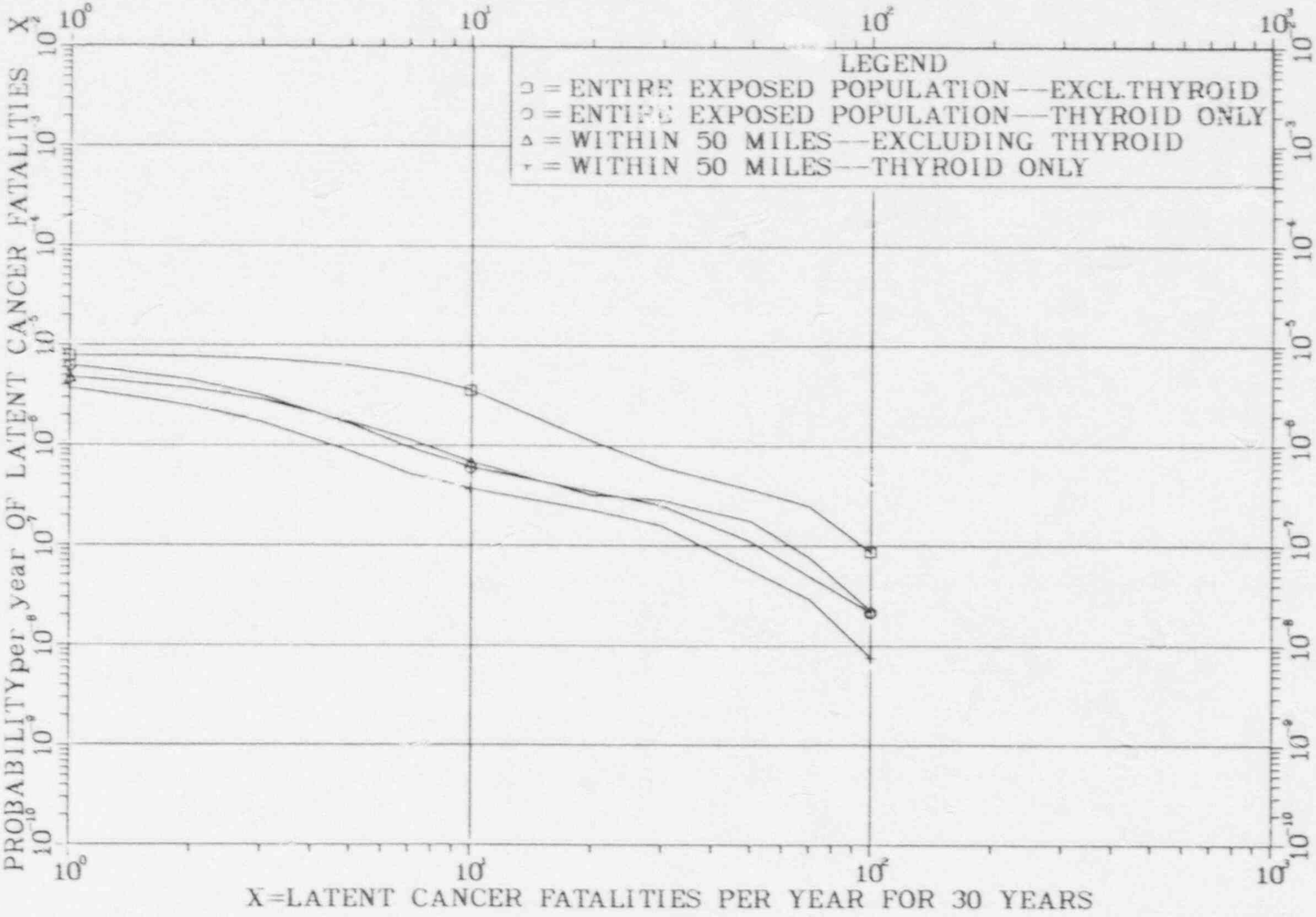

Figure 5.6. Probability Distributions of Cancer Fatalities.

Notes: 1) See page 5-65 for discussion of uncertainties in risk estimates.
2) To convert miles to kilometers multiply by 1.6.

Table 5.20. Summary of Environmental Impacts and Probabilities

Probability of Impact Per Year	Persons Exposed over 200 rem	Persons Exposed over 25 rem	Acute Fatalities	Population Exposure Millions of person-rem 80 km (50 mi) Total	Latent Cancer fatalities[a] 80 km (50 mi) Total	Cost of Offsite Mitigating Actions Millions of Dollars
10^{-4}	0	0	0	0/0	0/0	0
10^{-5}	0	0	0	0.006/0.006	0/0	4
5×10^{-6}	0	3,000	0	0.35/3.9	0/0	300
10^{-6}	500	10,000	10	3/12	345/850	700
10^{-7}	3,000	300,000	250	30/55	3,000/4,500	6,500
10^{-8}	12,000	500,000	800	45/70	2,800/2,800[b]	10,000
Related Figure	5.3	5.3	5.5	5.4	5.6	5.7

[a] Thirty times the values of all cancer fatalities in the figure 5.6 are shown in this column reflecting the thirty-year period over which they might occur. Genetic effects would be approximately twice the number of latent cancers.

[b] Thyroid cancer fatalities. (Cancers of all other organs do not contribute to this probability level.)

NOTE: Please refer to Section 5.8.2.4 for a discussion of uncertainties in risk estimates.

For perspective, population doses shown in Figure 5.4 may be compared with the annual average dose to the population within 80 km (50 mi) of the Comanche Peak site due to natural background radiation of 150,000 person-rem, and to the anticipated annual population dose to the general public from normal station operation of 50 person-rem (excluding plant workers) (Tables 5.10 and 5.12).

Figure 5.5 shows the probability distributions for acute fatalities, representing radiation injuries that would produce fatalities within about one year after exposure. Virtually all the acute fatalities would be expected to occur within the 40 km (25-mile) radius. The results of the calculations shown in this figure and in Table 5.20 reflect the effect of evacuation within the 16 km (10-mile) plume exposure pathway EPZ only. For the very low probability accidents having the potential for causing radiation exposures above the threshold for actute fatality at distances beyond 16 km (10 mi), it would be realistic to expect that authorities would evacuate persons at all distances at which such exposures might occur. Acute fatality consequences would therefore be expected to be very much less than the numbers shown. Results of the calculations reflecting evacuation beyond 16 km (10 mi) will be included in the final environmental statement.

Figure 5.6 represents the statistical relationship between population exposure and the induction of fatal cancers that might appear over a period of many years following exposure. The impacts on the total population and the population within 80 km (50 mi) are shown separately. Further, the latent fatal cancers have been subdivided into those attributable to exposures of the thyroid and all other organs.

Economic and Societal Impacts

As noted in Section 5.8.2.1, the various measures for avoidance of adverse health effects including those due to residual radioactive contamination in the environment are possible consequential impacts of severe accidents. Calculations of the probabilities and magnitudes of such impacts for the Comanche Peak facility and environs have also been made. Unlike the radiation exposure and adverse health effect impacts discussed above, impacts associated with adverse health effects avoidance are more readily transformed into economic impacts.

The results are shown as the probability distribution for costs of offsite mitigating actions in Figure 5.7 and are included in the impact summary Table 5.20. The factors contributing to these estimated costs include the following:

- Evacuation costs,
- Value of crops contaminated and condemned,
- Value of milk contaminated and condemned,
- Costs of decontamination of property where practical, and
- Indirect costs due to loss of use of property and incomes derived therefrom.

The last named costs would derive from the necessity for interdiction to prevent the use of property until it is either free of contamination or can be economically decontaminated.

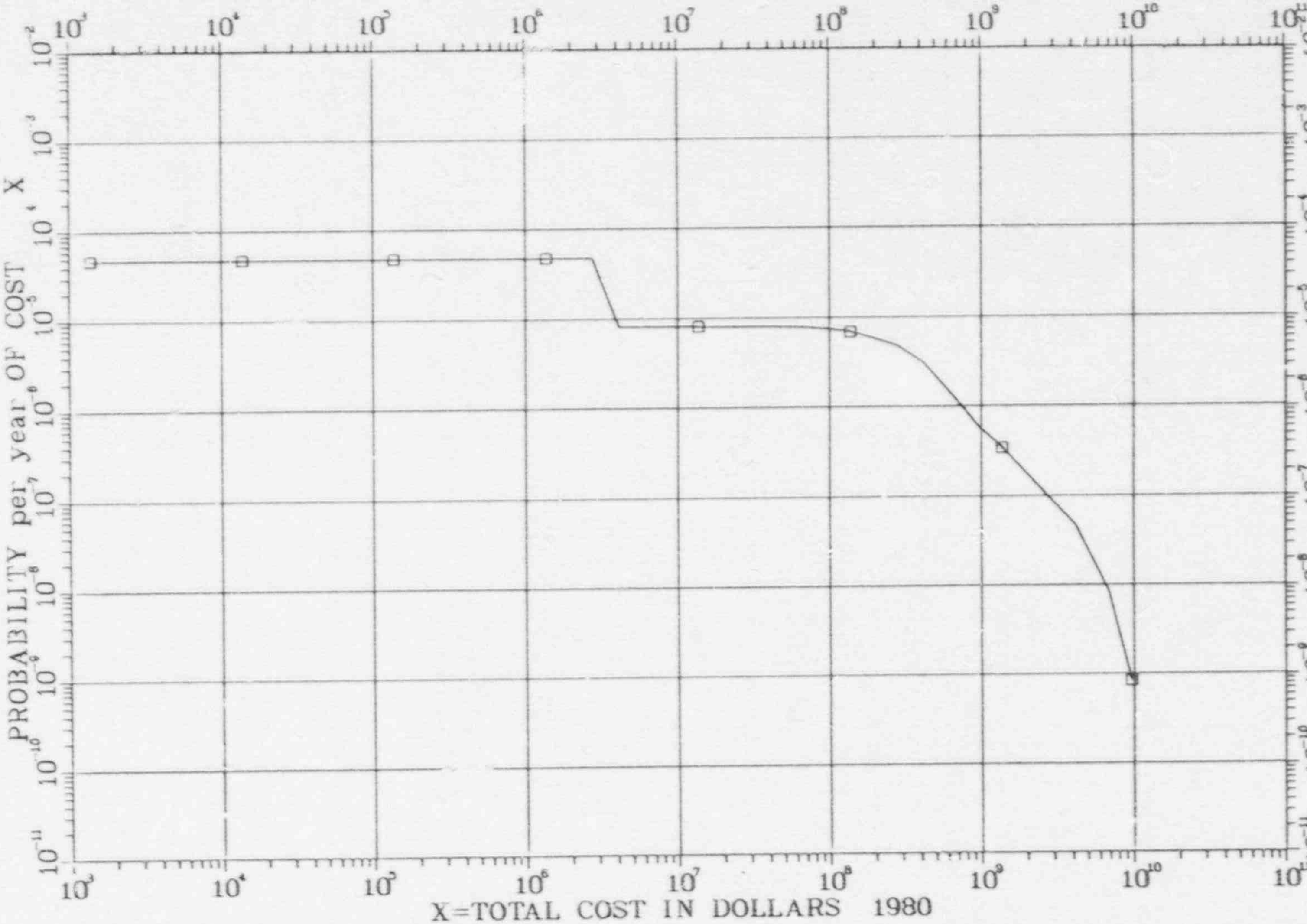

Figure 5.7. Probability Distribution of Mitigation Measures Cost.

Note: See page 5-65 for discussion of uncertainties in risk estimates.

Figure 5.7 shows that at the extreme end of the accident spectrum these costs could approach ten billion dollars, but that the probability that this would occur is exceedingly small, less than one chance in one billion per reactor-year.

Additional economic impacts that can be quantified include costs of decontamination of the facility itself and the costs of replacement power. Probability distributions for these impacts have not been calculated, but they are included in the discussion of risk considerations in Section 5.8.2.4 Risk Considerations.

Releases to Groundwater

A groundwater pathway for public radiation exposure and environmental contamination that would be associated with severe reactor accidents was identified in Section 5.8.2.1 Exposure Pathways. Consideration has been given to the potential environmental impact of this pathway for the Comanche Peak station. The principal contributors to the risk are the core melt accidents associated with the evaluated accident sequences and release categories. The penetration of the basemat of the containment buildings can release molten core debris to the strata beneath the station. Soluble radionuclides in this debris can be leached and transported with groundwater to downgradient domestic wells used for drinking or to surface water bodies used for aquatic food and recreation. In pressurized water reactors, such as the Comanche Peak units, there is an additional opportunity for groundwater contamination due to the release of contaminated sump water to the ground through a breach in the containment.

An analysis of the potential consequences of a liquid pathway release of radioactivity for generic sites was presented in the "Liquid Pathway Generic Study" (LPGS) (Ref. 32). The LPGS compared the risk of accidents involving the liquid pathway (drinking water, irrigation, aquatic food, swimming and shoreline usage) for four conventional, generic land-based nuclear plants and a floating nuclear plant, for which the nuclear reactors would be mounted on a barge and moored in a water body. Parameters for the land-based sites were chosen to represent averages for a wide range of real sites and are thus "typical," but represented no real site in particular.

The discussion in this section is an analysis to determine whether or not the Comanche Peak site liquid pathway consequences would be unique when compared to land-based sites considered in the LPGS.

The foundations of the Comanche Peak reactors are located in the Glen Rose formation which constitutes the bedrock of the station site. This formation is about 60 m thick and consists of limestone with claystone lenses. Underlying this strata is the Twin Mountains formation, which is primarily sandstone with some claystone and argillaceous limestone seams.

Groundwater in the site region occurs mainly in the Twin Mountains formation, although northwest of the station the Glen Rose limestone yields small amounts of water in isolated areas. In the station area, no groundwater was encountered in the Glen Rose limestone during excavation for construction of the reactor containment structures.

The Glen Rose limestone underlying the station is essentially impervious, without the open voids, caverns, joints, and fractures frequently found in some limestones. This is due to small amounts of argillaceous impurities in the limestone, which make the rock resistant to solutioning.

The station is located on a peninsula formed by Squaw Creek Reservoir, which is a cooling lake for the station. Under normal conditions, the reservoir water level will remain in a 1.5-m range between elevations 234.5 m and 236 m. This is about 2.5 m to 4 m lower than the basemat of the containment structures. Although no groundwater was encountered in the Glen Rose limestone during construction, water from Squaw Creek Reservoir will eventually seep into this strata and raise the groundwater level beneath the plant. It is expected that the groundwater gradient of the water table will be from the reservoir toward the center of the peninsula where the plant is located. Because of the low permeability of the limestone, however, seepage from the reservoir will be very slow. It is expected that the groundwater gradient will remain in the direction of the center of the peninsula on which the plant is located during the lifetime of the plant. The upper limit of the effect of seepage would raise the water table only to the Squaw Creek Reservoir water level. In this situation, rainfall occurring on the plant site could percolate into the ground and reverse the groundwater gradient below the station toward the reservoir. Because of the low permeability of the strata and the high evaporation rates in this area, however, most rainfall will flow across the ground surface and drain away as surface runoff or will return to the atmosphere by evaporation and transpiration. In addition, the plant site has been sloped so that surface water flows from the plant toward Squaw Creek Reservoir. It is considered that recharge of the water table due to precipitation will be negligible and will not affect the groundwater gradient or level beneath the station.

In the event of a breach in the containment, there could be a release of radioactivity to the ground below the station. However, lateral movement of any contaminated ground water would be limited because there is no movement mechanism, i.e., the groundwater gradient would be toward the center of the peninsula where the station is located or as an extreme, the groundwater elevation would be at the same level as the surrounding Squaw Creek Reservoir. Any radioactively contaminated water released from the containment structure could thus proceed in a downward direction only. Using bounding heat transfer calculations, the Reactor Safety Study (WASH-1400) has estimated that the core-soil mass could form a cylinder 15 m high with a diameter of 20 m. The Glen Rose limestone is about 60 m thick. Approximately 50 m of this is below the basemat of the reactors; therefore, the solidified melt would remain at least 35 m above the bottom of the formation.

The underlying Twin Mountains formation is the most productive aquifer in the region. This formation is under artesian pressure and is not hydraulically connected with the Glen Rose formation. Any contamination of the Twin Mountains aquifer would be highly unlikely, since it is under artesian pressure. Any connection between the Twin Mountains and Glen Rose formations would induce flow outward from the artesian aquifer.

Since no radioactive materials would enter either the surface water of Squaw Creek Reservoir or the Twin Mountains regional aquifer, there is no credible liquid pathway for public radiation exposure and environmental contamination. Thus the Comanche Peak site is not unique in its liquid pathway contribution to risk when compared to other land-based sites in the "Liquid Pathway Generic Study."

Risk Considerations

The foregoing discussions have dealt with both the frequency (or likelihood of occurrence) of accidents and their impacts (or consequences). Since the ranges of both factors are quite broad, it is useful to combine them to obtain average measures of environmental risk. Such averages can be particularly instructive as an aid to the comparison of radiological risks associated with accident releases and with normal operational releases.

A common way in which this combination of factors is used to estimate risk is to multiply the probabilities by the consequences. The resultant risk is then expressed as a number of consequences expected per unit of time. Such a quantification of risk does not at all mean that there is universal agreement that peoples' attitudes about risk, or what constitutes an acceptable risk, can or should be governed solely by such a measure. At best, it can be a contributing factor to a risk judgment, but not necessarily a decisive factor.

In Table 5.21 are shown average values of risk associated with population dose, acute fatalities, latent fatalities, and costs for evacuation and other protective actions. These average values are obtained by summing the probabilities multiplied by the consequences over the entire range of distributions. Since the probabilities are on a per-reactor-year basis, the averages shown are also on a per-reactor-year basis.

Table 5.21. Annual Average Expected Values of Environmental Risks Due to Accidents at Comanche Peak†[1]

Population exposure (person-rem)	
Within 50 mi	16
Total	58
Number of acute fatalities	0.0001
Number of latent cancer fatalities	
All organs excluding thyroid	0.00034
Thyroid only	0.00012
Cost of protective actions and decontamination ($)	3900

†[1] See Section 5.8.2.4 Uncertainties for discussions of uncertainties in risk estimates.

The population exposures and latent cancer fatality risks may be compared with those for normal operation releases shown in Tables 5.10 and 5.12. The comparison (excluding exposure to the plant personnel) shows that the accident risks are substantially lower than those for normal operation.

There are no acute fatality or economic risks associated with protective actions and decontamination for normal releases; therefore, these risks are unique for accidents. For perspective and understanding of the meaning of the acute fatality risk of 0.0001 per year, however, we note that to a good approximation the population at risk is that within about 16 km (10 miles) of the plant, about 21,000 persons in the year 2000. Accidental fatalities per year for a population of this size, based upon overall averages for the United States, are approximately four from motor vehicle accidents, two from falls, one from drowning, and one from burns (Ref. 22).

Figure 5.8 shows the calculated risk expressed as whole-body dose to an individual from early exposure as a function of the distance from the plant within the plume exposure pathway EPZ. The values are on a per-reactor-year basis and all accident sequences and release categories in Table 5.19 contributed to the dose, weighted by their associated probabilities.

Within the 16 km (10 mile) radius plume exposure pathway EPZ, the calculations show that the best estimate evacuation can reduce the risk of acute fatality to an individual to near zero. Evacuation and other protective actions also reduce the risk to an individual of latent cancer fatality. Figures 5.9 and 5.10 show curves of constant risks per reactor-year to an individual living within the plume exposure pathway EPZ of the Comanche Peak plant, of acute death and death from latent cancer, respectively, as functions of distance due to potential accidents in a reactor. Directional variation of these curves reflect the variation in the average fraction of the year and the wind would be blowing into each direction from the plant. For comparison the following risks of fatality per year to an individual living in the U.S. may be noted; automobile accident 2.2×10^{-4}, falls 7.7×10^{-5}, drowning 3.1×10^{-5}, burning 2.9×10^{-5}, and firearms 1.2×10^{-5} (Ref. 22).

The economic risk associated with evacuation and other protective actions could be compared with property damage costs associated with alternative energy generation technologies. The use of fossil fuels, coal or oil, for example, would emit substantial quantities of sulfur dioxide and nitrogen oxides into the atmosphere, and, among other things, lead to environmental, and ecological damage through the phenomenon of acid rain (Ref. 22, pp 559-560). This effect, however, has not been sufficiently quantified to draw a useful comparison at this time.

There are other economic impacts and risks that can be monetized that are not included in the cost calculations discussed in Section 5.8.2.4 Economic and Societal Impacts. These are accident impacts on the facility itself that result in added costs to the public, i.e., ratepayers, taxpayers, and/or shareholders. These are costs associated with decontamination of the facility itself and costs for replacement power.

No detailed methodology has been developed for estimating the contribution to economic risk associated with cleanup and decontamination of a nuclear power plant that has undergone a serious accident toward either a decommissioning or a resumption of operation. Experience with such costs is currently being accumulated as a result of the Three Mile Island accident. It is already clear, however, that such costs can approach or even exceed the original capital cost of such a facility. As an illustration of the possible contribution to the economic risk, if the probability of an accident serious enough to require extensive cleanup and decontamination is taken as the sum of the four accident sequences and release categories in Table 5.19, i.e., about 4.8

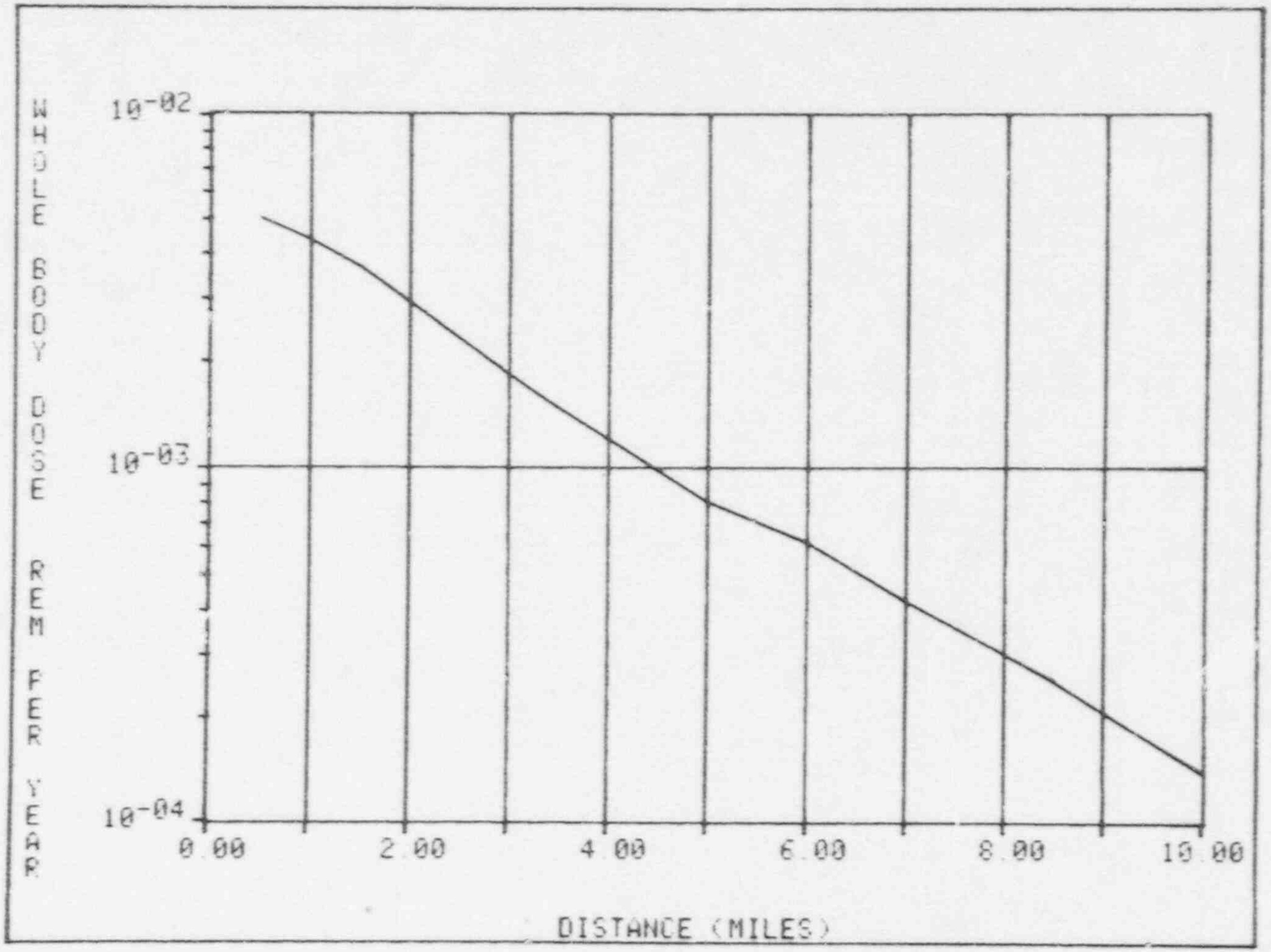

Figure 5.8. Individual Risk of Dose as a Function of Distance.

Notes: 1) See page 5-65 for discussion of uncertainties in risk estimates.
2) To convert miles to kilometers multiply by 1.6.

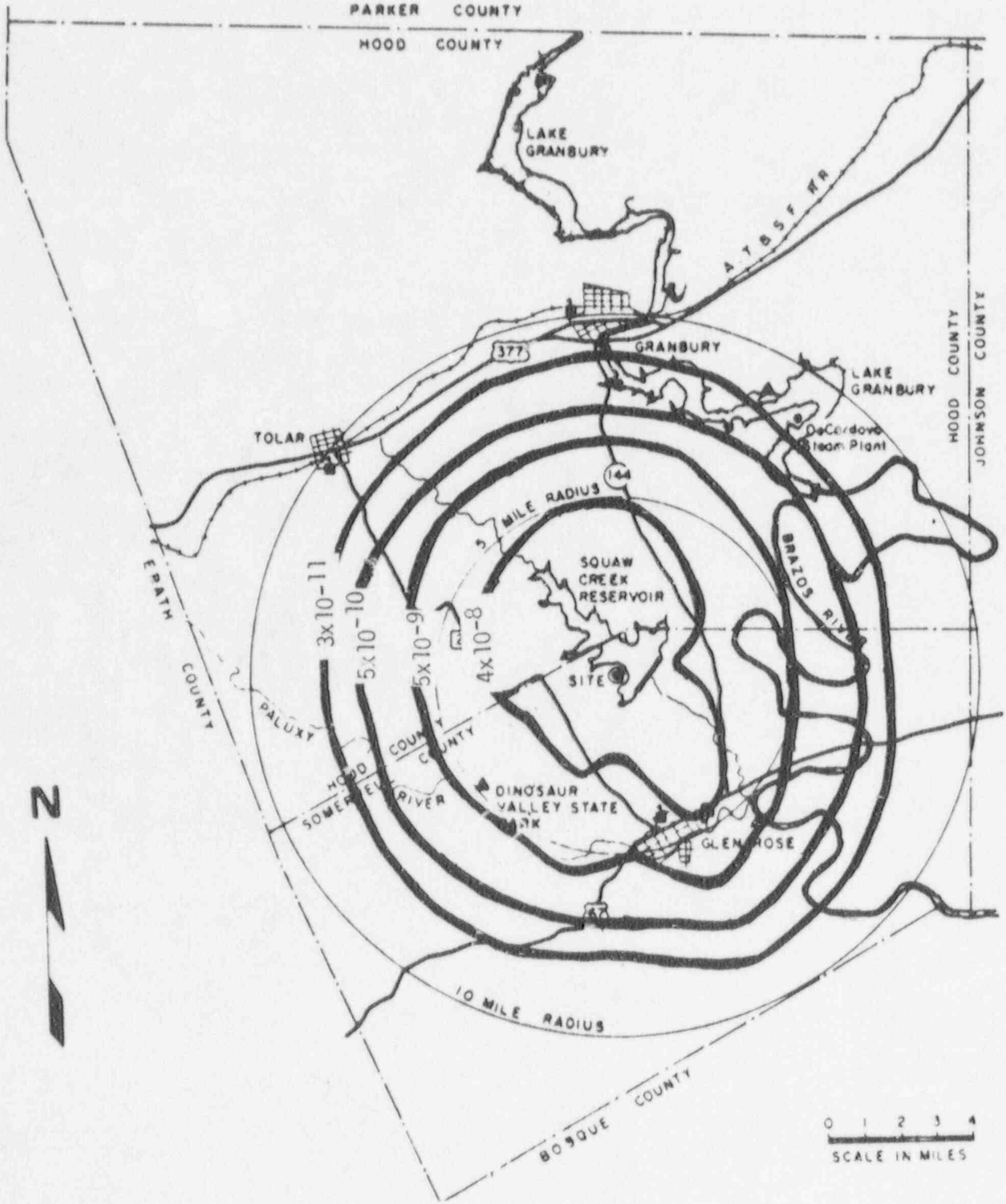

Figure 5.9.
Isopleths of Risk of Acute Fatality per Reactor Year for an Individual.

Note: To convert miles to kilometers multiply by 1.6.

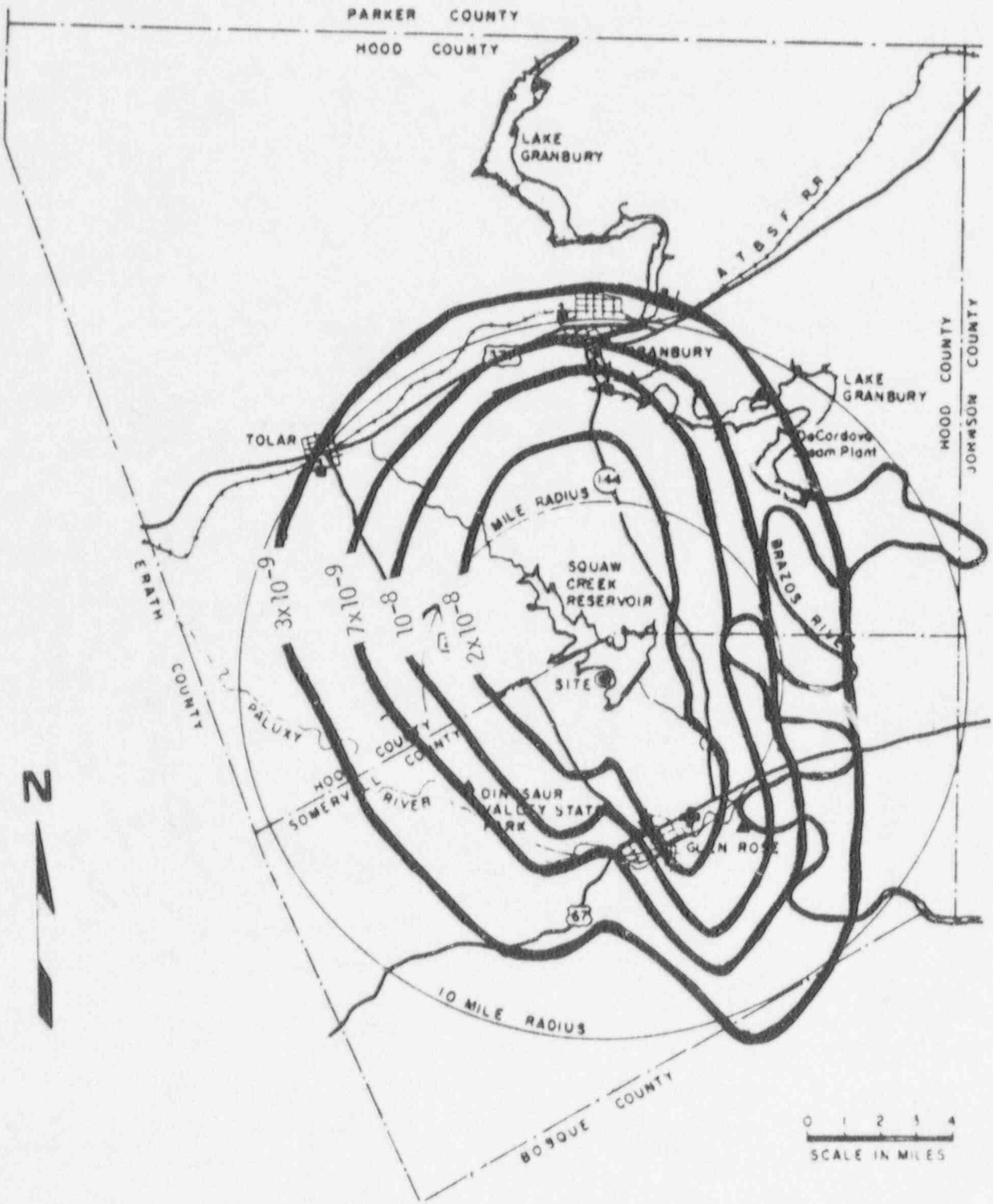

Figure 5.10.
Isopleths of Risk of Latent Cancer Fatality per Reactor Year to an Individual.

Note: To convert miles to kilometers multiply by 1.6.

chances in 100,000 per year, and if the "average" decontamination cost for these sequences is assumed to be one billion dollars, then the estimated economic risk would be about $48,000 per year.

Other costs besides damage to or loss of the facility result from accidents. The major additional costs are replacement power and either building a new facility or cleanup and decontamination of the damaged unit. These costs are affected by the point in the lifetime of the plant at which an accident might occur. The present worth cost is highest for an accident occuring at the beginning of the plant operating life and decreasing over the plant life. It is assumed for these calculations, that one unit of Comanche Peak 1 or 2 is permanently lost and replaced by new capacity after eight years and the undamaged unit is shutdown for three years before restart. For illustrative purposes, the costs and economic risk have been estimated for a "worst case" situation for the 2318 megawatt (electric) Comanche Peak station by postulating a total loss of one of the units in the first year of a projected 30 year operating life. Net replacement power cost of 19 mill/kWh is assumed. Using a 60% capacity factor, the annual cost of replacement power would be $230 million for the two units in 1980 dollars. The additional capital costs as a result of having to construct a new facility are $67 million per year, again in 1980 dollars.

If the probability of sustaining a total loss of the original facility is taken as the probability of the occurrence of a core melt accident (approximated by the sum of probabilities for the accident sequences and release category in Table 5.19, i.e., about 4.8 chances in 100,000 per year), then the average contribution to economic risk that would result from a loss early in the operating life of a Comanche Peak unit is about $15,000 for each of the first three years until the undamaged plant is returned to service, then $9100 per year until the damaged unit is replaced, and $3300 per year additional capital costs for the assumed remaining 22 years of plant service.

Uncertainties

The foregoing probabilistic and risk assessment discussion has been based upon the methodology presented in the Reactor Safety Study (RSS) which was published in 1975.

In July 1977, the NRC organized an Independent Risk Assessment Review Group to (1) clarify the achievements and limitations of the Reactor Safety Study Group, (2) assess the peer comments thereon and the responses to the comments, (3) study the current state of such risk assessment methodology, and (4) recommend to the Commission how and whether such methodology can be used in the regulatory and licensing process. The results of this study were issued in September 1978 (Ref. 30). This report, called the Lewis Report, contains several findings and recommendations concerning the RSS. Some of the more significant findings are summarized below.

1. A number of sources of both conservatism and nonconservatism in the probability calculations in RSS were found, which were very difficult to balance. The Review Group was unable to determine whether the overall probability of a core melt given in the RSS was high or low, but they did conclude that the error bands were understated.

2. The methodology, which was an important advance over earlier methodologies that had been applied to reactor risk, was sound.

3. It is very difficult to follow the detailed thread of calculations through the RSS. In particular, the Executive Summary is a poor description of the contents of the report, should not be used as such, and has lent itself to misuse in the discussion of reactor risk.

On January 19 1979, the Commission issued a statement of policy concerning the RSS and the Review Group Report. The Commission accepted the findings of the Review Group.

The accident at Three Mile Island occurred in March 1979 at a time when the accumulated experience record was about 400 reactor years. It is of interest to note that this was within the range of frequencies estimated by the RSS for an accident of this severity (Ref. 22, p. 553). It should also be noted that the Three Mile Island accident has resulted in a very comprehensive evaluation of reactor accidents like that one, by a significant number of investigative groups both within NRC and outside of it. Actions to improve the safety of nuclear power plants have come out of these investigations, including those from the President's Commission on the Accident at Three Mile Island, and NRC staff investigations and task forces. A comprehensive "NRC Action Plan Developed as a Result of the TMI-2 Accident," NUREG-0660, Vol. I, May 1980 collects the various recommendations of these groups and describes them under the subject areas of: Operational Safety; Siting and Design; Emergency Preparedness and Radiation Effects; Practices and Procedures; and NRC Policy, Organization and Management. The action plan presents a sequence of actions, some already taken, that will result in a gradually increasing improvement in safety as individual actions are completed. The Comanche Peak station is receiving and will receive the benefit of these actions on the schedule indicated in NUREG-0660. The improvement in safety from these actions has not been quantified, however, and the radiological risk of accidents discussed in this section does not reflect these improvements.

5.8.2.5 Conclusions

The foregoing sections consider the potential environmental impacts from accidents at the Comanche Peak facility. These have covered a broad spectrum of possible accidental releases of radioactive materials into the environment by atmospheric and groundwater pathways. Included in the considerations are postulated design basis accidents and more severe accident sequences that lead to a severely damaged reactor core or core melt.

The environmental impacts that have been considered include potential radiation exposures to individuals and to the population as a whole, the risk of near- and long-term adverse health effects that such exposures could entail, and the potential economic and societal consequences of accidental contamination of the environment. These impacts could be severe, but the likelihood of their occurrence is judged to be small. This conclusion is based on (a) the fact that considerable experience has been gained with the operation of similar facilities without significant degradation of the environment; (b) that, in order to obtain a license to operate the Comanche Peak facility, it must comply with the applicable Commission regulations and requirements; and (c) a probabilistic assessment of the risk based upon the methodology developed in the Reactor Safety Study. The overall assessment of environmental risk of accidents, assuming protective action, shows that it is less than the risk for normal operational releases, although accidents have a potential for acute fatalities and economic costs that cannot arise from normal operations. The risks of acute fatality from potential accidents at the site are small in comparison with the risks of acute fatality from other human activities in a comparably sized population.

We have concluded that there are no special or unique features about the Comanche Peak site and environs that would warrant special or additional engineered safety features for the Comanche Peak Steam Electric Station.

5.8.3 The Uranium Fuel Cycle

On March 14, 1977, the Commission presented in the Federal Register (42 FR 13803) an interim rule regarding the environmental considerations of the uranium fuel cycle. It revises Table S-3 of Paragraph (e) of 10 CFR Part 51.20. In a subsequent announcement on April 14, 1978 (43 FR 15613), the Commission further amended Table S-3 to delete the numerical entry for the estimate of radon releases and to explain that the table does not cover health effects. The effectiveness of the interim rule has been extended several times.

On July 27, 1979, the Commission approved a final rule setting out revised environmental-impact values for the uranium fuel cycle to be included in environmental reports and environmental statements for reactors (44 FR 45362). The final rule reflects the latest information relative to reprocessing of spent fuel and radioactive waste management as discussed in NUREG-0116, "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle" (Ref. 33), and NUREG-0216 (Ref. 34), which presents staff responses to comments on NUREG-0116. The rule also considers other environmental factors of the uranium fuel cycle, including aspects of mining and milling, isotopic enrichment, fuel fabrication, and management of low- and high-level wastes. These are described in the Atomic Energy Commission report WASH-1248, "Environmental Survey of the Uranium Fuel Cycle" (Ref. 35).

Specific categories of natural-resource use are included in Table S-3 of the final rule and are reproduced here as Table 5.22.* These categories relate to land use, water consumption, thermal effluents, radioactive releases, burial of transuranic and high- and low-level wastes, and radiation doses from transportation and occupational exposures. The contributions in Table S-3 for reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle); that is, the cycle that results in the greater impact is used.

The following assessment of the environmental impacts of the fuel cycle as related to the operation of the proposed project is based on the values given in Table S-3 and the staff's analysis of the radiological impact from radon releases. For the sake of consistency, the analysis of fuel-cycle impacts has been cast in terms of a model 1000-MWe light-water-cooled reactor (LWR) operating at an annual capacity factor of 80%. In the following review and evaluation of the environmental impacts of the fuel cycle, the staff's analysis and conclusions would not be altered if the analysis were to be based on the net electrical power output of the proposed project.

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*A narrative explanation of Table S-3 was published on 4 March 1981 in the Federal Register (46 FR 15154-15175).

Table 5.22. (Table S-3) Summary of Environmental Considerations for the Uranium Fuel Cycle

Normalized to model LWR annual fuel requirement (WASH-1248) or reference reactor year (NUREG-0116)

Natural resource use	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1000-MWe LWR
Land, acres		
Temporarily committed[b]	100	
Undisturbed area	79	
Disturbed area	22	Equivalent to 110-MWe coal-fired power plant
Permanently committed	13	
Overburden moved, millions of metric tons	2.8	Equivalent to 95-MWe coal-fired power plant
Water, millions of gallons		
Discharged to air	160	Equals 2% of model 1000-MWe LWR with cooling tower
Discharged to water bodies	11,090	
Discharged to ground	127	
Total	11,377	Less than 4% of model 1000-MWe LWR with once-through cooling
Fossil fuel		
Electrical energy, thousands of megawatt hours	323	Less than 5% of model 1000-MWe LWR output
Equivalent coal, thousands of metric tons	118	Equivalent to the consumption of a 45-MWe coal-fired power plant
Natural gas, millions of standard cubic feet	135	Less than 0.3% of model 1000-MWe energy output
Effluents – chemical, metric tons		
Gases (including entrainment)[c]		
SO_x	4,400	
NO_x[d]	1,190	Equivalent to emissions from 45-MWe coal-fired power plant for a year
Hydrocarbons	14	
CO	29.6	
Particulates	1,154	
Other gases		
F^-	0.67	Principally from UF_6 production, enrichment, and reprocessing. Concentration within range of state standards – below level that has effects on human health
HCl	0.014	
Liquids		
SO_4^{2-}	9.9	From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are: NH_3 – 600 cfs NO_3 – 20 cfs Fluoride – 70 cfs
NO_3^-	25.8	
Fluoride	12.9	
Ca^{2+}	5.4	
Cl^-	8.5	
Na^+	12.1	
NH_3	10.0	
Fe	0.4	
Tailings solutions, thousands of metric tons	240	From mills only – no significant effluents to environment
Solids	91,000	Principally from mills – no significant effluents to environment
Effluents – radiological, curies		
Gases (including entrainment)		
Rn-222		Presently under reconsideration by the Commission
Ra-226	0.02	
Th-230	0.02	
Uranium	0.034	
Tritium, thousands	18.1	
C-14	24	
Kr-85, thousands	400	
Ru-106	0.14	Principally from fuel reprocessing plants
I-129	1.3	
I-131	0.83	
Tc-99		Presently under consideration by the Commission
Fission products and transuranics	0.203	
Liquids		
Uranium and daughters	2.1	Principally from milling – included in tailings liquor and returned to ground – no effluents; therefore, no effect on environment
Ra-226	0.0034	From UF_6 production
Th-230	0.0015	
Th-234	0.01	From fuel fabrication plants – concentration 10% of 10 CFR Part 20 for total processing 26 annual fuel requirements for model LWR
Fission and activation products	5.9×10^{-6}	
Solids (buried on site)		
Other than high level (shallow)	11,300	9100 Ci come from low-level reactor wastes and 1500 Ci come from reactor decontamination and decommissioning – buried at land burial facilities. Mills produce 600 Ci – included in tailings returned to ground; about 60 Ci come from conversion and spent fuel storage. No significant effluent to the environment
TRU and HLW (deep)	1.1×10^7	Buried at Federal repository
Effluents – thermal, billions of British thermal units	4,063	Less than 4% of model 1000-MWe LWR
Transportation, person-rems	2.5	
Exposure of workers and general public		
Occupational exposure, person-rems	22.6	From reprocessing and waste management

[a] In some cases where no entry appears, it is clear from the background documents that the matter was addressed and that, in effect, this table should be read as if a specific zero entry had been made. However, there are other areas that are not addressed at all in this table. Table S-3 of WASH-1248 does not include health effects from the effluents described in this table or estimates of releases of Radon-222 from the uranium fuel cycle. These issues which are not addressed at all by this table may be the subject of litigation in individual licensing proceedings. Data supporting this table are given in the *Environmental Survey of the Uranium Fuel Cycle*, WASH-1248, April 1974; the *Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle*, NUREG-0116 (Suppl. 1 to WASH-1248); and the *Discussion of Comments Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle*, NUREG-0216 (Suppl. 2 to WASH-1248). The contributions from reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no-recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor which are considered in Table S-4 of Sect. 51.20(g). The contributions from the other steps of the fuel cycle are given in columns A – E of Table S-3A of WASH-1248.

[b] The contributions to temporarily committed land from reprocessing are not prorated over 30 years, because the complete temporary impact accrues regardless of whether the plant services 1 reactor for 1 year or 57 reactors for 30 years.

[c] Estimated effluents based on combustion of equivalent coal for power generation.

[d] 1.2% from natural gas use and process.

5.8.3.1 Land Use

The total annual land requirement for the fuel cycle supporting a model 1000-MWe LWR is about 46 ha. About 5 ha/yr are permanently committed land and 41 ha/yr are temporarily committed. (A "temporary" land commitment is a commitment for the life of the specific fuel-cycle plant; e.g. mill, enrichment plant, or succeeding plants. On abandonment or decommissioning, such land can be used for any purpose. "Permanent" commitments represent land that may not be released for use after plant shutdown and/or decommissioning.) Of the 41 ha/yr of temporarily committed land, 32 ha/yr are undisturbed and 9 ha/yr are disturbed. Considering common classes of land use in the United States,* fuel-cycle land-use requirements to support the model 1000-MWe LWR do not represent a significant impact.

5.8.3.2 Water Use

The principal water-use requirement for the fuel cycle supporting a model 1000-MWe LWR is that required for removal of waste heat from the power stations supplying electrical energy to the enrichment step of this cycle. Of the total annual requirement of 43×10^6 m^3, about 42×10^6 m^3 are required for this purpose, assuming that these plants use once-through cooling. Other water uses involve the discharge to air (e.g. evaporation losses in process cooling) of about 0.6×10^6 m^3/yr and water discharged to ground (e.g. mine drainage) of about 0.5×10^6 m^3/yr.

On a thermal-effluent basis, annual discharges from the nuclear fuel cycle are about 4% of those from the model 1000-MWe LWR using once-through cooling. The consumptive water use of 0.6×10^6 m^3/yr is about 2% of that from the model 1000-MWe LWR using cooling towers. The maximum consumptive water use (assuming that all plants supplying electrical energy to the nuclear fuel cycle use cooling towers) would be about 6% of that of the model 1000-MWe LWR using cooling towers. Under this condition, thermal effluents would be negligible. The staff finds that these combinations of thermal loadings and water consumption are acceptable relative to the water use and thermal discharges of the proposed project.

5.8.3.3 Fossil-Fuel Consumption

Electrical energy and process heat are required during various phases of the fuel-cycle process. The electrical energy is usually produced by the combustion of fossil fuel at conventional power plants. Electrical energy associated with the fuel cycle represents about 5% of the annual electrical power production of the model 1000-MWe LWR. Process heat is generated primarily by the combustion of natural gas. This gas consumption, if used to generate electricity, would be less than 0.3% of the electrical output from the model plant. The staff finds that the direct and indirect consumptions of electrical energy for fuel-cycle operations are small and acceptable relative to the net power production of the proposed project.

5.8.3.4 Chemical Effluents

The quantities of chemical, gaseous, and particulate effluents associated with fuel-cycle-processes are given in Table S-3. The principal species are sulfur

*A coal-fired power plant of 1000-MWe capacity using strip-mined coal requires the disturbance of about 81 ha/yr for fuel alone.

oxides, nitrogen oxides, and particulates. Judging from data in a Council on Environmental Quality report (Ref. 36), the staff finds that these emissions constitute an extremely small additional atmospheric loading in comparison with those from the stationary fuel-combustion and -transportation sectors in the United States; i.e. about 0.02% of the annual national releases for each of these species. The staff believes that such small increases in releases of these pollutants are acceptable.

Liquid chemical effluents produced in fuel-cycle processes are related to fuel-enrichment, -fabrication, and -reprocessing operations and may be released to receiving waters. These effluents are usually present in dilute concentrations such that only small amounts of dilution water are required to reach levels of concentration that are within established standards. The flow of dilution water required for specific constituents is specified in Table S-3. Additionally, all liquid discharges into the navigable waters of the United States from plants associated with the fuel-cycle operations will be subject to requirements and limitations set forth in the NPDES permit.

Tailings solutions and solids are generated during the milling process. These solutions and solids are not released in quantities sufficient to have a significant impact on the environment.

5.8.3.5 Radioactive Effluents

Radioactive effluents estimated to be released to the environment from reprocessing and waste-management activities and certain other phases of the fuel-cycle process are listed in Table S-3. Using these data, the staff has calculated the 100-year involuntary environmental dose commitment* to the U.S. population. It is estimated from these calculations that the overall involuntary total-body gaseous dose commitment to the U.S. population from the fuel cycle (excluding reactor releases and the dose commitment due to radon-222) would be about 400 person-rem for each year of operation of the model 1000-MWe LWR (reference reactor year, or, RRY). Based on Table S-3 values, the additional involuntary total-body dose commitment to the U.S. population from radioactive liquid effluents due to all fuel-cycle operations other than reactor operation would be about 100 person-rem for each year of operation. Thus, the estimated involuntary 100-year environmental dose commitment to the U.S. population from radioactive gaseous and liquid releases due to these portions of the fuel cycle is about 500 person-rem (whole body) per RRY.

At this time, the radiological impacts associated with radon-222 releases are not addressed in Table S-3. Principal radon releases occur during mining and milling operations and as emissions from mill tailings. The staff has determined that releases per RRY from these operations are as given in Table 5.23. The staff has calculated population-dose commitments for these sources of radon-222 using the RABGAD computer code described in NUREG-0002, Appendix A, Section IV.J (Ref. 37). The results of these calculations for mining and milling activities prior to reclamation of open-pit uranium mines and tailings stabilization are given in Table 5.24.

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*The environmental dose commitment (EDC) is the integrated population dose for 100 years; i.e. it represents the sum of the annual population doses for a total of 100 years. The population dose varies with time, and it is not practical to calculate this dose for every year.

Table 5.23. Radon Releases from Mining and Milling Operations and Mill Tailings for Each Year of Operation of the Model 1000-MWe LWR

Source	Radon-222 Release
Mining†[1]	4060 Ci
Milling and tailings†[2] (during active milling)	780 Ci
Inactive tailings†[2] (prior to stabilization)	350 Ci
Stabilized tailings†[2] (for several hundred years)	1 to 10 Ci/yr
Stabilized tailings†[2] (after several hundred years)	110 Ci/yr

†[1] Testimony of R. Wilde from: "In the Matter of Duke Power Company (Perkins Nuclear Station)," U.S. Nuclear Regulatory Commission, Docket No. 50-488, filed April 17, 1978.

†[2] Testimony of P. Magno from: "In the Matter of Duke Power Company (Perkins Nuclear Station)," U.S. Nuclear Regulatory Commission, Docket No. 50-488, filed April 17, 1978.

Table 5.24. Estimated 100-Year Environmental Dose Commitment for Each Year of Operation of the Model 1000-MWe LWR

Source	Radon-222 Release (Ci)	Population-Dose Commitment (person-rem)		
		Total Body	Bone	Lung (bronchial epithelium)
Mining	4100	110	2800	2300
Milling and active tailings	1100	29	750	620
Total		140	3600	2900

When added to the 500 person-rem total-body dose commitment for the balance of the fuel cycle, the overall estimated total-body involuntary 100-year environmental dose commitment to the U.S. population from the fuel cycle for the model 1000-MWe LWR is about 640 person-rem. Over this period of time, this dose is equivalent to 0.00002% of the natural-background total-body dose of about three billion person-rem to the U.S. population.*

The staff has considered health effects associated with the releases of radon-222, including both the short-term effects of mining, milling, and active tailings, and the potential long-term effects from unreclaimed open-pit mines and stabilized tailings. The staff has assumed that underground mines will be sealed after completion of active mining, with the result that releases of radon-222 from them will return to background levels. For purposes of providing an upper-bound impact assessment, the staff has assumed that open-pit mines will be unreclaimed and has calculated that if all ore were produced from open-pit mines, releases from them would be 110 Ci/yr per RRY. However, because the distribution of uranium-ore reserves available using conventional mining methods is 66.8% underground and 33.2% open-pit (Ref. 38), the staff has further assumed that uranium to fuel LWRs will be produced by conventional mining methods in these proportions. This means that long-term releases from unreclaimed open-pit mines will be 37 Ci/yr (0.332 × 110) per RRY.

Based on these assumptions, the radon released from unreclaimed open-pit mines over 100- and 1000-year periods would be about 3700 Ci and 37,000 Ci per RRY, respectively. The total dose commitments for periods of 100, 500, and 1000 years would be as shown in Table 5.25. These commitments represent a worst-case situation because no mitigating circumstances are assumed. However, state and Federal laws currently require reclamation of strip and open-pit coal mines, and it is very probable that similar reclamation will be required for open-pit uranium mines. If so, long-term releases from such mines should approach background levels.

Table 5.25. Population-Dose Commitments from Unreclaimed Open-Pit Mines for Each Year of Operation of the Model 1000-MWe LWR

		Population-Dose Commitment (person-rem)		
Time Period (yr)	Radon-222 Release (Ci)	Total Body	Bone	Lung (bronchial epithelium)
100	3,700	96	2,500	2,000
500	19,000	480	13,000	11,000
1,000	37,000	960	25,000	20,000

*Based on an annual average natural-background individual dose commitment of 100 mrem and a stabilized U.S. population of 300 million.

For long-term radon releases from stabilized-tailings piles the staff has assumed that the tailings would emit, per RRY, 1 Ci/yr for 100 years, 10 Ci/yr for the next 400 years, and 100 Ci/yr for periods beyond 500 years. With these assumptions, the cumulative radon-222 release per RRY from stabilized-tailings piles would be 100 Ci in 100 years, 4090 Ci in 500 years, and 53,800 Ci in 1000 years (Ref. 39). The total-body, bone, and bronchial-epithelium dose commitments for these periods are as shown in Table 5.26.

Table 5.26. Population-Dose Commitments from Stabilized-Tailings Piles for Each Year of Operation of the Model 1000-MWe LWR

Time Period (yr)	Radon-222 Release (Ci)	Population-Dose Commitment (person-rem)		
		Total Body	Bone	Lung (bronchial epithelium)
100	100	2.6	68	56
500	4,090	110	2,800	2,300
1,000	53,800	1,400	37,000	30,000

Using risk estimators of 135, 6.9, and 22.2 cancer deaths per million person-rem for total-body, bone, and lung exposures, respectively, the estimated risk of cancer mortality due to mining, milling, and active-tailings emissions of radon-222 is about 0.11 cancer fatality per RRY. When the risk due to radon-222 emissions from stabilized tailings over a 100-year release period is added, the estimated risk of cancer mortality over a 100-year period is unchanged. Similarly, a risk of about 1.2 cancer fatalities per RRY over a 1000-year release period is estimated. When potential radon releases from reclaimed and unreclaimed open-pit mines are included, the overall risks of radon-induced cancer fatalities per RRY range as follows:

0.11-0.19 fatality for a 100-year period,
0.19-0.57 fatality for a 500-year period, and
1.2 -2.0 fatalities for a 1000-year period.

To illustrate: A single model 1000-MWe LWR operating at an 80% capacity factor for 30 years would be predicted to induce between 3.3 and 5.7 cancer fatalities in 100 years, 5.7 and 17 in 500 years, and 36 and 60 in 1000 years as a result of releases of radon-222.

These doses and predicted health effects have been compared with those that can be expected from natural-background emissions of radon-222. Using data from the National Council on Radiation Protection (NCRP) (Ref. 40), the average radon-222 concentration in air in the contiguous United States is about 150 pCi/m^3, which the NCRP estimates will result in an annual dose to the bronchial epithelium of 450 mrem. For a stabilized future U.S. population of 300 million, this represents a total lung-dose commitment of 135 million person-rem per year. Using the same risk estimator of 22.2 lung-cancer fatalities per million person-rem (lung) used to predict cancer fatalities for the model 1000-MWe LWR, lung-cancer fatalities alone from background radon-222 in the air can be calculated to be about 3000 per year, or 300,000 to 3,000,000 lung-cancer deaths over periods of 100 and 1000 years, respectively.

In addition to the radon-related potential health effects from the fuel cycle, other nuclides produced in the cycle, such as carbon-14, will contribute to population exposures. It is estimated that an additional 0.08 to 0.12 cancer death per RRY may occur (assuming that no cure for or prevention of cancer is ever developed) over the next 100 to 1000 years, respectively, from exposures to these other nuclides.

These exposures also can be compared with those from naturally-occurring terrestrial and cosmic-ray sources, which average about 100 mrem. Therefore, for a stable future population of 300 million persons, the whole-body dose commitment would be about 30 million person-rem per year, or three billion person-rem and 30 billion person-rem for periods of 100 and 1000 years, respectively. These dose commitments could produce about 400,000 and 4,000,000 cancer deaths during the same time periods. From the above analysis the staff concludes that both the dose commitments and health effects of the uranium fuel cycle are insignificant when compared with dose commitments and potential health effects to the U.S. population resulting from all natural-background sources.

5.8.3.6 Radioactive Wastes

The quantities of buried radioactive waste material (low-level, high-level, and transuranic wastes) are specified in Table S-3. For low-level waste disposal at land-burial facilities, the Commission notes in Table S-3 that there will be no significant radioactive releases to the environment. For high-level and transuranic wastes, the Commission notes that these are to be buried at a Federal repository, and that no release to the environment is associated with such disposal. It is indicated in NUREG-0116 (Ref. 33), in which are provided background and context for the high-level and transuranic Table S-3 values established by the Commission, that these high-level and transuranic wastes will be buried and will not be released to the biosphere. No radiological environmental impact is expected from such disposal.

5.8.3.7 Occupational Dose

The annual occupational dose attributable to all phases of the fuel cycle for the model 1000-MWe LWR is about 200 person-rem. The staff concludes that this occupational dose will not have a significant environmental impact.

5.8.3.8 Transportation

The transportation dose to workers and the public is specified in Table 5.15. This dose is small and is not considered significant in comparison with the natural-background dose.

5.8.3.9 Fuel Cycle

The staff analysis of the uranium fuel cycle does not depend on the selected fuel cycle (no recycle or uranium-only recycle), because the data provided in Table S-3 include maximum recycle-option impact for each element of the fuel cycle. Thus, the staff's conclusions as to acceptability of the environmental impacts of the fuel cycle are not affected by the specific fuel cycle selected.

5.9 Decommissioning

5.9.1 Introduction

NRC regulations do not require the applicant to submit decommissioning plans at the time of application for an operating license. Consequently, no definite plan for the decommissioning of the station has been developed. At the end of the station's useful lifetime, the applicant will prepare a proposed decommissioning plan for review by the NRC. The plan will comply with NRC rules and regulations then in effect.

5.9.2 New Information Provided by the Applicant Regarding Decommissioning

New information on the methodologies available and the costs for decommissioning nuclear power plants has become available since the publication of the FES-CP (Refs. 41, 42, and 43). The applicant has used this new information to estimate the economic costs of decommissioning CPSES. These costs and the applicant's present plans for decommissioning the Squaw Creek site are presented in the ER-OL (Sec. 5.8) and are summarized below.

The applicant plans to decommission both CPSES units together at the end of their economic operating life. However, the applicant does not plan to abandon the site and drain Squaw Creek Reservoir because (1) SCR is judged by the applicant to be an aquatic resource of significant value to the local area and (2) the site is judged by the applicant to be a good location for a power production facility and could be suitable for this purpose after CPSES has been decommissioned.

For the purpose of estimating costs only, the applicant has estimated that decommissioning CPSES will cost $42.1 million per unit (1978 dollars), based on the "immediate dismantlement" method for a reference PWR facility given in NUREG/CR-0130 (Refs. 41 and 42). Under this method, radioactive materials are removed and the station is disassembled and decontaminated during the four-year period following cessation of power production operations. Upon completion, the property could be released for unrestricted use.

5.9.3 New Information Provided by the Staff Regarding Decommissioning

The staff's assessment of the impacts resulting from the various decommissioning methodologies available for nuclear power plants has been updated from that presented in the FES-CP (Sec. 10.2.4) and is presented in NUREG-0586 (Ref. 43). This assessment is summarized below.

The technology for decommissioning nuclear facilities is well established. Although technical improvements in decommissioning techniques are to be expected, at the present time decommissioning can be performed safely and at reasonable cost. Radiation doses to the public as a result of decommissioning activities should be very small and would come primarily from the transportation of decommissioning waste to waste-burial grounds. Radiation doses to decommissioning workers should be a small fraction of the exposure they experience over the operating lifetime of the facility; these doses usually will be well within the occupational-exposure limits imposed by regulatory requirements. Decommissioning costs are reasonable and, at least for larger facilities such as reactors, are a small fraction of the present-worth commissioning costs (less than 10%).

Decommissioning of nuclear facilities is not an imminent health-and-safety problem. However, planning for decommissioning can affect health and safety as well as cost. Essential to such planning activity are the decommissioning alternative to be used and the timing of decommissioning. Also to be considered are (1) acceptable residual-radioactivity levels for unrestricted use of the facility, (2) financial assurance that funds will be available for performing required decommissioning activities at the end of facility operation (including premature closure), and (3) the facilitation of decommissioning. Decommissioning of a nuclear facility generally has a positive environmental impact. At the end of facility life, termination of a nuclear license is required. Such termination requires decontamination of the facility so that the level of any residual radioactivity remaining in the facility or on the site is low enough to allow either unrestricted use of the facility and the site or recommissioning of the facility as a nuclear or nonnuclear power plant.

Compared to operational requirements, the commitment of resources for decommissioning is generally small. The major environmental impact of decommissioning is the commitment of small amounts of land for the burial of waste. This is in exchange for being able to reuse the facility and site for other nuclear or nonnuclear purposes. Because in many instances (such as at a reactor facility) the land has valuable resource capability, the return of this land to the commercial or public sector is highly desirable. In decommissioning nuclear facilities, the objective of NRC regulatory policy is to ensure that proper and explicit procedures are followed to mitigate any potential for adverse impact on public health and safety or on the environment.

Three alternative methods can be and have been used to decommission reactors. "DECON" is defined as immediate removal of the radioactive materials, thereby reducing radioactivity to levels that would permit the property to be released for unrestricted use. "SAFSTOR" is defined as those activities required to place and maintain a radioactive facility in such condition that (1) the risk to safety is within acceptable bounds and (2) the facility can be safely stored for as long a time as desired and subsequently decontaminated to levels that would permit release of the facility for unrestricted use. SAFSTOR consists of a short period of preparation for safe storage; a safe-storage period of continuing care consisting of security, surveillance, and maintenance (variable length up to 100 years); and a short period of deferred decontamination. Several variations of SAFSTOR are possible. "ENTOMB" means to encase and maintain property in a strong and structurally long-lived material to ensure retention until radioactivity decays to a level acceptable for releasing the facility for unrestricted use. ENTOMB is intended for use where the residual radioactivity will decay to levels permitting unrestricted release of the facility within a reasonable period of time.

Estimated costs of decommissioning vary, depending on the characteristics of the particular reactor and the decommissioning mode chosen. For a large PWR, DECON is estimated to cost $33.3 million (in 1978 dollars). SAFSTOR is estimated to cost $42.8 million with a 30-year safe-storage period and $41.8 million with a 100-year safe-storage period and $41.8 million with a 100-year safe-storage period. ENTOMB is estimated to cost $20.3 million with the pressure vessel and its internals retained and $27.4 million with the pressure vessel and internals removed, plus a $40,000 annual maintenance-and-surveillance cost in both cases.

5.9.4 Conclusion

The NRC staff makes the following preliminary conclusions on decommissioning impacts (Ref. 43):

> The technical basis exists for performing decommissioning in a safe, efficient and timely manner. Decommissioning as used here means to safely remove contaminant radioactive material down to residual levels considered acceptable for permitting unrestricted use of a facility and its site. Decommissioning has major beneficial impact because it allows a nuclear facility which no longer has operational value to be made available for unrestricted use. Moreover, making the facility available for unrestricted use eliminates the potential problems of increased numbers of sites used for the confinement of radioactively contaminated materials, as well as potential health, safety, regulatory and economic problems; and also releases valuable industrial land that can be reused with great benefit. When properly performed, decommissioning has only minor adverse impact. These include: an occupational dose burden which is of marginal significance to health and safety and which is a small percent of such burden experienced over the operational life of a facility; a relatively modest cost compared to the net present worth of the commissioning cost; and the irreversible commitment of a small amount of land (primarily for low-level waste) at an appropriate radioactive waste burial facility.

For CPSES, the applicant's decommissioning cost estimate does not differ significantly from the staff's estimate for the comparable method, "DECON."

5.10 Emergency Planning

In connection with the promulgation of the Commission's upgraded emergency planning requirements, the NRC staff (Office of Standards Development) issued NUREG-0685, "Environmental Assessment for Effective Changes to 10 CFR Part 50 and Appendix E to 10 CFR Part 50; Emergency Planning Requirements for Nuclear Power Plants," (August 1980). At this time, however, the staff does not have sufficient information to determine whether any environmental impacts will result from implementation by the applicant of the upgraded emergency planning requirements in 10 CFR Part 50, Appendix E, such as construction of a near-site emergency operations facility and the conduct of emergency preparedness exercises. Upon receipt of all components of the applicant's emergency plan and implementing procedures, the staff will be in a position to determine whether or not such plan and implementing procedures will result in any environmental impacts.

5.11 Measures and Controls to Limit Adverse Impacts

5.11.1 Project Design

The assessment of the potential environmental impacts resulting from the design of the Comanche Peak Steam Electric Station, as it relates to operation, has been updated in this environmental statement. The staff has concluded, with the exception of the station circulating water intake structure, that the expected impacts are acceptable and do not require additional measures and controls to limit adverse impacts.

In the staff's assessment of the potential environmental impact of the operation of the circulating water intake structure, the staff concludes that loss of aquatic biota will occur through entrainment and impingement. However, the magnitude of this loss and its resultant impact on aquatic biotic populations in SCR is not presently quantifiable (Sec. 5.5.2). A study program, to be conducted during the initial years of station operation, is required under the provisions of the EPA-issued NPDES permit for CPSES (see App. E) to determine the effects of the intake structure on aquatic biota during operation. Changes in the location, design, construction, or capacity of the intake structure may be required if it is determined that the structure does not represent the best technology available for minimizing adverse environmental impact, under Section 316(b) of the Clean Water Act. Under the provisions of the Second Memorandum of Understanding Between NRC and EPA, (Ref. 44) the NRC will be informed of the results of the study and, based on the results of the study, will assess the environmental impacts of operation of the intake structure. The NRC will rely on the decision made under the authority of the Clean Water Act for any requirement for a design change to the intake structure.

5.11.2 Operating Practices

The assessment of the potential environmental impacts resulting from the operating practices of the Comanche Peak Steam Electric Station have been updated in this environmental statement. The staff has concluded that the expected impacts are acceptable and do not require additional measures and controls to limit adverse impacts, with the exception of (1) the potential pumping of groundwater for station water use for other than circulating cooling water and (2) the use of chlorine for biofouling control in the station circulating cooling water system.

In the staff's assessment of the potential adverse impacts of the water withdrawal for use in station water systems, the staff identified a potential adverse impact resulting from the use of groundwater as a primary source for systems other than the circulating cooling water systems (Sec. 5.3.1). The staff concludes that the magnitude of this adverse impact can be mitigated through a change in plant operating procedures. The staff recommends that an operating license condition be imposed which would restrict the use of groundwater by CPSES to (1) potable and sanitary purposes and (2) supplementation of the supply of treated surface water during short periods of peak demand when station requirements exceed the capacity of the surface water treatment plant (Sec. 5.3.1.2).

In the staff's assessment of the use of chlorine for biofouling control at CPSES, the staff concluded that there exists a potential for adverse impact on aquatic biota in the vicinity of the station discharge structure due to the toxicity of residual chlorine in the discharge and that the proposed discharge concentrations were unnecessarily high (FES-CP, Secs. 3.6.2 and 11.6.1). A study program, to be conducted during the initial years of station operation, is required under the provisions of the EPA-issued NPDES permit for CPSES (see App. E) to demonstrate the minimum level of chlorination necessary to prevent biofouling of the condenser tubes. Under the provisions of the Second Memorandum of Understanding Between NRC and EPA (Ref. 44), the NRC will be informed of the results of the study and, based on the results of the study, will assess the environmental impacts of the final chlorination program demonstrated as necessary under this study. The NRC will rely on the decision made under the authority of the Clean Water Act for any requirement for a change in the chlorination program at CPSES.

5.11.3 Monitoring Provisions

5.11.3.1 Nonradiological

Preoperational Programs

The applicant's preoperational environmental monitoring programs were originally described in the ER-CP (Sec. 6.1). These programs were evaluated, and recommended modifications to the programs were made by the staff in the FES-CP (Sec. 6.1). The preoperational monitoring that was actually conducted by the applicant is described in the ER-OL (Sec. 6.1). The results of these programs, since publication of the FES-CP, have been evaluated by the staff and are presented in this environmental statement as indicated below.

The preoperational onsite meteorological program provided data for three additional years (May [illegible]73 to May 1976). Data on temperature and wind speed and direction were c[illegible]d. The data are summarized in Section 4.3.3.1.

The preoperational surface-water monitoring program provided data on physical, chemical, and ecological parameters in Squaw Creek below the SCR dam site, in Lake Granbury near the SCR makeup-water pumping station and blowdown discharge, in the Paluxy River near its confluence with the Brazos River, and in the Brazos River downstream of Lake Granbury. The data included the physical and chemical parameters of streamflow, temperature, conductivity, turbidity, pH, dissolved oxygen, and alkalinity; and the ecological measures of phytoplankton and zooplankton densities, aquatic macrophyte abundance, benthic macroinvertebrate community composition, and fish population composition, size, and condition. These measurements were made during 1974 through 1979. The results are summarized in Section 4.3.4.2. A larval fish study in Lake Granbury was also conducted by the applicant in 1978. The results of this study are summarized in Section 4.3.4.2.

The preoperational groundwater monitoring program provided data on the level and chemical quality of the groundwater in four observation wells onsite. In addition, the program provided data on the amount of groundwater used during construction. These data were for April 1975 through May 1979. The data are summarized in Section 5.3.1.2.

The preoperational terrestrial monitoring program provided data on land use and terrestrial ecology on and in the vicinity of the CPSES site and transmission-line and water-pipeline rights-of-way. The collected data on land-use types are summarized in Section 4.3.1. The ecological data includes types, numbers, and distribution of terrestrial invertebrates for 1975, 1977, and 1979; types and distribution of herpetofauna for 1975 through 1979; and types, numbers, and distribution of birds for 1975 through 1979. These data are summarized in Section 4.3.4.1.

Since issuance of the CPSES construction permits in 1974, the staff has received specific guidance with regard to imposing conditions for protection of the aquatic environment. Decisions* of the Atomic Safety and Licensing Appeals Board (ASLAB) have held as a matter of law that the NRC does not have the requisite legal authority for including conditions of its own for the protection of the aquatic environment because the Clean Water Act placed full responsibility for these matters with the Environmental Protection Agency. In accordance with the ASLAB's findings, prior staff practice has been modified to include (1) emphasis on coordination with EPA and state permitting agencies during environmental reviews and (2) reliance on the certifications and permits issued under the Clean Water Act for protection of water quality and aquatic biota. For these reasons, the staff has not recommended that any nonradiological aquatic monitoring be done. Rather, aquatic environmental monitoring will be conducted at CPSES in accordance with the requirements of the NPDES permit for the station. Aquatic monitoring programs required by the NPDES permit are described in Secs 4.2.4.1 and 5.5.2 and Appendix E.

With regard to nonradiological terrestrial environmental monitoring, the staff's independent assessment of the operation of CPSES, as presented in this environmental statement (Sec. 5.2 and 5.5.1), has not identified any causal links between station operation and impacts to the terrestrial environment. Therefore, the staff does not recommend any nonradiological terrestrial environmental monitoring for implementation at CPSES.

5.11.3.2 Radiological

Radiological environmental-monitoring programs are established to provide data on measurable levels of radiation and radioactive materials in the site environs. Appendix I to 10 CFR Part 50 requires that the relationship between quantities of radioactive material released in effluents during normal operation, including anticipated operational occurrences, and resultant radioactive doses to individuals from principal pathways of exposure be evaluated. Monitoring programs are conducted to verify the effectiveness of in-plant controls used for reducing the release of radioactive materials and to provide public reassurance that undetected radioactivity will not build up in the environment. A surveillance program is established to identify changes in the use of unrestricted areas to provide a basis for modifications of the monitoring programs.

<u>Preoperational Programs</u>

The preoperational phase of the monitoring program provides for the measurement of background levels and their variations along the anticipated important

*See Carolina Power and Light Company (H.B. Robinson, Unit 2), ALAB-569, 10 NRC 557 (1979); Philadelphia Electric Company (Peach Bottom Atomic Power Station, Unit 3), ALAB-532, 9 NRC 279 (1979); Tennessee Valley Authority (Yellow Creek Nuclear Plant, Units 1 and 2), ALAB-515, 8 NRC 702 (1978).

pathways in the area surrounding the facility, the training of personnel, and the evaluation of procedures, equipment, and techniques. This is discussed in greater detail in NRC Regulatory Guide 4.1, Rev. 1, "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants," and the Radiological Assessment Branch Technical Position, "An Acceptable Radiological Environmental Monitoring Program," March 1978.

The applicant has proposed a radiological environmental-monitoring program to meet the objectives discussed above. It is presented in the ER-OL (Sec. 6.1.5). The sample types, criteria for selection, collection frequencies, locations, and analyses which are to be performed are presented in Table 3.12-1 of the Standard Radiological Technical Specifications, NUREG-0472 "Radiological Effluent Technical Specifications for PWR's," Revision 3, March 1979.

The applicant proposes to initiate parts of the program two years prior to the start of station operation, with the remaining portions beginning either six months or one year prior to operation.

The staff concludes that the preoperational monitoring program proposed by the applicant appears to meet the objectives of the staff guidelines discussed above and is acceptable.

Operational Programs

The operational offsite radiological-monitoring program is conducted to measure radiation levels and radioactivity in plant environs. It assists and provides backup support to the effluent-monitoring program as recommended in NRC Regulatory Guide 1.21, "Measuring, Evaluating and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water Cooled Nuclear Power Plants." The effluent-monitoring program is required to evaluate individual and population exposures and verify projected or anticipated radioactivity concentrations.

The applicant plans essentially to continue the proposed preoperational program during the operating period. However, refinements may be made in the program to reflect changes in land use or preoperational-monitoring experience.

An evaluation of the applicant's proposed operational-monitoring program is being performed, and the details of the required monitoring program will be incorporated in the environmental technical specifications for the operating license.

5.12 Unavoidable Adverse Impacts

The staff has reassessed the physical, social, biological, and economic impacts that can be attributed to the operation of CPSES. Inasmuch as the units are currently under construction, and the water-cooling system (Squaw Creek Reservoir) is essentially complete, many of the predicted and expected adverse impacts of the construction phase are evident. The staff has not identified any additional adverse effects other than those presented in the FES-CP that will be caused by the operation of the station. The applicant is committed to a program of reclamation and restoration of the station site that will begin at the end of the construction period.

5.13 Irreversible and Irretrievable Commitments of Resources

There has been no change in the staff's assessment of these impacts from those presented in the FES-CP (Sec. 10.3) except that the continuing escalation of costs has increased the dollar values of uranium fuel for the plant. Changes in these values are discussed in Section 2.2.

5.14 Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

There have been no changes in the staff's evaluation of the use of land for CPSES since the staff's analysis of land use in the FES-CP (Sec. 5.1.1). The staff's evaluation of transmission-line impacts remains the same as in the FES-CP (Sec. 5.12).

5.15 Possible Conflicts

The staff has considered local land use and determined that use of the site for power generation was acceptable (Affidavit of Dr. [illegible] Kline, April 14, 1975). There is no new information regarding the staff's conclusions on local land use. Accordingly, the staff concludes that there are no possible conflicts between the proposed action and the objectives of Federal, regional, state, and local land-use plans, policies, and controls for the area concerned.

5.16 Benefit-Cost Summary

5.16.1 Benefits

The primary benefits to be derived from operation of the CPSES units include about 12 billion kWh of baseload electrical energy that the station will be able to produce annually (this projection assumes that both units will operate at an average 65% capacity factor) (Sec. 2.2). Another primary benefit is the improved reliability of the TUCS system brought about by the addition of 2300 MWe of generating capacity to the system, as well as the saving of about $150 million in production costs per unit per year (Sec. 2.4). Finally, the operation of CPSES will increase the diversity of fuel supply of the TUCS system by providing baseload generating capacity using a fuel type other than the natural gas, oil or lignite fuels presently used by the TUCS system (Sec. 2.3).

Secondary benefits arising from operation of CPSES include wages paid to 187 operating personnel (about $5 million per year in 1982) and taxes paid to local political subdivisions (Secs. 5.7.1 and 5.7.2). The taxes are estimated to be about $700,000 per year in every year of operation, but are subject to renegotiation by TUCS and country and state taxing bodies. This includes payments to school districts in the cities of Glen Rose, Granbury, and Tolar, which amount to more than one-half the total.

5.16.2 Costs

5.16.2.1 Economic

The economic costs associated with station operation include fuel costs and operation and maintenance costs, which--for 1985, the first full year both units are to be operating commercially--are 9 mills/kWh and 3.5 mills/kWh in

1985 dollars, respectively (ER-OL, Amend. 1, Response to Staff Question 21). The cost of decommissioning is a small additional cost of station operation. The staff's estimate for decommissioning each unit is $33 million in 1978 dollars (Sec. 5.9).

5.16.2.2 Socioeconomic

No significant socioeconomic costs are expected from either the operation of the station or the number of station personnel and their families living in the area (Sec. 5.7.4).

5.16.2.3 Environmental

Nonradiological

The nonradiological environmental costs of land-use, water use, and ecological effects previously estimated in the FES-CP have been re-estimated on the basis of any new information and have been found not to have increased (Secs. 5.2, 5.3, and 5.5).

Radiological

The radiological environmental costs resulting from CPSES operation have been reestimated on the basis of any new information in the following areas: dose to the general public; occupational dose; dose to the public and workers due to transportation of radioactive materials; dose to biota other than man and dose associated with the uranium fuel cycle. These costs are summarized below.

The risks to the general population due to radioactive effluents from CPSES are a very small fraction of the estimated occurrence of cancer deaths in the U.S. population and genetic disorders in future generations of the U.S. population due to each year of exposure to natural-background radiation. Therefore, the staff concludes that the health impact to the general public due to routine operation of the station will be undetectable (Sec. 5.8.1.5).

Assuming that the average annual dose commitment per nuclear worker at CPSES will be in the same range as that at similarly sized PWRs, the staff estimates an average annual worker dose of about 1 rem/yr. However, based on the staff's review of the applicant's Final Safety Analysis Report as well as occupational dose data from over 180 reactor-years of operation, it is projected that the occupational doses at CPSES could average as much as 1300 person-rem/yr per unit when averaged over the life of the station (Sec. 5.8.1.2). In terms of job-related fatalities, the staff concludes that the risk to the average nuclear plant worker is within the range of risks associated with other occupations, and is acceptable (Sec. 5.8.1.5).

The transportation dose to workers and the public is specified in Table 5.15. This dose is small and is not considered significant in comparison to the natural-background dose (Sec. 5.8.3.8).

Based on studies of radiation exposure to biota other than man, there have been no cases of exposures that can be considered significant in terms of harm to the species or that approach the exposure limits to members of the public permitted by 10 CFR Part 20. Evidence to date indicates no other living organisms are very much more radiosensitive than man. No measurable radiological impact on populations of biota is expected as a result of routine operation of CPSES (Sec. 5.8.1.4).

The environmental risk from accident radiation exposure is very low (see Sec. 5.8.2).

The data on the uranium fuel cycle provided in Table 5.22 (Table S-3) include maximum recycle-option impacts of each element of the fuel cycle. Thus, the staff's conclusions as to acceptability of the environmental costs of the fuel cycle are not affected by the specific fuel cycle selected (Sec. 5.8.3.9).

5.16.3 Conclusions

As a result of the analysis and review of potential environmental, technical, economic, and social impacts, the staff has been able to forecast more accurately the effects of operation of CPSES. No new information has been obtained that alters the overall balancing of the benefits versus the environmental costs of station operation. Consequently, the staff has determined that the station will most likely operate with acceptable environmental impact. The staff finds that the primary benefits of minimizing system production costs and increasing baseload generating capacity by 2300 MWe greatly outweigh the environmental, social, and economic costs. Benefits and costs are summarized in Table 5.27.

Table 5.27 Benefit-Cost Summary of CPSES Units 1 and 2

Benefit or cost	Magnitude or Reference†[1]	Staff assessment†[2] of cost or benefit
	BENEFITS	
	Primary	
Electrical energy (Sec. 2.2)	12×10^9 kWh/yr	Moderate
Additional TUCS capacity (Sec. 2.4)	2300 MWe	Moderate
Reduced generating costs (Sec. 2.2)	$150 million/unit/yr	Large
Diversity of fuel supply (Sec. 2.3)	NA	Large
	Secondary	
Local taxes (Sec. 5.7.2)	$1.8 million/yr	Large
Employment (Sec. 5.7.1)	187 employees	Moderate
Payroll (Sec. 5.7.1)	$4.7 million/yr	Moderate
Local purchases	NA	Small
Flood control (Sec. 5.3.2)	65% reduction in 100-year flood flow below SCR dam	Large

Table 5.27 (Continued)

Benefit or cost	Magnitude or Reference†[1]	Staff assessment†[2] of cost or benefit
	COSTS	
	Economic	
Fuel (Sec. 2.2)	9 mills/kWh	Small
Operation and maintenance (Sec. 2.2)	3.5 mills/kWh	Small
Decommissioning (Sec. 5.9)	$33 million/unit	Small
	Socioeconomic	
Historic and prehistoric sites (Sec. 5.6)	See Sec. 5.6	None
Labor Force interaction with local infrastructure (Sec. 5.7.4)	See Sec 5.7.4	Small
	Nonradiological	
Resources committed:		
a. Land (Sec. 4.3.1)	3285 ha	Moderate
b. Water (FES-CP Sec. 3.4.3)	1.86×10^8 m^3	Moderate
c. Uranium (fuel) (FES-CP Sec. 10.3.4)	12,710 Meteric Tons	Small
d. Other materials and supplies (FES-CP Sec. 10.3.4)	NA	Small
Aquatic Resources		
a. Consumption Surface Water (Sec. 5.3.3)	0.81 m^3/sec.	Small
Groundwater (Sec. 5.3.1)	0.19 m^3/min	Small
Groundwater level drawdown at site boundary (Sec. 5.3.1)	1.5 m	Small
b. Surface water contamination thermal (Sec. 5.3.3; FES-CP Sec. 5.3.3)	274 billion J/min	Small
Chemical (except biocides) (Sec. 5.3.4)	See Sec. 5.3.4	Small
Chemical-biocides	0-0.5 mg/ℓ TRC	†[3]
c. Ecological		
Squaw Creek Reservoir (Sec. 5.5.2)		
Impingement (FES-CP Sec. 5.5.2)	See Sec. 5.5.2	†[3]
Entrainment (FES-CP Sec. 5.5.2)	See FES-CP	†[3]

Table 5.27 (Continued)

Benefit or cost	Magnitude or Reference†[1]	Staff assessment†[2] of cost or benefit
c. Ecological (continued) <u>Squaw Creek Reservoir</u> (Sec. 5.5.2)		
Thermal effects (FES-CP Sec. 5.5.2)	8.3°C increase	Small
Total dissolved solids (FES-CP Sec. 5.5.2)	2500 mg/ℓ	None
Stratification (FES-CP Sec. 5.5.2)	See FES-CP	Small
<u>Lake Granbury</u> (Sec. 5.5.2)		
Makeup water withdrawal (Sec. 5.5.2)	See Sec. 5.5.2	Small
Discharge of SCR blowdown (FES-CP SEC. 5.5.2)	See FES-CP	Small
Terrestrial Resources		
a. Fog (Sec. 5.4.1)	See Sec. 5.4.1	Small
b. Ice (Sec. 5.4.1)	See Sec 5.4.1	Small
c. Erosion (Sec. 5.2)	NA	None
d. Ecological (Sec. 5.5.1; FES-CP Sec. 5.5.1)	NA	None
Meteorology and Air Quality		
a. Offsite air temperature and humidity (Sec. 5.4.1)	See Sec. 5.4.1	Small
b. Combustion exhaust gases	See Sec. 5.4.2	Small
c. Fugitive dust (Sec. 5.4.2)	See Sec. 5.4.2	None
d. Ozone (from transmission lines) (FES-CPS Sec. 5.5.1)	See FES-CP	None
	<u>Radiological Environmental</u>	
General Population (Normal Operation) (Sec. 5.8.1.2)	131 person-rem per year	Small
General Population (Accident Risk) (Sec. 5.8.2.4)	58 person-rem per year	Small
CPSES Workers (Sec. 5.8.1.2)	2600 person-rem per year	Small

Table 5.27 (Continued)

Benefit or cost	Magnitude or Reference†1	Staff assessment†2 of cost or benefit
Transporation Fuel and Waste (Sec. 5.8.3.8)	14 person-rem/yr	Small
Biota other than man (Sec. 5.8.1.4)	See Sec. 5.8.1.4	Small
Uranium Fuel Cycle (Sec. 5.8.3)	See Sec. 5.8.3	Small

†1 - Where a particular unit of measure for a benefit/cost category has not been specified in the EIS, or where an estimate of the magnitude of the benefit/cost under consideration has not been made, the reader is directed to the appropriate EIS section for further information.

†2 - Subjective Measures of Costs and Benefits

Small - impacts which, in the reviewers' judgment, are of such minor nature, based on currently available information, that they do not warrant detailed investigations or considerations of mitigative actions.

Moderate - impacts which, in the reviewers' judgment, are likely to be clearly evident. Mitigation alternatives are usually considered for moderate impacts.

Large - impacts which, in the reviewers' judgment, represent either a severe penalty or a major benefit. Acceptance requires that large negative impacts should be more than offset by other overriding project considerations.

†3 Staff assessments of the severity of these environmental costs have not been prepared pending the completion of impact assessment studies to be conducted under the provisions of the NPDES permit for CPSES (Sec. 5.11).

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***Available free upon written request to the Division of Technical Information and Document Control, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

6 LIST OF PREPARERS

The following personnel of the Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC, participated in the preparation of the Draft Environmental Statement:

S.B. Burwell:	Licensing Project Manager.
J.C. Lehr:	Environmental Review Coordinator.
S. Acharya:	Accidents.
S. Baker:	Accidents.
J.S. Boegli:	Effluent-treatment systems.
S. Chestnut:	Accidents.
K. Dempsey:	Accidents.
C.M. Ferrell:	Demography.
M. Fliegel:	Accidents.
R.O. Gonzales:	Hydrology, floodplain effects.
R. Gotchy:	Accidents.
R.W. Houston:	Accidents.
J. Lewis:	Meteorology.
D. Nash:	Accidents.
W.J. Pasciak:	Radiological Assessment.
A.A. Sinisgalli:	Accidents.
M. Taylor:	Accidents.
M.C. Thadani:	Accidents.
R. Van Neil:	Accidents.

The following personnel of the Division of Environmental Impact Studies of Argonne National Laboratory, Argonne, Illinois, participated in the preparation of the Draft Environmental Statement:

J.E. Carson:	Project Leader, air quality, cooling-pond effects.
L.S. Busch:	Need for power, benefit-cost analysis, alternatives.
E.J. Christian:	Terrestrial ecology, land use.
S.A. Curtis:	Cultural resources.
E.W. Daniels:	Terrestrial and aquatic ecology.
P.S. Denise:	Socioeconomics.

V.A. Harris:	Nonradioactive-waste discharges, water quality.
R.B. Keener:	Copy editor.
S.P. Stearner:	Aquatic ecology.
Y.H. Tsai:	Thermal discharges.

7 LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS REQUESTED TO COMMENT ON THE DRAFT ENVIRONMENTAL STATEMENT

The following Federal, state, and local agencies are asked to comment on the Draft Environmental Statement:

Advisory Council on Historic Preservation
County Commissioners, Hood County, Texas
County Commissioners, Somervell County, Texas
Department of Agriculture, Soil Conservation Service
Department of the Army, Corps of Engineers
Department of Commerce
Department of Energy
Department of Health and Human Services
Department of Housing and Urban Development
Department of the Interior, Geological Survey
Department of Transportation
Environmental Protection Agency
Federal Aviation Administration
Federal Energy Regulatory Commission
Energy Advisory Council, State of Texas
Governor's Office of Energy Resources, State of Texas
Office of the Attorney General, State of Texas
Office of the Governor, State of Texas
State of Texas General Land Office
Texas Air Control Board
Texas Archeology Research Laboratory
Texas Department of Health
Texas Department of Public Safety
Texas Department of Water Resources
Texas Forest Service
Texas Historical Commission
Texas Industrial Commission
Texas Parks and Wildlife Department
Texas Public Utilities Commission
Texas Railroad Commission

8 RESPONSES TO COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT

(Reserved for responses)

APPENDIX A

COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT

(Reserved for comments)

APPENDIX B

NEPA POPULATION-DOSE ASSESSMENT

Population-dose commitments are calculated for all individuals living within 80 km of the facility, employing the same models used for individual doses (see Regulatory Guide 1.109, Rev. 1). In addition, population doses associated with the export of food crops produced within the 80-km region and the atmospheric and hydrospheric transport of the more mobile effluent species, such as noble gases, tritium, and carbon-14, have been considered.

NOBLE-GAS EFFLUENTS

For locations within 80 km of the facility, exposures to these effluents are calculated with a constant mean wind-direction model according to the guidance provided in Regulatory Guide 1.111, Rev. 1, and the dose models described in Section 4.8 and Regulatory Guide 1.109, Rev. 1. Beyond 80 km, and until the effluent reaches the northeastern corner of the United States, it is assumed that all the noble gases are dispersed uniformly in the lowest 1000 m of the atmosphere. Decay in transit was also considered. Beyond this point, noble gases having a half-life greater than one year (e.g. Kr-85) were assumed to mix completely in the troposphere with no removal mechanisms operating.

Transfer of tropospheric air between the northern and southern hemispheres, although inhibited by wind patterns in the equatorial region, is considered to yield a hemisphere average tropospheric residence time of about two years with respect to hemispheric mixing. Since this time constant is quite short with respect to the expected midpoint of plant life (15th yr), mixing in both hemispheres can be assumed for evaluations over the life of the nuclear facility. This additional population-dose commitment to the U.S. postulation was also evaluated.

IODINES AND PARTICULATES RELEASED TO THE ATMOSPHERE

Effluent nuclides in this category deposit onto the ground as the effluent moves downwind, which continuously reduces the concentration remaining in the plume. Within 80 km of the facility, the deposition model in Regulatory Guide 1.111, Rev. 1, was used in conjunction with the dose models in Regulatory Guide 1.109, Rev. 1. Site specific data concerning production and consumption of foods within 80 km of the reactor were used. For estimates of population doses beyond 80 km it was assumed that excess food not consumed within the 80 km distance would be consumed by the population beyond 80 km. It was further assumed that all the particulates released from the facility would deposit onto the ground plane within the 80 km region and thus would make no contribution to the population dose outside the 80 km region.

CARBON-14 AND TRITIUM RELEASED TO THE ATMOSPHERE

Carbon-14 and tritium were assumed to disperse without deposition in the same manner as krypton-85 over land. However, they do interact with the oceans.

This causes the carbon-14 to be removed with an atmospheric residence time of four to six years, with the oceans being the major sink. From this, the equilibrium ratio of the carbon-14 to natural carbon in the atmosphere was determined. The same ratio was then assumed to exist in man so that the dose received by the entire population of the United States could be estimated. Tritium was assumed to mix uniformly in the hydrosphere, which was assumed to include all the water in the atmosphere and in the upper 70 m of the oceans. With this model, the equilibrium ratio of tritium to hydrogen in the environment can be calculated. The same ratio was assumed to exist in man, and was used to calculate the population dose in the same manner as was done with carbon-14. Doses obtained in this manner were then assumed to be received by the number of individuals living within the direction sector and distance described above. The population density in this sector is taken to be representative of the eastern United States, which is about 62 people per square kilometer.

LIQUID EFFLUENTS

Concentrations of effluents in the receiving water within 80 km of the facility were calculated in the same manner as described above for the Appendix I calculations. No depletion of the nuclides present in the receiving water by deposition on the bottom of the Squaw Creek Reservoir was assumed. It was also assumed that aquatic biota concentrate radioactivity in the same manner as was assumed for the Appendix I evaluation. However, food-consumption values appropriate for the average, rather than the maximum, individual were used. It was assumed that all the sport and commercial fish and shellfish caught within the 80-km area were eaten by the United States population.

Beyond 80 km, it was assumed that all the liquid-effluent nuclides except tritium have deposited on the sediments so that they make no further contribution to population exposures. The tritium was assumed to mix uniformly in the hydrosphere and to result in an exposure to the United States population in the same manner as discussed for tritium in gaseous effluents.

APPENDIX C. FINAL ENVIRONMENTAL STATEMENT - CONSTRUCTION PHASE - COMANCHE PEAK STEAM ELECTRIC STATION UNITS 1 AND 2

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Final

environmental statement

related to the proposed

COMANCHE PEAK STEAM ELECTRIC STATION UNITS 1 AND 2

TEXAS UTILITIES GENERATING COMPANY

DOCKET NOS. 50-445 & 50-446

JUNE 1974

UNITED STATES ATOMIC ENERGY COMMISSION

DIRECTORATE OF LICENSING

SUMMARY AND CONCLUSIONS

This Environmental Statement was prepared by the U.S. Atomic Energy Commission, Directorate of Licensing.

1. This action is administrative.

2. The proposed action is the issuance of construction permits to the Texas Utilities Generating Company for the construction of the Comanche Peak Steam Electric Station, Units 1 and 2, located in Somervell County, Texas (Docket Nos. 50-445 and 50-446).

   The station will employ two identical pressurized water reactors to produce up to 3425 megawatts thermal (MWt) each. A steam turbine-generator will use this heat to provide 1161 MWe (net) of electrical power capacity. A design power level of 3579 MWt (3565 MWt fission heat) is anticipated at a future date and is considered in the assessments contained in this statement. This will provide 1206 MWe (net) of electrical energy. The exhaust steam will be cooled by a once-through flow of water obtained from and discharged to Squaw Creek Reservoir.

3. Summary of environmental impact and adverse effects:

   a. Construction-related activities on the site will disturb about 400 acres of rangeland, not including the 3228 acres of land inundated by Squaw Creek Reservoir, which will be constructed in conjunction with the station. The land inundated includes about 8 linear miles of Squaw Creek and the adjacent riparian communities, and 940 acres of cropland, which is considered irreversibly lost. About 200 acres of this land not to be used for the reservoir, plant facilities, parking lots, roads, switchyard, evaporation pond, etc., is to be restored by seeding and landscaping to prevent erosion.

   b. Approximately 15 miles of transmission line corridors will require about 439 acres of land for the rights-of-way.

   c. Relocation of the current pipelines as proposed will involve about 100 acres. A railroad spur 10.2 miles long will affect 185 acres of land. Diversion and return lines between Lake Granbury and Squaw Creek Reservoir will affect about 100 acres.

d. Station construction will involve some community impacts. As many as 8 farm residences will be displaced. Farming, hunting, and grazing on the site will be suspended. Traffic on local roads will increase due to construction and commuting activities. Influx of construction workers' families (1150 peak work force) is expected to cause no major housing or school problems. There will be a demand for increased services in Somervell and Hood counties.

e. The total flow of circulating water will be 2,200,000 gpm, which will be taken from and returned to Squaw Creek Reservoir. Cross evaporation from the reservoir will consume about 45,000 acre-ft of water per year, resulting in a two-fold increase of total dissolved solids concentration. About 39,000 acre-ft of this per year will come from Lake Granbury. This will result in an increase in total dissolved solids concentration in the Brazos River of 2.3% below Lake Granbury. The thermal alterations and increases in total dissolved solids concentration will not significantly affect the aquatic productivity of Squaw Creek Reservoir, Lake Granbury or the Brazos River.

f. Aquatic organisms entrained in the station's circulating water system are assumed to have 100% mortality due to thermal and mechanical shock.

g. The risk associated with accidental radiation exposure is very low.

h. No significant environmental impacts are anticipated from normal operational releases of radioactive materials within 50 miles. The estimated dose to the offsite population within 50 miles from operation of the station is 15 man-rems/year, less than the normal fluctuations in the 100,000 man-rems/year background dose this population would receive.

4. Principal alternatives considered:

a. Purchase of power

b. Alternative energy systems

c. Alternative sites

d. Alternative heat dissipation methods

5. The following Federal, State, and local agencies were asked to comment on the Draft Environmental Statement:

Advisory Council on Historic Preservation
Department of Agriculture
Department of the Army, Corps of Engineers
Department of Commerce
Department of Health, Education, and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Environmental Protection Agency
Federal Power Commission
Office of the Governor, State of Texas
County Judge, Somervell County

6. This Environmental Statement was made available to the public, to the Council on Environmental Quality, and to the other specified agencies in June 1974.

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 Comanche Peak Steam Electric Station, Units 1 and 2, against environmental and other costs and considering available alternatives, the staff concluded that the action called for under the National Environmental Policy Act of 1969 (NEPA) and Appendix D to 10 CFR Part 50 is the issuance of construction permits for the facilities subject to the following limitations for the protection of the environment:

a. The applicant shall take the necessary mitigating actions, including those summarized in Sect. 4.5 of this Environmental Statement, during construction of the station and associated transmission lines to avoid unnecessary adverse environmental impacts from construction activities.

b. The applicant shall modify his monitoring programs in accordance with staff recommendations and complete the preoperational environmental studies (Sect. 6).

c. During the design phase of the station, the applicant shall evaluate alternative measures that will mitigate the potential adverse effects of high intake velocities at the Squaw Creek Reservoir (SCR) intake structures. These measures shall include, but not be limited to, (1) an evaluation of fish diversion facilities and fish return mechanisms; and (2) provisions for adding such devices to the SCR intakes structures if operational monitoring programs indicate adverse impingement effects are occurring (Sect. 11.6.2).

d. The applicant shall design the station to control the addition of chlorine to the circulating water system such that the concentration of total residual chlorine at the point of discharge to Squaw Creek Reservoir is 0.1ppm or the minimum practicable level demonstrated by the applicant as being necessary. The minimum practicable level of chlorination necessary shall be determined by the applicant prior to the initiation of power operation through a study program. This study shall include an evaluation of the effects of residual chlorine releases on Squaw Creek Reservoir; a demonstration of the minimum total residual chlorine level necessary for efficient operation of the station and an evaluation of the monitoring program to be used to determine total residual chlorine and its effects. Alternative methods of reducing chlorine residuals shall also be investigated and these shall include but not limited to optimizing chlorine dosage, modifying condenser design to permit sequential treatment of sections of the condensers, and optimizing the chlorination schedule to coincide with periods of low condenser flow (Sect. 11.6.1).

e. The rate of groundwater withdrawal during construction of the station shall not exceed 250 gpm. Withdrawal of groundwater shall be reduced to an annual average of 30 gpm at the end of five years. During this period, the applicant shall evaluate alternative actions that will mitigate potential adverse effects resulting from the station's groundwater use. Such actions or measures shall include but not be limited to using an alternate source of water for station operation, monitoring neighboring wells to determine effects of the station's use of groundwater during construction and further analysis of regional data to determine whether groundwater mining is occurring in the vicinity of the site. The results of these applicant evaluations shall be submitted as part of the applicant's Environmental Report - Operating License Stage (Sect. 11.6.7).

f. A control program shall be established by the applicant to provide for a periodic review of all construction activities to assure that those activities conform to the environmental conditions set forth in the construction permits.

g. Before engaging in a construction activity which may result in a significant adverse environmental impact that was not evaluated or that is significantly greater than that evaluated in this Environmental Statement, the applicant shall provide written notification to the Director of Licensing.

h. If unexpected harmful effects or evidence of irreversible damage are detected during facility construction, the applicant shall provide to the staff an acceptable analysis of the problem and a plan of action to eliminate or significantly reduce the harmful effects or damage.

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FOREWORD

This environmental statement was prepared by the U.S. Atomic Energy Commission, Directorate of Licensing (the staff) in accordance with the Commission's regulation, 10 CFR 50, Appendix D, which implements the requirements of the National Environmental Policy Act of 1969 (NEPA).

The NEPA states, among other things, that it is the continuing responsiblity of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may:

- Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
- Assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings.
- Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences.
- Preserve important historic, cultural, and natural aspects of our natural heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice.
- Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities.
- Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Further, with respect to major Federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of the NEPA calls for preparation of a detailed statement on:

(i) the environmental impact of the proposed action,

(ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,

(iii) alternatives to the proposed action,

(iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and

(v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

An environmental report accompanies each application for a construction permit or a full-power operating license. A public announcement of the availability of the report is made. Any comments by interested persons on the report are considered by the staff. In conducting the required NEPA review, the staff meets with the applicant to discuss items of information in the environmental report, to seek new information from the applicant that might be needed for an adequate assessment, and generally to ensure that the staff has a thorough understanding of the proposed project. In addition, the staff seeks information from other sources that will assist in the evaluation, and visits and inspects the project site and surrounding vicinity. Members of the staff may meet with State and local officials who are charged with protecting State and local interests. On the basis of all the foregoing and other such activities or inquiries as are deemed useful and appropriate, the staff makes an independent assessment of the considerations specified in Section 102(2)(C) of the NEPA and Appendix D of 10 CFR 50.

This evaluation leads to the publication of a draft environmental statement, prepared by the Directorate of Licensing, which is then circulated to Federal, State and local governmental agencies for comment. A summary notice is published in the Federal Register of the availability of the applicant's environmental report and the draft environmental statement. Interested persons are requested to comment on the proposed action and the draft statement.

After receipt and consideration of comments on the draft statement, the staff prepares a final environmental statement, which includes a discussion of questions and objections raised by the comments and the disposition thereof; a final benefit-cost analysis, which considers and balances the environmental effects of the facility and the alternatives available for reducing or avoiding adverse environmental effects with the environmental, economic, technical, and other benefits of the facility; and a conclusion as to whether--after the environmental, economic, technical, and other benefits are weighed against environmental costs and after available alternatives have been considered, the action called for, with respect to environmental issues, is the issuance or denial of the proposed permit or license, or its appropriate conditioning to protect

environmental values. This final environmental statement and the safety evaluation report prepared by the staff are submitted to the Atomic Safety and Licensing Board for its consideration in reaching a decision on the application.

Single copies of this statement may be obtained by writing the Deputy Director for Reactor Projects, Directorate of Licensing, U.S. Atomic Energy Commission, Washington, D.C. 20545. Frank Miraglia is the AEC Environmental Project Manager for this statement (301-443-6980).

1. INTRODUCTION

1.1 THE PROPOSED PROJECT

Pursuant to the Atomic Energy Act of 1954, as amended, and the Commission's regulations in Title 10, Code of Federal Regulations, an application was filed by the Texas Utilities Generating Company, as agents for the Dallas Power and Light Company, Texas Electric Service Company, and Texas Power and Light Company (hereinafter referred to as the applicant) for construction permits for two pressurized water nuclear reactors designated as the Comanche Peak Steam Electric Station, Units 1 and 2 (Docket Nos. 50-445 and 50-446), each of which is designed for initial operation at approximately 3425 thermal megawatts with a net electrical output of approximately 1161 megawatts. The proposed facilities are to be located on the applicant's site in Somervell County, Texas, approximately 5 miles north-northwest of Glen Rose, Texas, and approximately 40 miles southwest of Fort Worth, in north central Texas.

Appendix D of 10 CFR Part 50 requires that the Director of Regulation, or his designee, analyze the report and prepare a detailed statement of environmental considerations. It is within this framework that this Final Environmental Statement related to the construction of the Comanche Peak Steam Electric Station (CPSES) has been prepared by the Directorate of Licensing (staff) of the U.S. Atomic Energy Comm'ssion.

Major documents used in the preparation of this statement were the applicant's Preliminary Safety Analysis Report (PSAR), Environmental Report (ER), and supplements thereto issued for CPSES.

Independent calculations and sources of information were also used as a basis for the assessment of environmental impact. In addition, some of the information was gained from visits by the staff to the CPSES site and surrounding areas in August 1973.

As a part of its safety evaluation leading to the issuance of construction permits and operating licenses, the Commission makes a detailed evaluation of the applicant's plans and facilities for minimizing and controlling the release of radioactive materials under both normal conditions and potential accident conditions, including the effects of natural phenomena on the facility. Inasmuch as these aspects are considered fully in other documents only the salient features that bear directly on the anticipated environmental effects are repeated in this environmental statement.

Copies of this Final Environmental Statement and the applicant's Environmental Report (ER) are available for public inspection at the Commission's Public Document Room, 1717 H Street, N.W., Washington, D.C., and at the Somervell County Public Library, P.O. Box 417, Glen Rose, Texas 76043.

1.2 STATUS OF REVIEWS AND APPROVALS

To construct CPSES and the related facilities, the applicant is required to apply for and receive certain permits, licenses, and other authorizations from a number of Federal and State agencies and, in some cases, from regional and local agencies. Certain of these permits and licenses are discussed below:

U.S. Atomic Energy Commission

This agency has regulatory authority over the design, construction, and operation of the proposed facility. The applicant has applied for construction permits for Units 1 and 2. Applications for operating licenses must be made at later dates and a license granted before operation of either unit commences.

Texas Water Rights Commission

This agency issues permits for the appropriation and usage of State waters. Permit No. 2871, dated June 26, 1973, has been granted to the applicant by the Texas Water Rights Commission.

Texas Water Quality Board (TWQB)

This agency issues permits authorizing waste discharges into State waters. A public hearing by this agency was held on January 31, 1974, to review the applicant's request for a waste discharge permit and certification pursuant to Section 401 of the Federal Water Pollution Control Act (FWPCA). On February 27, 1974, the TWQB approved the requested waste discharge permit. A water quality certificate pursuant to Section 401 of the FWPCA was issued by the TWQB on March 1, 1974.

Texas Air Control Board

Issues permits authorizing releases of gaseous effluents into the atmosphere.

Texas State Department of Health for General Sanitation

Issues permits authorizing construction and operation of sanitary treatment systems.

Texas State Department of Health-Division of Occupational Health

Issues licenses for use of source and special nuclear material used for calibration and check sources in nuclear equipment and for radiographic devices used during construction.

Texas Highway Department

Issues permits authorizing proposed alterations or construction affecting State Highways.

Hood County

Issues permits authorizing proposed alterations or construction affecting county roads.

2. THE SITE

2.1 STATION LOCATION

The applicant plans to locate the Comanche Peak Steam Electric Station (CPSES), Units 1 and 2, in sparsely populated and essentially rural Somervell County, Texas. The proposed location is about 35 air miles southwest of the city limits of Fort Worth (1970 population, 393,476) and 60 air miles southwest of the city limits of Dallas (1970 population, 844,401). Figures 2.1.1 and 2.1.2 show the relationship of the site to the surrounding area, with radii of 50 and 5 miles respectively. It is approximately 5 air miles north-northwest of Glen Rose (1970 population, 1554), county seat of Somervell County, and approximately 10 air miles south of Granbury (1970 population, 2473), county seat of Hood County. Unit 1 is at latitude 97° 47' 06.5" and longitude 32° 17' 49" while Unit 2 is at latitude 97° 47' 06" and longitude 32° 17' 52". The applicant also plans to construct a dam across Squaw Creek and impound water for cooling purposes in proposed Squaw Creek Reservoir. This 3228-acre reservoir will extend into Hood County but will be within the 8876 acres of land owned by the applicant, all of which is considered part of the site. Squaw Creek is a small tributary stream in the area which drains into the Paluxy River, which in turn drains into the Brazos River below the De Cordova Bend Dam. The area is part of the Great Plains Province with elevations within the site boundaries ranging from 640 to 860 ft above mean sea level (MSL).

Lake Granbury, impounded on the Brazos River by the De Cordova Bend Dam (closed in 1969), lies approximately 7 air miles northeast of CPSES. Virtually all of the makeup and blowdown water for Squaw Creek Reservoir will come from Lake Granbury, which will also serve as the heat sink for the fossil-fueled De Cordova Bend Steam Electric Station, located 8-1/2 air miles northeast of the CPSES site.

The nearest commercial airport with scheduled passenger service is Waco's Municipal Airport, about 55 air miles southeast of the CPSES. The new Dallas-Fort Worth Regional Airport is about 60 air miles northeast of the site.

Seven small airports serving only general aviation are located within 20 miles of CPSES (see Fig. 2.1.3), the closest being a landing strip at the Bar L Ranch, 5.5 miles west-southwest. Also included in this group is the Granbury Municipal Airport (10 miles north-northwest), which has a paved runway lighted for 3000 ft.

2-3

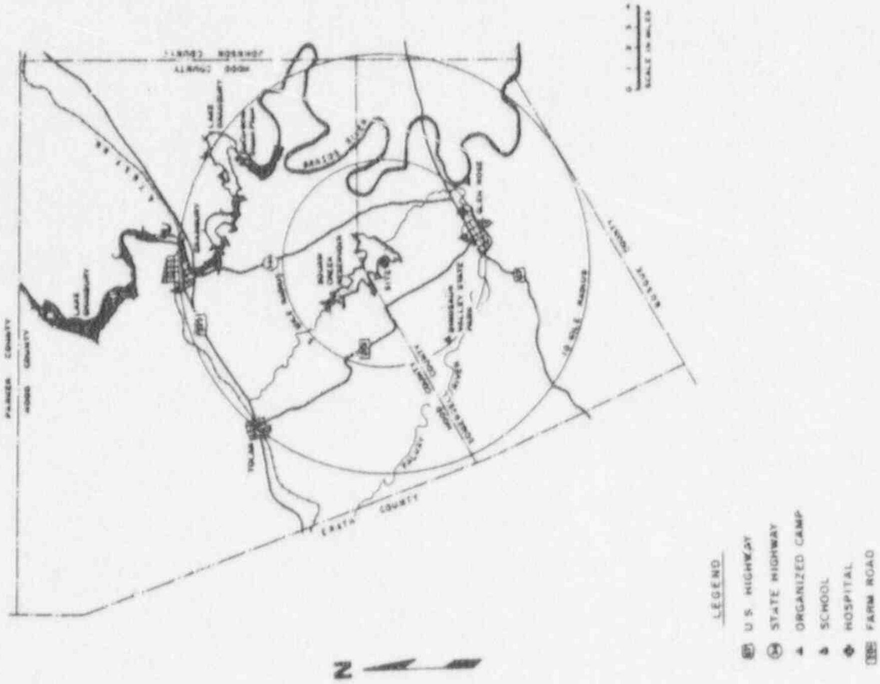


Fig. 2.1.2. Area within 5 and 10 miles of CPSES.

2-2

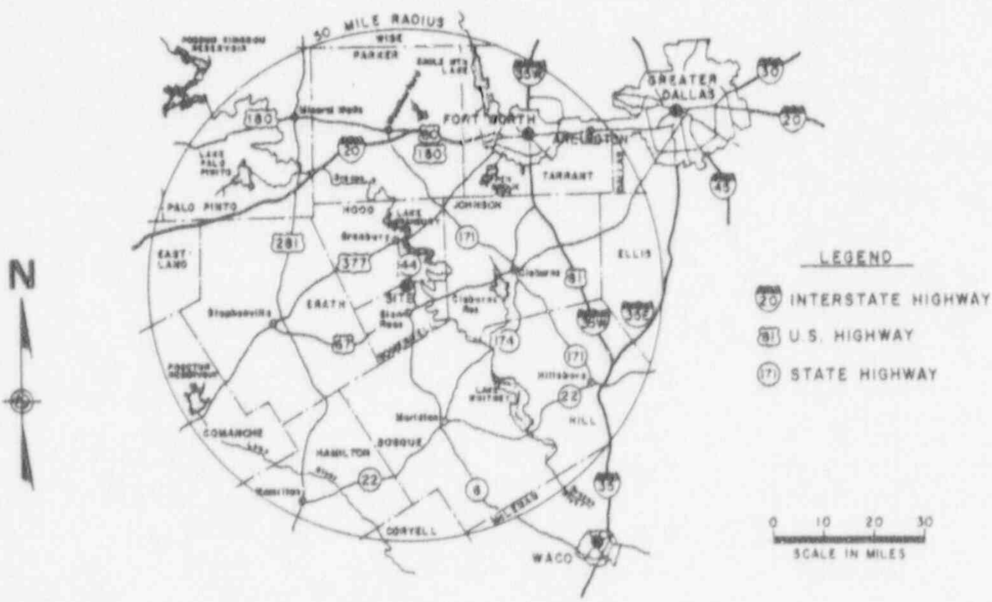


Fig. 2.1.1. Area within 50 miles of CPSES.

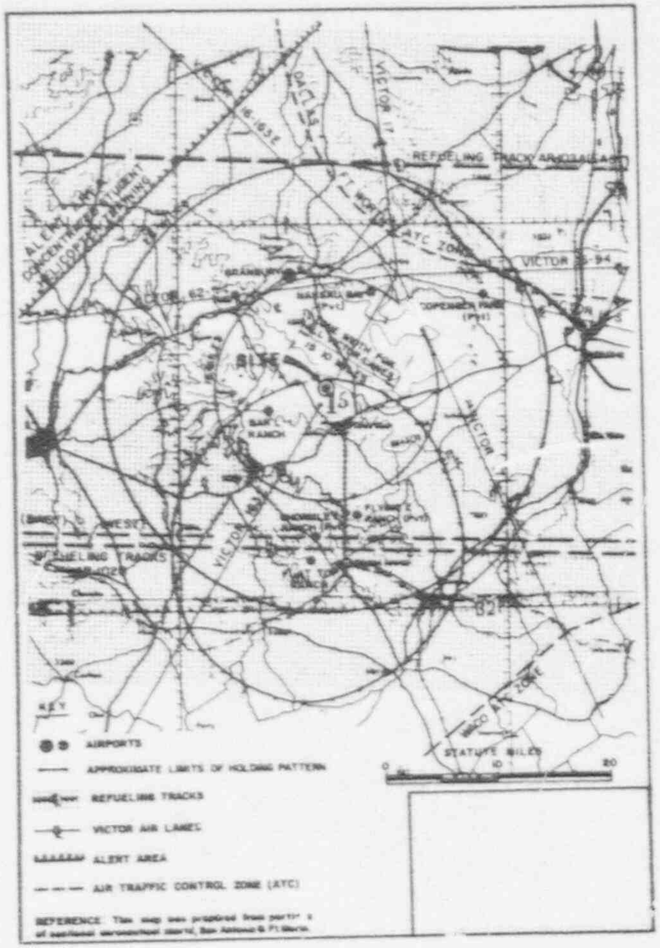


Fig. 2.1.3. Air traffic map of CPSES area.
Source: ER, Fig. 2.1-6.

At present three pipelines cross the applicant's property. One, a 36-in. natural gas line, passes north of the construction area at the upper end of Squaw Creek Reservoir. (An additional 36-inch gas line is to be laid parallel to the existing gas line in the near future.) The other two, a 26-in. crude oil line and a 6-in. natural gas line, pass across the construction area.

The closest highway to the CPSES is State Highway 144, which is 2.5 miles northeast. U.S. Highway 67 is 4.5 miles south-southeast and U.S. Highway 377 is 9 miles to the northeast. Farm-to-Market Roads 51 and 201 are approximately 5 miles northwest and 2 miles west, respectively. The Atchison, Topeka and Santa Fe Railroad has a line about 9.5 miles northwest of the site.

The exclusion area for CPSES is shown in Fig. 2.1.4. The shortest distance between the reactor containment buildings and the exclusion area boundary is the 4900-ft distance on the southwest side.

2.2 REGIONAL DEMOGRAPHY, LAND USE, AND WATER USE

2.2.1 Regional demography

The State of Texas increased in population between 1960 and 1970 at a faster rate than the United States (16.9 vs 13.3%). However, the growth rate of this period for Texas was the second lowest since data have been available for the State beginning in 1850. There was only a 10.1% increase during the 1930-1940 period. In the urban areas the population increased 24.1% between 1960 and 1970, while rural residents decreased by 4.9%. With regard to the growth situation for Hood County (1970 population, 6368) and Somervell County (1970 population, 2793), Hood County grew at a rate (17%) near that of Texas, while Somervell County increased only 8.4%. The larger Hood County rate is believed due to its closer proximity to the Fort Worth Standard Metropolitan Statistical Area (SMSA), which includes Tarrant County (1970 population, 716,316) to the northeast and Johnson County (1970 population, 45,720) to the east. Another factor is the impoundment of Lake Granbury in 1969, which is leading to the development of residential and recreational housing within Hood County.

The 50-mile radius includes most of the Fort Worth SMSA and a small part of the Dallas SMSA. It includes all of the city of Fort Worth, which is a "population center" (1970 population, 393,476) as defined in 10 CFR Part 100. Communities with a population of 1000 or more in 1970 within 50 miles of the site are given in Table 2.2.1. Table 2.2.2 shows the present and projected populations within the 5-, 10-, and 50-mile radii. Additional details and sector population projections are presented in the ER (ER, Sect. 2.2).

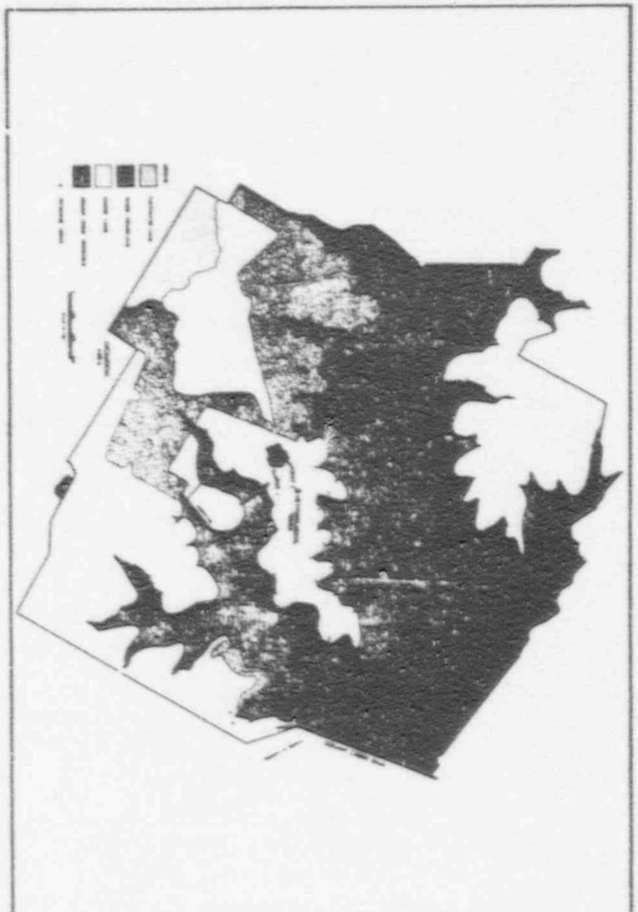


Fig. 2.1.4. Exclusion area for CPSES.
Source: ER, Fig. 2.1-4.

Table 2.2.1. Large communities in region

Community	1970 population	Distance from site (miles)	Direction
Glen Rose	1,554	5	SSE
Granbury	2,473	10	N
Cleburne	16,015	23	ENE & E
Stephenville	9,277	26	WSW & W
Keene	2,440	27	ENE
Meridian	1,162	27	SSE
Benbrook	8,169	32	NNE & NE
Burleson	7,713	32	NE
Weatherford	11,750	32	N
Alvarado	2,129	34	ENE
Whitney	1,371	36	SE
Dublin	2,810	36	WSW
Clifton	2,578	37	SSE
Itasca	1,483	38	ESE
Mineral Wells	18,411	40	NNW
Fort Worth	393,476	41	NE
Hillsboro	7,224	43	ESE
Mansfield	3,658	41	ENE
Azle	4,493	44	NNE
Saginaw	2,382	45	NNE
Hamilton	2,760	45	SSW
De Leon	2,170	45	WSW
Springtown	1,194	47	N
Valley Mills	1,022	47	SSE
Midlothian	2,322	47	ENE
Arlington	90,643	48	NE
Hurst	27,215	50	NE

Table 2.2.2. Present and projected populations

Year	0–5 miles	0–10 miles	0–50 miles
1970	1983	6,554	816,854
1980	2780	13,070	997,100
1990	3715	19,055	1,344,800
2000	4505	23,155	1,616,000
2010	5390	28,000	1,943,500
2020	6485	33,605	2,340,300

The nearest occupied house after Squaw Creek Reservoir is filled will be about 1-3/4 miles west of CPSES. The nearest church is Cedar Grove Chapel about 3-1/4 miles northeast of the site. The nearest schools, which are operated by the Glen Rose Independent School District, comprising most of Somervell County and a portion of Hood County, are on a single campus in Glen Rose. The 1971/72 enrollment was 610 students plus staff. Marks-English Hospital in Glen Rose, which includes a nursing home and houses 131 patients plus staff, is the nearest hospital.

Public recreation sites are the Dinosaur Valley State Park (4-1/2 miles southwest), Lake Granbury Recreation (8 to 10 miles northeast), and several children's camps, the closest of which is the Cedar Brake Girl Scout camp (4-2/3 miles southwest). Also located in the area are Big Rocks City Park and the Somervell County Historical Museum both in Glen Rose and the Lake Whitney Recreation Area (4 miles southeast of Glen Rose).

The major industries in the area are two dressmaking plants in Granbury and the fossil-fueled De Cordova Bend Steam Electric Station (8-1/2 miles northeast).

2.2.2 Land use

Over 96% of the land in Hood and Somervell counties is used for agricultural purposes. The change in land usage in these counties between 1958 and 1967 is shown in the ER (ER, p. 2.2-7) and indicates that there is increasing acreage being used for pasture and forest, while the amount of cropland and rangeland is decreasing.

Livestock and livestock products yield nearly two-thirds of the cash receipts from farm marketings. Since the area is dominated by rangelands, cattle represent the majority of livestock, although hogs, goats, sheep, and chickens are also raised, the latter mainly for egg production.

There are four commercial dairy herds (total, 240 cows) within 10 miles of the station. The closest herd (80 cows) is 5 miles south-southeast and involves a feedlot operation using no more than 2 acres.

The dominant cash crop within 5 miles of the plant is peanuts. The total 1971 production for Hood and Somervell counties was about 8,[illegible]3,000 lb. The yield averaged about 750 lb per acre.

2.2.3 Water use

Present water use in the area is primarily for domestic, irrigation, and livestock purposes.

2.2.3.1 Groundwater

Information on the location, type, capacity, and use of all wells in the vicinity of the site is given in the applicant's ER (ER, Fig. 2.2-7; ER, Table 2.2-12). Most are completed in the Twin Mountains formation, although a few wells north of the site are completed in the Glen Rose formation.

Information on the larger capacity wells within 20 miles of the site is also given in the applicant's ER (ER, Fig. 2.2-7). These wells, which account for most of the municipal, irrigation, and industrial groundwater supplies in the area, are completed in the Twin Mountains formation. The Texas Water Development Board has completed a study (ER, Section 2.2.3.1) indicating that pumpage within 20 miles of the site totals about 100 acre-ft per year. This yearly pumpage is expected to increase to about 200 acre-ft by 2020.

2.2.3.2 Surface water

All potential surface water users in Texas must file for permission with the Texas Water Rights Commission. A summary of the 1972 listing of applications, claims, and certified filings for surface water use from Squaw Creek is given in Table 2.2.3. A similar listing for the Brazos River is given in the applicant's ER (ER, Table 2.2-15).

Table 2.2.3. Squaw Creek water users

Claim number	User	Location	Use	Amount allocated (acre-ft/year)
2980	Dean Williams	Within Squaw Creek Reservoir area, in Somervell County near Hood-Somervell county line	Irrigation	30
3960	Carlisle Cravens	Within Squaw Creek Reservoir area, in Hood County near Hood-Somervell county line	Irrigation	150

Source: *Water Rights Master File*, 1972, Texas Water Rights Commission, Austin, Texas.

The Texas Water Rights Commission granted the Brazos River Authority in Permit 2111-A the use of 100,000 acre-ft/year of water from Lake Granbury, of which 70,000 acre-ft/year is designated for industrial use. This 70,000 acre-ft/year water allotment was contracted by the Brazos Water Authority to the Texas Electric Service Company and the Texas Power and Light Company for industrial cooling purposes.

C-20

The contract was approved by the Texas Water Rights Commission in the Term Permit CP-20. This permit allows for the use of the Brazos River bed and banks between Possum Kingdom Reservoir and Lake Granbury and downstream of the De Cordova Bend Reservoir to points of diversion to convey the water to points of use. It also states that the water returned to the Brazos River will not be in such condition that it will be detrimental to others.

Of the 70,000 acre-ft/year water allotment, the users plan to use 15,000 acre-ft/year at the Tradinghouse Steam Electric Station, 3,500 acre-ft/year at the De Cordova Bend Steam Electric Station, 38,300 acre-ft/year at the CPSES, and 13,200 acre-ft/year for future needs.

The use of 38,300 acre-ft/year of water for CPSES was approved by the Texas Water Rights Commission in Permit 2871. Permit 2871 also allows for the diversion of 165,300 acre-ft of flood waters from Lake Granbury over a three-year period to fill Squaw Creek Reservoir. It is stipulated diversion of the floodwaters can be done only when the Brazos River flow measured at the Glen Rose gage exceeds 300 cfs during September through February and exceeds 500 cfs during March through August.

The nearest downstream municipal use of Brazos River water is at Waco, nearly 140 miles downstream of Lake Granbury. The Brazos River Authority has an application for 10,000 acre-feet of water from Lake Granbury for municipal use. At present, however, the city of Marlin (located 170 miles downstream of Lake Granbury) is the nearest municipal water user who has contracted to purchase water from the Brazos River Authority.

2.3 HISTORIC AND ARCHAEOLOGICAL SITES AND NATURAL LANDMARKS

2.3.1 <u>Historic sites</u>

There are eight historical markers in the Glen Rose area as listed by the Guide to Official Texas Markers. Only one site, the Squaw Creek Indian Fight Battleground, is in close proximity to the site for CPSES (ER, Sect. 2.3.1).

Comanche Peak, for which the proposed plant is named, is a prominent mesa located 5-1/2 miles to the north. It was an Indian and pioneer landmark and used by the Indians as a meeting place and supply center.

2.3.2 <u>Archaeological sites</u>

The archaeological potential of the CPSES area was assessed in a study for the applicant by SMU's Department of Anthropology. A number of interesting sites were discovered. These are described and cataloged in a report presented as Appendix A of the ER.

2.3.3 <u>Natural landmarks</u>

Dinosaur Valley State Park is the only Federally listed natural or historical landmark close to CPSES (4.5 miles southwest). Originally created by the State of Texas, it protects exposed dinosaur tracks in the Cretaceous limestone strata of the Glen Rose formation. CPSES will not effect this natural landmark.

2.4 GEOLOGY AND SEISMOLOGY

2.4.1 <u>Geology</u>

The physiographic setting of the central Texas region is shown in Fig. 2.4.1. The site lies within the Comanche Plateau subdivision of the Central Texas section of the Great Plains province not far from the boundary separating the latter from the Coastal Plain province.

The Paluxy sand and the Glen Rose formation are geologic formations which crop out in the site vicinity. The entire bedrock section in the immediate site area is made up of the Glen Rose formation. It is underlain by the Twin Mountains formation, whose sandstones are water-bearing and constitute the major aquifer for groundwater locally.

The limestone and claystone of the Glen Rose formation will be the station foundation materials.

Additional geological detail is presented in the applicant's ER (ER, Sect. 2.4) and the Preliminary Safety Analysis Report (PSAR).

2.4.2 <u>Seismology</u>

Earthquake activity in the region can be classified as low to moderate, and no physical evidence exists that the site has experienced major seismic activity at any time.

Additional seismic detail appears in the applicant's ER (ER, Sect. 2.4.4, Fig. 2.4-6).

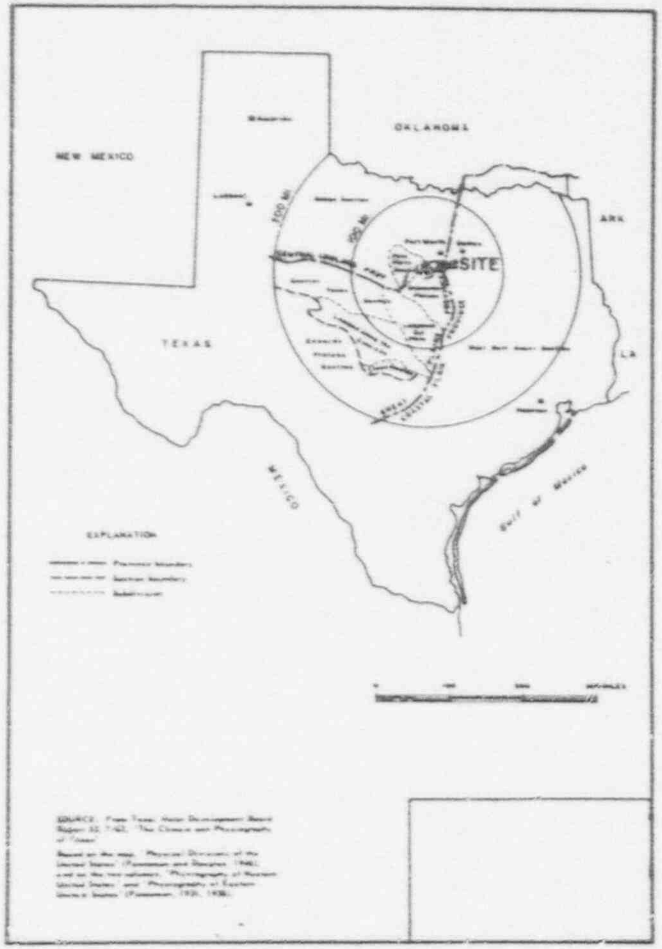


Fig. 2.4.1. Physiography of central Texas.
Source: ER, Fig. 2.4-1.

2.5 SURFACE WATER AND GROUNDWATER

2.5.1 Surface water

2.5.1.1 Squaw Creek and Paluxy River watershed

Squaw Creek, which will be impounded to form the proposed Squaw Creek Reservoir, flows in a southeasterly direction and is a tributary of the Paluxy River. A short distance downstream from the mouth of Squaw Creek, the Paluxy River flows into the Brazos River. The drainage area contributing to the reservoir site is 64 square miles.[1]

The Paluxy River watershed comprises an area of 410 square miles. It drains the eastern part of Erath County, southwestern part of Hood County, and north central part of Somervell County.

The watershed lies in the Texas-Gulf Water Resource Region. The Paluxy River flows into the Brazos River downstream from Lake Granbury and upstream from Lake Whitney.

The U.S. Geological Survey has measured the flow of the Paluxy River at Glen Rose a few miles upstream of the confluence with Squaw Creek and published the results in annual reports since mid-1947.[2] These records were used as the basis for estimating the runoff from the Squaw Creek watershed during the 24-year period from 1948 through 1971.[1] To correct for the different watershed areas the values were scaled down in proportion to the drainage area ratio (64/410 = 0.156). The resulting Squaw Creek runoff quantities are summarized in Table 2.5.1. A stream gaging station was established by the U.S. Geological Survey in October 1973 on Squaw Creek at its intersection with the bridge on State Highway 144 (ER, Sect. 6.1.1.1).

Major floods in the Paluxy River watershed resulting in severe damage occur on the average of once every three to four years. Major floods during recent years occurred in 1949, 1952, 1955, 1957, 1959, and 1963. The flood of October 1949, having an estimated 6.6% chance of occurrence, produced a peak discharge of 48,500 cfs at the stream gage on the Paluxy River near Glen Rose and inundated an estimated 12,800 acres of floodplain.[3] The maximum flood of record, which occurred in April 1908, produced a peak discharge of 59,000 cfs at the same gage, flooded about 14,000 acres, and had a 4.6% chance of occurrence.[3] It is estimated that the 1% chance of occurrence flood would inundate about 17,500 acres of floodplain.[3]

Table 2.5.1. Summary of estimated runoff data, Squaw Creek watershed, 1948–71

Values in acre-feet

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1948	320	1,830	770	200	980	580	500	60	190	50	70	90	5,640
1949	170	700	960	1,460	11,430	1,140	240	170	90	800	120	160	17,440
1950	390	830	280	700	620	260	610	90	710	100	100	100	4,790
1951	80	110	100	110	270	1,470	60	10	0	10	30	50	2,300
1952	70	70	80	480	4,520	150	40	10	0	0	300	90	5,810
1953	80	50	90	260	650	20	130	250	50	230	100	70	1,980
1954	70	50	70	660	360	440	30	20	0	200	140	60	2,100
1955	50	80	120	270	5,800	360	100	30	3,110	160	40	60	10,180
1956	60	120	60	130	3,550	40	0	200	20	70	50	370	4,670
1957	60	70	150	6,010	9,880	1,530	240	50	30	870	1,320	520	20,730
1958	800	560	1,080	1,100	2,420	390	910	50	120	120	110	120	7,980
1959	100	100	80	460	80	470	240	190	80	6,950	490	570	9,810
1960	2,330	830	560	780	1,150	370	300	90	40	90	70	130	6,740
1961	2,010	2,100	900	550	400	1,030	760	130	150	2,960	590	580	12,160
1962	360	260	250	320	160	260	190	140	140	3,360	350	380	6,170
1963	250	180	170	330	770	270	30	20	10	0	40	80	2,150
1964	210	180	330	1,380	280	60	40	50	740	80	1,410	130	4,890
1965	400	1,610	370	260	4,420	480	70	20	60	270	120	120	8,200
1966	130	220	170	1,430	1,520	910	130	300	290	100	110	120	5,430
1967	100	90	110	190	340	110	830	40	480	130	140	180	2,740
1968	2,880	930	6,670	1,400	8,250	910	1,280	1,010	240	150	210	210	22,200
1969	190	190	640	4,890	5,630	970	200	350	130	940	240	570	14,940
1970	620	1,380	4,030	2,240	1,140	710	160	70	320	230	160	140	11,200
1971	130	120	120	120	710	140	840	410	90	1,800	300	3,260	8,040
Average	494	528	673	1,072	2,722	547	330	157	304	820	275	340	8,262

Source: *Squaw Creek Reservoir Engineering Report*, Freese, Nichols and Endress, Dallas, Texas, 1972.

Upland erosion in the watershed is moderate. The highly erosive Cross Timbers soils suffered severe sheet and gully erosion in the past.[3]

Streambank erosion is destroying an average of 2.74 acres of land in the Paluxy River watershed annually.[3] Most of this destruction is occurring on the main stem channel lying within Hood County and extending into northern Somervell County. Small amounts occur on the tributaries and the upper reaches of the main stem. Floodplain scour damage in the watershed is moderate.[3]

2.5.1.2 Lake Granbury

Lake Granbury is an impoundment of the Brazos River in Hood County, Texas, formed by De Cordova Bend Dam, as shown in Fig. 3.4.1. This is a recent impoundment, since the dam was not closed until 1969. Possum Kingdom Reservoir is located upstream on the Brazos River and Lake Whitney is located downstream.

Water from Lake Granbury will be pumped to Squaw Creek Reservoir to help replace water lost as a result of evaporation and to limit the buildup of dissolved solids in Squaw Creek Reservoir by supplying blowdown water. The reservoir blowdown, with twice the concentration of total dissolved solids (TDS), will be returned to Lake Granbury.

The capacity and the area curves for Lake Granbury are shown in Fig. 2.5.1.

2.5.1.3 Brazos River

The Brazos River originates in the State of New Mexico about 30 miles west of the border with the State of Texas and flows generally in a southeastward direction to Freeport, Texas, where it discharges into the Gulf of Mexico. Rainfall in the Brazos River Basin varies from about 18 in./year at the headwaters to about 45 in./year near Freeport, Texas. Long-term records of the rate of inflow into Lake Granbury and the rate of discharge from De Cordova Bend Dam are not available since Lake Granbury is relatively new. However, the Brazos River flow has been measured since 1923[2] at a gaging station near the point where the Paluxy River enters the Brazos River.

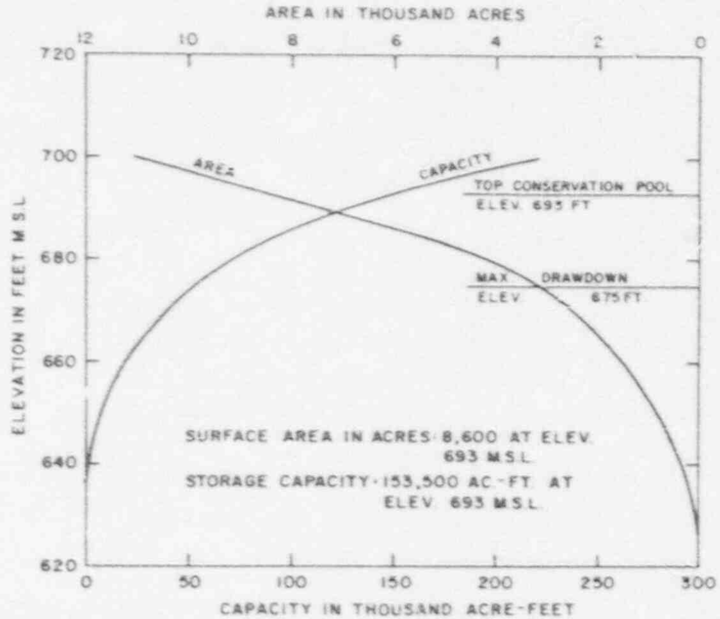


Fig. 2.5.1. Capacity and area curves for Lake Granbury. Source: ER, Fig. 2.5-4.

These records show that the average flow between 1923 and 1971 was about 1529 cfs (ER, Sect. 2.5.1.3).

A probability curve for the rate of flow at this location for the 1941-1962 time period is shown in Fig. 2.5.2. Data prior to 1941 were not included since the Possum Kingdom Reservoir, which provides flow regulation, was not completed until then. This curve shows that the average rate of flow during this time period was 1555 cfs. In 1952, however, the average rate of flow during the year was only 332 cfs.

2.5.1.4 Water quality

Water diverted to Squaw Creek Reservoir from Lake Granbury will have noticeably higher concentrations of dissolved minerals than that of natural runoff of the Squaw Creek watershed. The water quality data for Squaw Creek are given in the ER (ER, Tables 2.5-3, 2.5-4 and Appendices C and D). The applicant estimates that the total dissolved solids content is about 275 to 325 mg/liter. Because Lake Granbury has been in operation for only a short time, its long-term quality characteristics have not been established. In general, however, they can be expected to fall somewhere between the conditions observed at Possum Kingdom Reservoir and those at Lake Whitney. The USGS continuously monitors the chemical quality of water released from both of these reservoirs.[4]

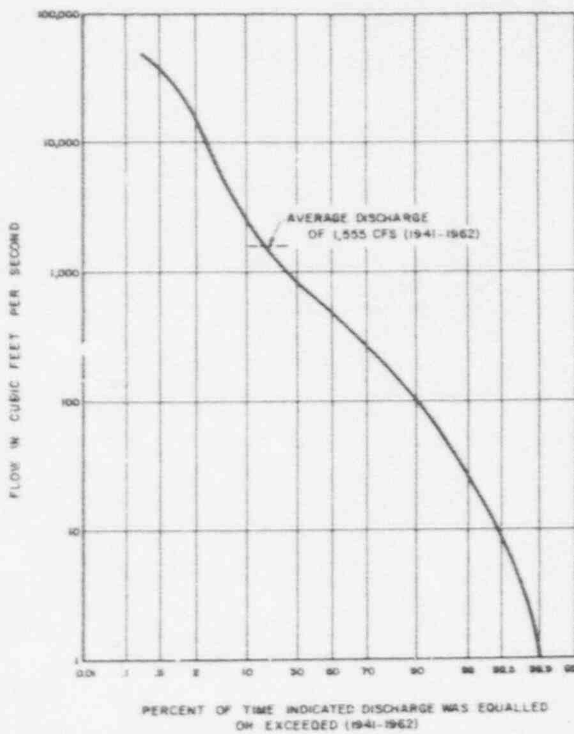
The chemical quality of water from Possum Kingdom Reservoir between 1960 and 1969 is given in Table 2.5.2. The average concentration of total dissolved solids in water coming from Possum Kingdom Reservoir during that decade was 1441 mg/liter. In that same period, the average level of total dissolved solids observed in the Lake Whitney water was 835 mg/liter.

Based on this information and other data on inflow to Lake Granbury, it is estimated that the average concentration of dissolved solids in Lake Granbury will be 1200 mg/liter.[1]

Additional chemical and ecological parameters for Lake Granbury are summarized by the applicant (ER, Table 2.5-8).

2.5.2 Groundwater

The applicant has sponsored studies of the groundwater in the vicinity of the site and reported the results in the ER (ER, Sect. 2.5.2). Most of the groundwater in the site region occurs in



SOURCE: GOINES, W.H., STREAMFLOW CHARACTERISTICS OF THE BRAZOS RIVER BASIN, U.S. GEOLOGICAL SURVEY, WATER RESOURCES DIVISION, OPEN FILE 87, 1965.

Fig. 2.5.2. Flow probability curve for the Brazos River at station 8-0910 near Glen Rose.
Source: ER, Fig. 2.5-5.

Table 2.5.2. U.S.G.S. chemical quality observations on the Brazos River below Possum Kingdom Dam, water years 1960 through 1969

Annual flow-weighted averages in milligrams per liter

Water year	Avg. flow (cfs)	Calcium	Magnesium	Sodium and potassium	Bicarbonate	Sulfate	Chloride	Total dissolved solids	Hardness as $CaCO_3$
1960	749	129	22	345	114	288	546	1,400	412
1961	1,409	165	28	444	115	398	697	1,800	526
1962	1,138	135	25	325	115	313	500	1,360	434
1963	867	126	25	320	124	286	496	1,320	417
1964	231	129	27	329	123	307	515	1,380	434
1965	515	130	33	362	122	304	581	1,470	459
1966	1,275	127	20	298	110	279	467	1,250	401
1967	522	143	25	359	113	310	576	1,480	450
1968	1,010	133	34	366	117	287	583	1,460	430
1969	1,170	115	26	360	125	245	569	1,380	393
Weighted average		134	25	355	117	304	558	1,441	437

Note: Beginning with 1963, "sodium and potassium" is the weighted average reading for sodium plus a constant average of 6 ppm for potassium.

Source: ER, Table 2.5-5.

bedrock. Some does exist in the shallow floodplain alluvium along stream valleys. Bedrock aquifers in the site vicinity include, in order of increasing age: the Paluxy formation, Glen Rose formation, and Twin Mountains formation, all of the Comanch series, Cretaceous age. Squaw Creek Reservoir and the CPSES are on the Glen Rose formation outcrop, which, in turn, is underlain by the Twin Mountains formation. The Paluxy formation is absent at the CPSES location but within the limits of the proposed reservoir.

The principal origins of groundwater in the Twin Mountains formation are rainfall and streamflow occurring in the outcrop area. Downdip from the outcrop, groundwater in the Twin Mountains formation is confined by fine-grained materials of the overlying Glen Rose formation. Hydrostatic pressure in the Twin Mountains is great enough to create static water levels which rise above the formation and, sometimes, to cause flowing wells. The piezometric level, at the site, measured in a test boring in this formation, is approximately elevation 670 ft above mean sea level about 60 ft above the formation surface.

The principal origins of groundwater in the Glen Rose formation are rainfall in the outcrop area and minor seepage from both the overlying Paluxy formation and underlying Twin Mountains formation.

CPSES and Squaw Creek Reservoir will be constructed on the Glen Rose formation. The Glen Rose limestones are essentially impermeable due to slight amounts of argillaceous impurities present.

These limestones are resistant to solution effects; open voids, caverns, joints, collapse features, and frequent fractures — frequent in some limestone formations — are notably absent in the Glen Rose formation near the site.

Groundwater, therefore, moves very slowly into and through the formation; entrance is afforded principally through existing joints and fractures. Occasional isolated sand lenses also contain groundwater.

Detailed examination of cores from test borings revealed minor solutioning features and minimal fractures. Packer-pressure tests in the Glen Rose formation, performed in most borings in the site area, incurred essentially no water take in rock beneath the upper, usually thin, weathered zone. Northwest of the site, where the formation is covered by outliers of the Paluxy, a few domestic water wells are completed in the Glen Rose formation.

These wells produce potable water and are reliable during droughts, generally due to the slow release of groundwater to the Glen Rose formation from the overlying Paluxy formation. Elsewhere, wells completed in the Glen Rose are often unreliable during droughts.

In its outcrop areas, the Glen Rose formation discharges water naturally through springs and seeps. In confined portions of the formation, there is a little transfer of water into overlying or underlying formations when differential pressures occur.

Following the subsurface exploration program, a number of the geologic and foundation test borings were observed to determine water levels. Of these borings, one was completed in the Twin Mountains aquifer; the piezometric water level in that boring is elevation 670 ft above mean sea level. The rest of the boreholes monitored for groundwater were completed in the Glen Rose formation. Static water levels observed in these borings range from 749 to 830 ft above mean sea level.

Typical results of analyses of groundwater are given in the ER (ER, Table 2.5-9). The water is generally of the sodium bicarbonate type with a dissolved solids content in the 300 to 800 mg/liter range.

2.6 METEOROLOGY

2.6.1 Regional climatology

The site is located in North Central Texas, in a transition zone between the humid subtropical climate of East Texas and a more continental climate to the north and west. The climate of the site can be described as continental, characterized by rapid changes in temperature and marked extremes, modified by frequent incursions of warm, moist air advancing from the Gulf of Mexico. During the winter, the area is often affected by cold, dry polar air pressing southward replacing warm, moist tropical air. Temperature falls of 20°F or more within an hour are not uncommon following the passage of a cold front. However, periods of extreme cold are usually short-lived. Snowfall is generally light and has occurred during all winter months.

The influence of the maritime climate is felt most strongly in the Spring, when warm, moist air from the Gulf moves over the area, resulting in maximum precipitation. Spring is also characterized by sporadic transition between warm and cold conditions, resulting in the highest average number of thunderstorm days.

The highest temperatures of summer are associated with fair skies, southwesterly winds and dry air. The hot weather is broken about four times a month by thunderstorms. Fall is characterized by fair weather, lowest average wind speeds, and moderate temperatures. The first freeze usually occurs around November 22.

2.6.2 Local meteorology

Based on meteorological measurements at Dallas, Fort Worth, Waco, and Abilene (about 100 miles west of the site), mean monthly temperatures at the site may be expected to range from about 46°F in January to about 85°F in July and August. Record minimum temperatures have been -9°F at Abilene (January 1947), -5°F at Waco (January 1949), and -10°F at Dallas (February 1899). The record maximum temperature has been 111°F, reported at all 3 stations on different dates. Maximum temperatures at the site may be expected to reach 90°F or higher almost 100 days per year, while falling below 32°F on only about 40 days per year.

Maximum precipitation occurs at the site area during April and May, with the maximum monthly average being 4.8 inches at Dallas. The minimum monthly average at Dallas is 1.9 inches, while at Abilene it is about 1 inch. Annual average precipitation varies from 23 inches at Abilene to about 34.5 inches at Dallas. Climatological stations nearer to the site indicate annual average precipitation around 31 inches. A large part of the annual precipitation results from thundershower activity, with occasional heavy falls over brief periods of time. Maximum monthly precipitation in the site area was 15.4 inches at Dallas in April 1966. The monthly minimum value of precipitation is zero. The maximum precipitation in a 24 hour period was 9.18 inches at Dallas in August 1947. Annual average snowfall in the area varies from 4.3 inches at Abilene to 1.5 inches at Waco. The average annual snowfall at Dallas is about 2 inches. The maximum monthly snowfall for Dallas is 7.4 inches, which is also the 24 hour maximum, both occurring in January 1964.

Wind data from the site, for the period May 15, 1972 through March 1, 1973, indicate a predominance of south to southeasterly winds, occurring about 43% of the time. West winds were the least frequent at less than 2%. Onsite data indicate a mean wind speed of 6.4 mph and a frequency of calms about 3%. Long-term wind data at Waco and Dallas indicate the predominant wind direction is south and a mean wind speed between 11 and 12 mph. The "fastest mile" of wind recorded at Waco is 69 mph. The onsite wind rose for the period May 15, 1972 through March 1, 1973, is presented in Fig. 2.6.1. One year of onsite data for the period May 15, 1972 through May 15, 1973 are given in the PSAR (PSAR, Table 2.3.3.2).

2.6.3 Severe weather

A variety of severe weather, from snow storms to tornadoes and hurricanes, can affect the site area.

The site is in an area where warm, moist, unstable air from the Gulf of Mexico contacts cooler and drier continental air pressing southward and eastward, triggering thunderstorms and occasionally tornadoes. Thunderstorms can be expected to occur between 40-45 days per year, being most frequent in April and May with monthly averages of 6 to 8 thunderstorm days, and being least frequent in December and January, with monthly averages of one thunderstorm day.

During the period 1955-1967, 58 tornadoes were reported within the one-degree latitude-longitude square encompassing the site, giving a mean annual tornado frequency of about 4.5. The computed recurrence interval for a tornado at the plant site is 316 years.

For the period 1931-1960, the annual average frequency of tropical cyclones that affected Texas was about 2.0. In the same 30 year time period, about 15 tropical cyclones were of hurricane force. During the period 1955-1967, in the one-degree latitude-longitude square containing the site, there were 77 windstorms of 50 knots

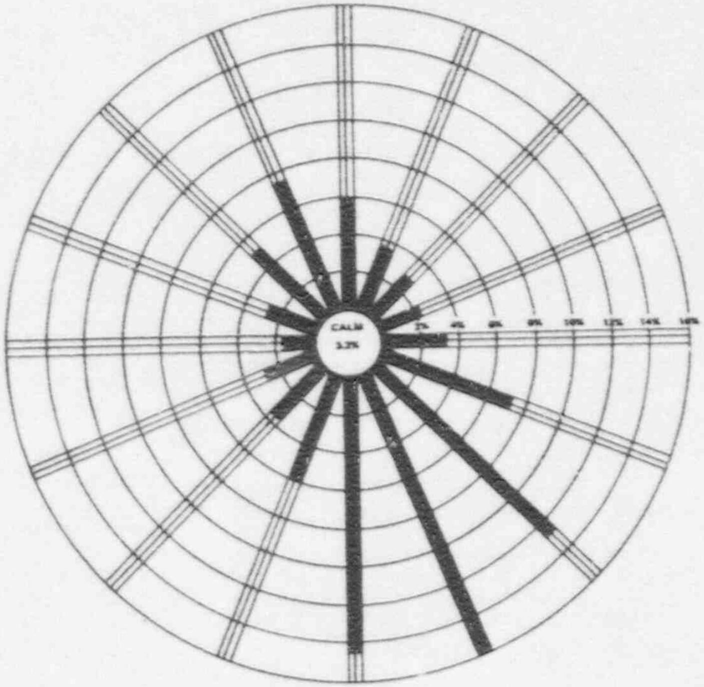


Fig. 2.6.1. Comanche Peak wind rose, May 15, 1972, to March 1, 1973.

or greater and 42 reports of hail 3/4 inch or larger. Damaging hailstorms are most frequent during April, May, and June.

Freezing rain occurs occasionally during the winter and early spring causing damage to trees and electrical power and telephone lines. At Carswell AFB, Fort Worth, the annual average frequency is 0.3 percent of all hours observed, but for December, January, February, and March the percentages are 0.3, 2.5, 0.5, and 0.1, respectively.

2.7 ECOLOGY OF THE SITE AND ENVIRONS

2.7.1 Terrestrial ecology

2.7.1.1 Soils

Thirteen different soil series occur on the site. Figure 2.7-2a of the Environmental Report presents a complete soils map of the site. The soils of the Squaw Creek area are of three types: (1) upland, stony shallow clays, overlaying the Glen Rose limestone formation; (2) bottomland, calcareous alluvial loams, overlaying Quaternary alluvium; and (3) upland, Cross Timbers sands and sandy loams, overlaying the Paluxy sandstone formation. Within the property boundary of the project area, the first type is the most commonly occurring; the second type occupies less area, primarily along Squaw Creek and Panther Branch; and the third type occupies the least area, primarily to the south and southeast of the station site.

Rather than a detailed discussion of all of the soil series of the site, attention is focused on certain soil series which are (1) common in the proposed Squaw Creek Reservoir area, (2) in the construction zone of the station, and (3) characteristic of the types described earlier. Figure 2.7-2b of the ER illustrates a profile of soil series at the location of the station along a north-south transect, as indicated in Fig. 2.7-2a.

Tarrant series stony clay[1]

These soils contain 35 to 65% (by volume) fragments of limestone. The soil depth varies from as much as 20 in. to surface limestone. Slopes are mainly 1 to 8%, but occasionally up to 40%. The soils have rapid to medium runoff, a moderate water intake rate, and a low available water capacity. When these soils have good vegetation cover, erosion is slight, but when bare, erosion is rapid and damage may be severe. Tarrant soils are best suited for use as

rangeland and, if not overgrazed, provide a wide variety of forage for both livestock and wildlife.

Lewisville series clay loam[2]

The Lewisville series consist of deep, gently sloping to sloping calcareous soils. These soils are primarily old alluvial soils formed along stream terraces, although sometimes occurring on slopes below limestone hills. Slopes range from zero to 10% but usually are 2 to 6%. These soils are well drained; they have moderate permeability and a high available water capacity. Most areas along the stream terraces are cultivated; many of the more sloping areas below limestone hills are used as rangeland. Erosion is slight on the gentle slopes.

Bosque series loam[2]

The Bosque series consist of deep, calcareous loamy soils of the bottomlands. These nearly level soils formed in bands of loamy alluvium along the floodplains of streams. Slopes are usually less than 1%. These soils are well drained; they have moderate permeability and high available water capacity. Most of these soils are cultivated in small grains, sorghums, and pecan orchards, although much native vegetation occurs along stream banks.

Windthorst series fine sandy loam[2]

The Windthorst series consists of deep to moderately deep loamy to sandy soils on uplands. Slopes vary from 1 to 8%. These soils are moderately well drained and moderately slowly permeable; they have a high available water capacity. Many of the gently sloping areas are cultivated in peanuts, sorghums, and small grains. In sloping areas when cultivated, both wind erosion and water erosion may be severe.

2.7.1.2 Producers

A summary of the vegetation communities of the site (Table 2.7.1) was calculated using the vegetation map (ER, Fig. 2.7-2c) developed by the applicant from quantitative survey data, aerial photography, and qualitative observations. As indicated by the property boundary of the project area (ER, Fig. 2.7-2c), the project acreage examined is 8575 acres, approximately 300 acres smaller than the total land ownership of the applicant at this site. Figure 2.7-2b of the

Table 2.7.1. A summary of the vegetation communities of the Comanche Peak site

Communities within the property boundary of the project area

Vegetation type	Acres	Percent
Juniper-Threeawn Uplands		
Cleared	2526	30
Uncleared	424	5
Juniper–Hairy Grama Slopes	1410	16
Broomweed Benches	869	10
Upper Riparian		
Nonagricultural	2022	24
Agricultural	978	11
Lower Riparian	346	4
Cross Timbers	0	0
Total	8575	100

Environmental Report illustrates an environmental profile of the site on a north-south transect through the proposed location of the station, as indicated in Fig. 2.7-2c. A complete species list of producers is found in Appendix C of the Environmental Report.

Interactions of topography, drainage, soil moisture, soil fertility, and perturbations, both natural and human-induced, have resulted in six distinct vegetation types on the site.

Juniper-Threeawn Uplands

This is one of the most common vegetation types on the site (35%). The Juniper-Threeawn community occurs predominantly on limestone soils, primarily Tarrant series stony soil. Little bluestem (*Andropogon scoparius*)[3] was the dominant climax species on these soils prior to overgrazing by domestic livestock.[4] As the native grasses were reduced by overgrazing, a secondary succession to brushy species (*Juniperus, Prosopis, Opuntia*, etc.) began.

About 86% of the Juniper-Threeawn Uplands was brush-cleared about 20 years ago and was stocked at approximately one cow to 9 acres. Scattered throughout the Juniper-Threeawn Uplands are plots of land which have not been brush-cleared in at least 20 years. The

stand of uncleared Juniper-Threeawn Uplands examined by the applicant also was being grazed, stocked at one cow to 14 acres.

Mean coverage and frequency of occurrence of trees and shrubs in both cleared and uncleared Juniper-Threeawn Uplands are presented in Table A-1 of Appendix A. In one of the cleared stands, juniper (*Juniperus* spp.) and mesquite (*Prosopis glandulosa*) are codominant. In the second cleared stand examined, juniper is the dominant tree species. Few shrubs occur in the cleared uplands. In the uncleared uplands, juniper is clearly the dominant tree species. Common shrubby species are elbowbush (*Forestiera pubescens*) and cedar elm (*Ulmus crassifolia*). The mean percentage canopy coverage and percentage frequency of occurrence of ground cover vegetation for cleared uplands are in Table A-2 and for uncleared uplands, in Table A-3. Threeawns (*Aristida* spp.) are the dominant grasses in the first cleared stand, but because of the shallower soil, hairy tridens (*Erioneuron pilosum*) is the dominant grass in stand 2. Common broomweed (*Xanthocephalum dracunculoides*) is the dominant forb in both stands. In areas protected from grazing, scattered patches of little bluestem are present. In the uncleared uplands, threeawns, Texas grama (*Bouteloua rigidiseta*), tall dropseed (*Sporobolus asper*), and hairy grama (*Bouteloua hirsuta*) are dominant in open areas, while sedges (*Cyperaceae*) are essentially the only species occurring under brush canopies. Very few forbs occur.

Juniper — Hairy Grama Slopes

The Juniper — Hairy Grama community is the second most common vegetation type occurring on limestone soils, primarily Tarrant series. Juniper — Hairy Grama Slopes occupy about 16% of the entire site. Mean percentage canopy coverage and percentage frequency of occurrence of vegetation on Juniper — Hairy Grama Slopes are found in Table A-4. The dominant trees were Ashe and redberry junipers. Hairy grama is the dominant grass, with threeawn and tall grama (*Bouteloua pectinata*) occurring commonly. On Juniper — Hairy Grama Slopes the mean percentage of open ground with vegetation was found to be 67.8.

Broomweed Benches

Broomweed Benches are the third type of vegetation growing on limestone soils. About 10% of the site is composed of Broomweed Benches. Broomweed Benches are found along hillsides on weathered limestone slopes, usually at elevations between 720 and 780 ft. These Broomweed Benches are easily seen in Figs 2.7-2a and 2.7-2c of the Environmental Report. The stand examined by the applicant is located in a pasture which was cleared about 20 years ago and stocked at one cow to 9 acres. Mesquite is the dominant woody species and King Ranch bluestem (*Andropogon ischaemum*) and tall dropseed (*Sporobolus asper*) are the dominant grasses. Common broomweed (*Xanthocephalum dracunculoides*) is the dominant forb. The composition and distribution of other grasses and forbs are highly variable due to differences in topography, microclimate, and soil. Approximately 86% of the area examined had no brush cover. Survey data are given in Table A-5.

Lower Riparian

The Lower Riparian vegetation type occurs along Squaw Creek at elevations less than 725 ft. The combination of streamside topography and alluvial soils results in a more mesic environment than the surrounding uplands. The resulting concentration of woody vegetation along stream banks is characteristic of riparian communities in much of north central Texas. The relative frequency, relative dominance, relative density, and importance values of the woody species of the Lower Riparian vegetation type are given in Table A-6. In the overstory stratum, cedar elm (*Ulmus crassifolia*), bur oak (*Quercus macrocarpa*), and redberry and Ashe juniper (*Juniperus* spp.) have high importance values. In the understory stratum, juniper, cedar elm, and American beautyberry (*Callicarpa americana*) have high importance values. Mesic species such as American sycamore (*Platanus occidentalis*), black willow (*Salix nigra*), and Eastern cottonwood (*Populus deltoides*) occur along the creek bottoms. Bur oak (*Quercus macrocarpa*), elm (*Ulmus americana*), and ashes (*Fraxinus* sp.) usually occur somewhat farther away from streamside. The herbaceous ground cover in the Lower Riparian is the most diverse of the site. The density of herbs is highly variable, depending on the extent of canopy coverage by trees and whether cattle are excluded.

Upper Riparian

The Upper Riparian type was arbitrarily designated as vegetation occurring on alluvial soils at elevations greater than 725 ft. The alluvial soils of the Upper Riparian are primarily Lewisville clay loam. About 33% of the area within the Upper Riparian designation (ER, Fig. 2.7-2c) has been used for agricultural purposes. The relative frequency, relative dominance, relative density, and importance values of the woody species of the Upper Riparian are given in Table A-7. Moving outward from the Lower Riparian, the

density of trees and shrubs decreases, composition changes extensively, and certain species are excluded as a result of decreased water availability in the Upper Riparian. Both the overstory and understory are dominated by cedar elm. The overstory of both the Upper and Lower Riparian types was dominated by cedar elm, junipers, bur oak, and pecan. Cedar elm and junipers were of high importance in the understory of both types. However, mesquite, which occurred in only trace values in the Lower Riparian, has the second highest importance value in the Upper Riparian.

Cross Timbers

The Cross Timbers vegetation type occurs primarily on sandy upland soils. Because most areas with sandy soil are now used for agricultural purposes, the Cross Timbers vegetation type is distributed as small uncleared plots that occupy a very small percentage of the entire Squaw Creek Reservoir area. According to Fig. 2.7-2c of the ER, no significant acreage of Cross Timbers vegetation occurs within the property boundary of the project area. Detailed discussion of the Cross Timbers and Cross Timbers Savanna are found in Appendix C of the Environmental Report.

2.7.1.3 Consumers

Section 2.7 and Appendix C of the Environmental Report contain lists of the vertebrate species expected to occur in the Squaw Creek Reservoir area; species actually observed in the area are indicated. Scientific names and classifications are included in these checklists. Surveys of vertebrate consumers were conducted with respect to the vegetation types of the site. The two distinct wildlife habitat types are the uplands on limestone soils (Juniper-Threeawn Uplands, Broomweed Benches, and Juniper — Hairy Grama Slopes) and the bottomlands on alluvial soils (Upper and Lower Riparian).

Amphibians

Fifteen species of amphibians may occur on the site, although only five species were observed. Gulf Coast toads (*Bufo valliceps*), bullfrogs (*Rana catesbeiana*), and leopard frogs (*Rana pipiens*) were seen at stock ponds in the uplands and along Squaw Creek.

Reptiles

Fifty-two species of reptiles may occur on the site; twenty-one species were observed. Pond sliders (*Chrysemys scripta*) and spiny softshell turtles (*Trionyx spiniferus*) are common in the deeper pools of Squaw Creek. One common snapping turtle (*Chelydra serpentina*) was observed in late October. Plain-bellied water snakes (*Natrix erythrogaster*) are common in Squaw Creek. Western ribbon snakes (*Thamnophis proximus*), six-lined race runners (*Cnemidophorus sexlineatus*), ground skinks (*Lygosoma laterale*), rough green snakes (*Opheodrys aestivus*), and copperheads (*Agkistrodon contortrix*) are associated with the Lower Riparian. Most reptiles on the site prefer upland habitats. Greater earless lizards (*Cophosaurus texanus*) are the most abundant reptilian species, commonly found in dry, rocky creek bottoms and along limestone outcrops. Collared lizards (*Crotaphytus collaris*) occur in the same habitat. Texas spiny (*Sceloporus olivaceus*) and Eastern fence lizards (*Sceloporus undulatus*) were seen along fence lines and in trees throughout the area. The limestone outcrops and dry, rocky ravines, with cacti, mesquite, and juniper, provide suitable habitat for a variety of reptiles, including Western diamondback rattlesnakes (*Crotalus atrox*), Texas horned lizards (*Phrynosoma cornutum*), bull snakes (*Pituophis melanoleucus*), king snakes (*Lampropeltis calligaster*), and coachwhips (*Masticophis flagellum*).

Birds

A total of 118 species, including 43 resident and 75 migratory birds, may be expected to occur on the site, at least temporarily (ER, Appendix C, Amend. 1, Sept. 27, 1973).* Seventy-four species were actually observed on the site; of these, 36 species were considered abundant or commonly encountered; the other 38 species were considered uncommon. The quantitative estimates of bird densities presented in Table 2.7.2 represent the average of a number of censuses conducted in early November 1972. Because of expected wide confidence limits, the mean densities are best considered as indicative of relative abundance, not as absolute densities. Bird densities were higher in the bottomlands than in the uplands, except for the fringillids (a taxonomic grouping under which observations of 14 species were combined). In addition to the Lower Riparian habitats, three somewhat specialized habitats were observed to be of importance to bird populations. These include (1) comparatively dense stands of mesquite, usually distributed in the Upper Riparian and occasionally on hilltops where the soil is not rocky and shallow, (2) heterogeneous mixtures of woody species growing in narrow bands along limestone outcrops where brush clearing is difficult, (3) thick growths of juniper along fence lines.

*Appendix C contained in Amendment 2 of the ER, dated January 25, 1974, presents the results of more recent censuses.

Table 2.7.2. Estimated densities of birds in two habitat types in the Squaw Creek Reservoir area based on 15 strip censuses

Species or group	Estimated density (number per 100 acres) Bottomlands	Uplands
Robins	605	27
Fringillids	170	225
Meadowlarks	156	43
Mourning doves	19	12
Other birds	205	120
Total	1,155	427

Source: staff revision of material in Appendix C of the Environmental Report, Amend. 1, dated Sept. 27, 1973.

Waterfowl following the Central Flyway may pass near or possibly over the Squaw Creek area.[5] The waterfowl observed on Squaw Creek and nearby stock ponds are primarily dabbling ducks, such as the mallard (*Anas platyrhynchos*), pintail (*Anas acuta*), and shoveler (*Spatula clypeata*). No quantitative estimates of densities were made; however, observations indicate that waterfowl as winter residents are not common to the Squaw Creek area.

The bobwhite quail (*Colinus virginianus*) is an important game bird commonly occurring on the site. Sixty-six bobwhite coveys were observed during the summer and fall of 1972. The density of bobwhite was estimated to range from 17 per 100 acres up to 40 per 100 acres. The number of bobwhite quail observed per mile by Texas Parks and Wildlife Department personnel[6] in Hood and Somervell counties is presented in Table 2.7.3. From these data, it is apparent that the quail populations of this five-county area undergo annual fluctuations and that the populations in Hood and Somervell counties are not unique with respect to the surrounding area.

The mourning dove (*Zenaidura macroura*) is another important game bird occurring on the site. The abundance of mourning doves in the Squaw Creek Reservoir area is seasonally variable because of the species' migratory behavior. As seen in Table 2.7.2, late fall densities were estimated at 12 per 100 acres in the uplands and 19 per 100 acres in the bottomlands. The number of mourning doves observed per mile by Texas Parks and Wildlife Department personnel[7] in Hood and Somervell counties and three adjacent counties is found in Table 2.7.4. Although these data indicate wide spatial and temporal variations in mourning dove abundance, dove populations in Hood and Somervell counties do not appear unique with respect to the surrounding area.

Table 2.7.3. Number of bobwhite quail observed per mile during August censuses by the Texas Parks and Wildlife Department

County	Number per mile				
	1967	1968	1969	1970	1971
Bosque	0.60	1.56	0.99	0.72	0.51
Hood and Somervell	0.36	1.24	0.53	1.24	1.20
Johnson	0.68	1.91	0.80	1.16	0.14
Erath	0.27	1.25	2.20	2.59	

Table 2.7.4. Number of mourning doves observed per mile and percent change between years during August census by the Texas Parks and Wildlife Department

County	1967	Percent change	1968	Percent change	1969	Percent change	1970
Bosque	9.81	−58	4.16	−79	0.87	+26	1.10
Hood and Somervell	3.22	−52	1.55	+53	2.37	−56	1.05
Johnson	1.75	−57	0.76	−79	0.16	+888	1.58
Erath	3.00	−7	2.80	−26	2.07	+27	2.63

Two species of raptorial birds, classified by the U.S. Department of the Interior as rare and/or endangered species,[8] may be expected to occur in the Squaw Creek Reservoir area. These are: peregrine falcons (*Falco peregrinus*), and Southern bald eagles (*Haliaeetus leucocephalus*). Prairie falcons (*Falco mexicanus*) which are classified as a threatened species[8] may also occur in the site area. None of these species were observed during the ecological surveys conducted on the site.

The golden-cheeked warbler (*Dendroica chrysoparia*), classified as threatened,[8] may occur on the site. This warbler is dependent upon stands of mature Ashe junipers (usually 25 to 40 ft tall). Much of the Juniper-Threeawn Uplands appears to be suitable habitat for this species;[9,10] however, none have been observed there.

Mammals

Thirty-seven species of mammals may be expected to occur in the Squaw Creek Reservoir area. Twenty-seven species were observed in the area. (Appendix C, ER)

The relative abundances of small mammals in three habitat types in the Squaw Creek Reservoir area are presented in Table 2.7.5.

Table 2.7.5. Relative abundance of small mammals in three habitat types in the Squaw Creek Reservoir area based on trapping results

Species	Bottomlands (1,495)[a]		Uplands				Total (4,114)	
			Limestone (2,011)		Sandy (608)			
	No.	TNI[b]	No.	TNI	No.	TNI	No.	TNI
Deer mouse			2	1.0	12	19.7	14	3.4
Hispid cotton rat	5	3.3	6	3.0			11	2.7
Pygmy mouse	1	0.7	7	3.5			8	1.9
White-footed mouse	2	1.3	3	1.5	1	1.6	6	1.5
Fulvous harvest mouse			1	0.5	4	6.6	5	1.2
Southern plains wood rat			4	2.0			4	1.0
Brush mouse			4	2.0			4	1.0
Hispid pocket mouse	1	0.7					1	0.2
All species	9	6.0	27	13.5	17	28.0	53	12.9

[a]Number of trap nights.

[b]Trap-night index: number of animals caught divided by number of trap nights in type times 1,000.

Compiled from ER Appendix C, Amend. 1, dated Sept. 27, 1973.

Deer mice (*Peromyscus maniculatus*), hispid cotton rats (*Sigmodon hispidus*), and pygmy mice (*Baiomys taylori*) are the three most abundant small mammal species in the area as estimated by the trap-night index. Three habitat types were sampled (bottomlands, limestone uplands, and sandy uplands), and only one small mammal species, the white-footed mouse (*Peromyscus leucopus*), was trapped in all three. The greatest number of species (7) and the highest number of individuals (27) were found in the limestone uplands.

Other small mammals which were observed are least shrew (*Cryptotis parva*), Eastern fox squirrel (*Sciurus niger*), plains pocket gopher (*Geomys bursarius*), and house mouse (*Mus musculus*). No estimates of abundance were provided for these species.

Thirteen species of medium-sized mammals were observed on the site. The estimates of relative abundance of certain of these mammals are given in Table 2.7.6. The most abundant is the opossum (*Didelphis marsupialis*), which was more commonly trapped in bottomlands than in uplands. The next two most abundant species, raccoon (*Procyon lotor*) and striped skunk (*Mephitis mephitis*), were equally distributed between bottomlands and uplands. Other medium-sized mammals that were observed, but for which no estimates of abundance were made, include spotted skunk (*Spilogale putorius*), coyote (*Canis latrans*), red fox (*Vulpes fulva*), black-tailed jackrabbit (*Lepus californicus*), swamp rabbit (*Sylvilagus aquaticus*), Eastern cottontail (*Sylvilagus floridanus*), and the nine-banded armadillo (*Dasypus*

Table 2.7.6. Relative abundance of certain medium-sized mammals in two habitat types on the Squaw Creek Reservoir area based on trapping results

Species	Bottomlands (299)[a]		Uplands (307)		Total (606)	
	No.	TNI[b]	No.	TNI	No.	TNI
Opossum	26	87	12	39	38	63
Raccoon	8	27	8	26	16	26
Unknown	3	10	6	20	9	15
Striped skunk	4	13	4	13	8	13
Gray fox	1	3	6	20	7	12
Ringtail	0	0	3	10	3	5
Bobcat	1	3	0	0	1	2
All species	43	143	39	127	83	135

[a]Number of trap nights.

[b]Trap-night index: number of animals caught divided by number of trap nights in type times 1,000.

Compiled from ER Appendix C.

novemcinctus). Armadillos are common throughout the area but were more frequently observed in the riparian. Jackrabbits are most common in the limestone uplands. Cottontails and swamp rabbits were usually encountered near thickets in the Lower Riparian type. Fox squirrels are common in the Lower Riparian but are seldom observed in the uplands.

The only large mammal living in the Squaw Creek Reservoir area is the white-tailed deer (*Odocoileus virginianus*). Based on 52 observations of deer during 1973, the density of deer in the southern part of the site was estimated to be between two and four deer per square mile. Estimates of deer abundance in Hood, Somervell, and three adjacent counties are presented in Table 2.7.7. By comparison with these surrounding counties, Hood and Somervell counties have low deer densities, and the site itself has a particularly sparse population.

2.7.2 Ecology of the aquatic environs

The construction and operation of the CPSES will affect two bodies of water: (1) Squaw Creek, which will be dammed to form Squaw Creek Reservoir, and (2) Lake Granbury, which will yield makeup water for the reservoir and receive blowdown.

None of the aquatic species identified in the site area are listed as threatened by the U.S. Department of the Interior.[11]

Table 2.7.7. White-tailed deer census in five Texas counties conducted during August from 1965 through 1970 by walking cruise lines

County	1965	1966	1967	1968	1969	1970
Acres per deer[a]						
Bosque	16.10	19.15	9.79	9.79	9.22	9.17
Erath	16.52	21.09	31.70	29.32	25.38	16.98
Hood	9.91	15.70	23.96	28.65	26.69	33.16
Johnson	9.86	7.89	40.11	11.09	9.49	6.56
Somervell	72.89	14.86	27.25	54.50	29.73	23.47
Does per buck						
Bosque	4.41	3.54	3.62	3.27	3.22	2.29
Erath	3.33	15.00	3.40	1.76	2.86	3.48
Hood	1.67	3.00	4.92	2.37	2.10	4.29
Johnson	1.50	11.00	2.60	3.57	2.36	2.8[illegible]
Somervell	2.50	3.00	8.00	1.33	2.67	2.33
Fawns per doe						
Bosque	0.74	0.65	0.53	0.53	0.65	0.72
Erath	1.04	0.76	0.68	1.11	0.98	0.57
Hood	0.80	0.86	0.41	0.92	0.79	0.73
Johnson	0.58	0.82	0.81	1.20	1.26	0.60
Somervell	0.40	1.33	1.37	0.75	1.38	1.21
Number of deer observed						
Bosque	2.89	2.80	8.45	8.45	8.64	8.25
Erath	1.32	1.41	1.19	1.38	1.47	2.20
Hood	0.45	0.37	1.11	0.92	[illegible]	[illegible]
Johnson	0.29	0.28	0.70	0.66	0.74	[illegible]
Somervell	0.09	[illegible]	0.24	0.12	0.22	0.38

[a]One deer per 10 acres is equivalent to 64 deer per square mile.

Compiled from ER Table 2.7-14.

2.7.2.1 Squaw Creek

Squaw Creek, which has a total length of 23 miles, can be termed both "intermittent" and "interrupted." Flow is dependent on vadose and groundwaters in addition to surface runoff. During the summer, the flow is interrupted at several points by the water going underground. Although frequently reduced to a series of pools during dry years, it is reported that there is continuous flow in the creek downstream of the proposed dam site during most years.[12] Table 2.5.1 shows an average monthly flow for Squaw Creek of 689 acre-ft, with a average high flow occurring in May (2,722 acre-ft) and the average low flow in August (157 acre-ft). Field measurements of water velocities for 1973 have confirmed this variation in flow.

The habitats in the creek are varied. There are wide shallow pools with an average maximum depth of 3 ft, width of 21 ft, and a substrate of silt and herbaceous material covering bedrock. Riffle areas have a depth of 2 in. and a width of only 5 ft with a substrate of coarse gravel.[12] Certain segments can also be classified as cascades, which are areas too shallow to be called pools and with too slow a current to be called riffles. These sections have a substrate of bedrock with little rubble, gravel, or fine material. It has been estimated that during summer the total length of Squaw Creek is composed of 35% pool area, 35% riffle area, and 30% cascade, and that 35% of the creek is fishable.[12]

In order to survive in an intermittent stream, organisms must be able to endure a variety of stresses associated with extreme fluctuations in flow, temperature, and chemical conditions. During dry periods, a stream might appear devoid of life. Organisms survive, however, by burrowing into moist interstitial spaces of the stream bed, living under leaf litter or rocks, or aestivating as pupae or larvae. The fauna inhabiting a stream such as Squaw Creek would typically have one generation per year, emerging in the spring and surviving the dry summer as eggs or small larvae.[13-15]

Producers

Macrophytes. The clear waters of Squaw Creek support abundant growths of aquatic plants. Dense growths of the submergent muskgrass (*Chara* sp.), a common plant in hard waters,[16] occur at the outer edges of the pool areas. Other macrophytes in the pools include pondweed (*Potamogeton* sp.), bushy pondweed or naiad (*Najas* sp.), and milfoil (*Myriophyllum* sp.). The emergents occurring in the littoral zone are cattail (*Typha* sp.), rush (*Juncus* sp.), willow (*Salix* sp.), bulrush (*Scirpus* sp.), and twig rush (*Cladium* sp.) (ER, Sect. 2.7.3.2.1).

Phytoplankton. Fourteen species of phytoplankton representing four phyla were identified (Table B-1 in Appendix B, based on counts for the months of April through August 1973).[17]* Diatoms dominated throughout the spring and summer, composing an average of 71.2% of the population, with *Cyclotella* and *Fragilaria* being the most abundant genera. The green algae comprised 15.9%, the blue-greens

*Appendix D contained in Amendment 2 of the ER, dated January 25, 1974 presents the results of chemical and aquatic biotic data for the months of March through December 1973.

4.4%, and euglenoids 8.5% of the phytoplankton. Ten fewer species were reported from Squaw Creek than from the Paluxy River.

It is likely that many of the species, especially the diatoms, are not true plankters but are really members of the "attached" community washed up from the stream bed.[14,18]

Periphyton. The filamentous green alga *Spirogyra* has been observed in riffle areas and the aquatic moss *Amblystegium* in areas where groundwater comes to the surface.[12] *Cladophora glomerata*, another green alga, which is typically the most abundant filamentous alga in clear alkaline streams,[14,19-21] is also known to occur in riffle segments of Squaw Creek (ER, Sect. 2.7.3.2.2).

As mentioned above, much of the plankton found in Squaw Creek is probably of benthic origin, and it is likely that the organisms in the plankton reflect what is present in the periphyton community on the stream bed. It thus appears that the periphyton would be dominated by diatoms. The major factor limiting development of the periphyton in Squaw Creek is probably the scouring effect of high water flows. During periods of heavy rain, it is possible that the periphyton community could be severely reduced.

Consumers

Zooplankton. The zooplankton of Squaw Creek is sparse (Table B-2). Planktonic rotifers dominated counts for March through August 1973, with *Pilinia* being the most abundant species.[17] The species listed are typical of the zooplankton found in alkaline streams.[14,22]

Benthos. The diverse benthic fauna of Squaw Creek (Table B-3) is composed of 40 species representing five phyla (Platyhelminthes, Annelida, Arthropoda, Mollusca, and Chordata).[17] Insect larvae dominate the community, comprising an average of 88% of the organisms over the sampling period. The predominant insects are the dipterans, which make up an average of 57% of the insect fauna, with a maximum of 84% in May. These would be expected in both pool and riffle areas of the creek.[23] The midge flies are generally the most abundant in Squaw Creek, and blackflies also become abundant during the summer.

The next most abundant insect group is the Ephemeroptera, or mayflies, of which two families are represented, the Baetidae and the Heptageniidae. The majority of the species listed are characteristic of running water; however, *Caenis* and *Tricorythodes* are restricted to the bottoms of quiet shallow water habitats.[22,24]

Hydropsyche simulans is the most abundant caddis fly in Squaw Creek. All the species present are inhabitants of swift-flowing water and would be expected in the riffle areas of the stream. All species except *Ryacophila* (a free-living genus) spin nets which are attached to rocks.[22,25,26]

Squaw Creek supports a very poor stonefly population, as is typical of intermittent streams in arid Western States. *Perlinella drymo* is a comparatively rare species, collected mainly in limited numbers from fast-flowing riffles of Eastern streams.[27]

Only 30 species of benthic organisms were found in the Paluxy River, into which the creek flows, and 29 species were found in the Brazos River. Squaw Creek contained more species of Diptera and Ephemeroptera but was the least productive in terms of number of organisms.

Fish. Twenty-seven species of fish, representing nine families, have been found in Squaw Creek.[12,17,28,-29] Abundances (compiled from Forshage[12] and Lamb[28]), along with habitat type, food habits, sport value, and spawning habits, are shown in Table B-4.

The stoneroller, typically found in clear, gravelly creeks, is the most abundant species in Squaw Creek and was seen in large schools in slow riffles and shallow pools.[12] The orangethroat darter, a riffle inhabitant, is also very abundant.[12] Other fish abundant in the creek are red and blacktail shiners, longear sunfish, plains killifish, channel catfish, spotted and largemouth bass, and black and yellow bullheads. Squaw Creek has a large proportion of game and forage fish species, the principal game fish being the two species of bass. Only six species of rough fish were found (river carpsucker, gray redhorse, gizzard shad, black and yellow bullheads, and logperch), and of these only the bullheads were abundant.

2.7.2.2 Lake Granbury

Lake Granbury is a relatively new reservoir, the dam having only been closed in September 1969.

In the following discussion, the area of primary interest is that influenced by the makeup intake and blowdown discharge for the CPSES. Station F in Mecom's study,[31] 225 ft above De Cordova Bend Dam, is the closest sampling station to this area.

Producers

Macrophytes. Aquatic plants are not abundant near the dam (ER, p. 2.7-55). Pondweed (*Potamogeton* sp.), muskgrass (*Chara* sp.), milfoil (*Myriophyllum* sp.), stonewort (*Nitella* sp.), and hornwort (*Ceratophyllum* sp.) are submerged plants known to be in the area. Emergent vegetation is sparse, possibly because of the large variations in water level (maximum drawdown of 18 ft) (ER, Sect. 2.7.3.3.2). Cattails have been seen in areas of the lake.[32]

Phytoplankton. In 1971-1972, the phytoplankton community in Lake Granbury was dominated at all seasons and all depths by the green alga *Actinastrum gracillum*, which averaged approximately 6,000,000 cells per liter[31] (Table B-5). At the site of the proposed makeup and blowdown lines, samples ranged from approximately 3,000,000 to almost 11,000,000 cells per liter; the species accounted for 86.9% of the total phytoplankton in July 1971 up to 95.9% in January 1972. A preliminary species list shows *Actinastrum* completely absent from 1973 collections.[17]* A total of 14 genera of green algae were identified, of which seven occurred only in the May sample. The numbers of green algae were fairly constant, although this level is much higher than the "peaks" of the other organisms.

Nineteen genera of diatoms were identified. *Fragilaria* was the most abundant in May and July, and *Cyclotella* and *Diploneis* were dominant in October and January. In both the green algae and the diatoms, there was a high diversity in the spring, with a definite decrease to one or two dominant genera in the fall and winter.

There are some blue-green algae present throughout the year, with relatively large numbers of *Anabaenopsis* occurring in most months. This is one of eight blue-green species noted as major components of Southwestern reservoir phytoplankton peaks.[33]

The phytoplankton at the approximate location of the CPSES diversion and blowdown lines seems to be typical of that in other parts of the lake.[31] No unique genera occur here that are not present elsewhere in the lake. A slightly higher number of genera, however, occur here throughout the year (annual mean of 17 genera) than the average for the entire lake (annual mean of 14 genera). Total cell counts are also higher. All stations had an annual average of 5,900,000 cells per liter, while there were 6,900,000 cells per liter near the dam.

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*Appendix D contained in Amendment 2 of the ER, dated January 25, 1974, presents the results of chemical and aquatic biotic data for the months of March through December 1973.

It must be noted that Lake Granbury is probably still in successional stages with continually changing phytoplankton populations, and it is not possible to observe any true population cycles with only the four seasonal samples provided. Although plankton cycles vary greatly between reservoirs and areas of the same reservoir,[34] Silvey and Wyatt made an attempt to describe the periodicity exhibited by algal populations in Southwestern reservoirs (Fig. 2.7.1).[33] It was found that green algae remain at an almost constant level and that blue-greens exert the major influence with a major peak in August.

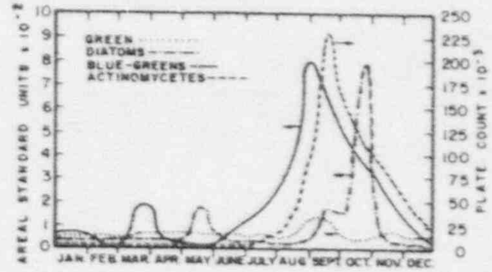
Periphyton. Large quantities of sessile algae grow along the perimeters of Southwestern reservoirs throughout the year.[33] Periphyton growth in Lake Granbury, however, is probably limited by the large drawdown permitted in the reservoir.

Consumers

Zooplankton. The concentration of zooplankton in the reservoirs of the Southwest is typically quite low,[33] with the population being dominated by organisms characteristic of brackish, alkaline water. The 11 species found near De Cordova Bend Dam are shown in Table B-6, in addition to 17 species whose collection site or abundance was not given.[17,31] The zooplankton is typical of a limnetic community, being composed of rotifers and crustaceans.[35] An average of five species are found near the dam at any season of the year, the same average as for the entire lake. Zooplankton counts, however, were lower here than in most other areas of the lake, with an annual average of 29 organisms per liter, compared with an average of 93 per liter for the entire lake.

Benthos. The benthic organisms found in Lake Granbury near the dam are shown in Table B-7.[31] Only five species were present: the oligochaetes *Limnodrilus hoffmeisteri* and *L. claparendianus*, and the larvae of *Chaoborus* sp., *Pentaneura* sp., and *Tendipes* sp. *Physa virgata*, a dominant organism in the rest of the lake, did not appear at station F, and midge larvae (*Tendipes* and *Pentaneura*) were not abundant.

The site of the diversion facilities has a very low number of benthic organisms compared to the other points in the lake during most of the year. The annual average for this area (67 organisms per square foot), however, is higher than that for the entire lake (62 per square foot) due to the high density of *Chaoborus* in January. The biota is characteristic of a habitat with low dissolved oxygen levels and a bottom of mud and ooze. Thirty-two species were found throughout the lake, but only eighteen of these were truly aquatic



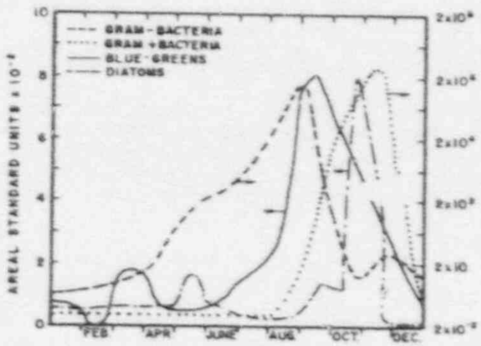


Fig. 2.7.1. Typical microbiotic cycles of a Southwestern reservoir.

Source: J. K. G. Silvey and J. T. Wyatt, "The Interrelationship between Freshwater Bacteria, Algae, and Actinomycetes in Southwestern Reservoirs," *The Structure and Function of Fresh-Water Microbial Communities*, ed. J. Cairns, Jr., Amer. Microsc. Soc., 1969, pp. 249-275.

species. It is thus apparent that the benthic community in Lake Granbury is not yet fully developed.

Fish. Thirty-three species, representing eleven families, have been found in Lake Granbury (Table B-4). Striped bass fingerlings (27,250 in number) were stocked in the lake in June 1972 (ER, Sect. 2.7.3.3.4), and Lake Granbury is also heavily stocked with large-mouth (1,700,000 in 1970) and channel catfish (45,600 in 1970).[32] The smallmouth buffalo is the most predominant commercial species[36] (ER, Sect. 2.7.3.5.3).

It can be seen that the lake has a higher proportion of rough fish (10 species, or 33%) than does Squaw Creek (22%). Netting data show 71.2% by number, 84.7% by eight of rough fish,[32] with gizzard shad, smallmouth buffalo, river carpsucker, and carp comprising the majority. Bluegill, channel catfish, and largemouth bass are the most abundant game fish (21.3% by number, 11.8% by weight). In order to obtain some form of quantitative comparison between Lake Granbury and Squaw Creek, the abundances shown in Table B-4 were estimated for Lake Granbury from Henn's netting data.[32]

There is probably very little spawning activity in the area of the diversion and return facilities. The bottom here is composed of mud, ooze, and fine sand, and aquatic vegetation is sparse.[31] The area does not provide suitable spawning habitat for most of the common species in the lake (Table B-4).

The Brazos River below Lake Granbury contains all the species reported from the lake.

Decomposers

Information on the bacteria in Lake Granbury is available in the form of coliform counts (total and fecal) from the Texas State Department of Health[37] and the Texas Water Quality Board.[38]

Table 2.7.8 lists the most probable number (MPN) per 100 ml[39] (ER, Appendix B). The coliform standards for the Brazos River from Lake Whitney to Lake Palo Pinto are 2000 MPN fecal and 20,000 MPN total coliforms.[38]

Figure 2.7.1 illustrates the bacterial cycles that might occur in relation to fluctuations of phytoplankton in a reservoir. The most common species of bacteria in Southwestern reservoirs are *Bacillus cereus*, *B. cereus* var. *mycoides*, brevibacteria, and streptocci (all

Table 2.7.8. Coliform counts in Lake Granbury

Most probable number in 100 ml

Date	U.S. 377 east of Granbury, Texas		F.M. 51 north of Granbury, Texas	
	Fecal	Total	Fecal	Total
02-17-71			2	10
06-08-71			10	210
10-19-71			20	1100
02-08-72			2	2
06-20-72			10	100
08-15-72	142	800	0	1100
11-15-72	20	200	240	500
02-06-73			10	100
05-16-73	40	600	30	100
06-19-73			10	100

Sources: Texas State Department of Health, "Bacteriological Water Quality," unpublished data, July 17, 1973; Texas Water Quality Board, "Surface Waters Sampling Data," Form 535804, pp. 252–255, July 1, 1972 – June 30, 1973.

Gram-positive), *Flavobacterium*, *Pseudomonas*, *Alcaligenes*, and the *Enterobacter-Klebsiella* group (all Gram-negative), and the actinomycetes *Streptomyces* and *Micromonospora*.[33]

2.8 RADIATION BACKGROUND

2.8.1 Natural radiation background

The Environmental Protection Agency has reported average background radiation dose equivalents for Texas as 100 millirems/person/year (whole body dose).[1] Of this total, 45 millirem/person was attributed to cosmic radiation. External gamma radiation (primarily from K-40 and the decay products of the uranium and thorium series) was estimated at 30 millirems/person for Texas. The remainder of the whole body dose is due to internal radiation dose (mostly H-3, C-14, K-40, Ra-226 and Ra-228 and their decay products), which was estimated to average 25 millirems/person throughout the United States.

An aerial gamma radiometric survey of the area within a ten-mile radius of the Comanche Peak station site was conducted in June 1973.[2] The results of the survey are not significantly different from the Environmental Protection Agency state-wide estimates.

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3. THE STATION

3.1 EXTERNAL APPEARANCE

A view of the station from the southwest is shown in Fig. 3.1.1. Prominent features are the two reactor containment vessels, the turbine-generator deck, and the electrical switchyard. Each of the containment vessels will be a steel-lined reinforced concrete structure with a domed roof, about 268 ft high and 144 ft in diameter.

The station will be visible from the nearest highway, Texas Route 144, which is located about 2-1/2 miles northeast.

3.2 REACTOR, STEAM-ELECTRIC SYSTEM, AND FUEL INVENTORY

The station will consist of two pressurized nuclear reactors supplied by the Westinghouse Electric Corporation. Each reactor will consist of a reactor vessel, four primary coolant loops, each with a circulating pump and a steam generator, one turbine-generator, one main steam condenser, and associated auxiliary equipment. Anticipated power levels for each of these reactors are as follows:

	Rated power level	Expected ultimate capability
Reactor output, MWt (including 14MWt pump heat)	3425	3579
Turbine-generator output, MWe	1161	1206
In-plant electrical consumption, MWe	48	50

The core in each reactor is an 11.1-ft-diam, 12-ft-high close-packed array of fuel assemblies that is contained within a pressure vessel. Each of the 193 fuel assemblies will contain 264 fuel rods consisting of cylindrical pellets of uranium oxide sealed inside zirconium alloy tubes. The total mass of UO_2 in each reactor core will be 111.4 tons. The pressure vessel will be contained within a thick concrete shield. The primary coolant circulating pumps and steam generators will be outside of the primary shield but within an inner concrete shield. The building structure will form the outer concrete shield, within which will be a sealed steel liner.

Heat produced by the fission reaction within the fuel rods will be transferred into the primary coolant.

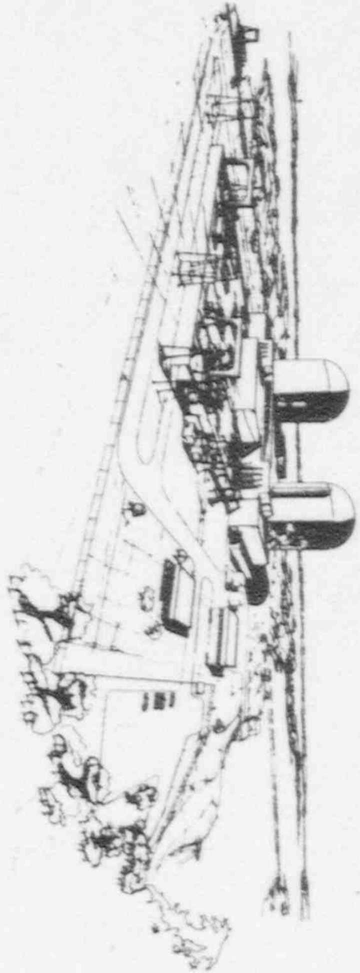

Fig. 3.1.1. View of CPSES from the southwest.
Source: ER, Fig. 3.1-1.

At design power, the reactor coolant water will be pressurized to about 2250 psia and will be heated from 557.3 to 616.9°F (291.8 to 324.9°C) within the reactor vessel. The heated reactor coolant water will be pumped to the inside of the tubes of the steam generator, where it will transfer its heat to the steam system water on the outside of the tubes. The steam leaving the steam generator will be at 1000 psia, 544.6°F (284.8°C), and 99.75% quality. It will pass through a turbine, driving a shaft connected to a generator which will produce electricity.

After its passage through the turbine, the exit steam will be cooled and condensed by a steam condenser. Condensation will take place on the outside of the condenser tubes, which are cooled by the reservoir water being pumped through them. The condensate will be recycled back to the steam generator.

3.3 STATION WATER USE

Condenser cooling will be the primary use for water in the station. At full power the turbine-generators will require the circulation of 2,200,000 gpm (4902 cfs) of cooling water, which will rise in temperature 14.2°F (7.9°C). (A 15°F circulating water temperature rise was used in the staff analyses to determine qualitatively the effect of increasing the plant operating condition to the design power level.) Estimates provided by the applicant of monthly averages of the plant factor, condenser heat load, circulating water flow rate, and temperature rise are summarized in Table 3.3.1.

In addition to the steam condenser requirements, reservoir cooling water will be required for the auxiliary equipment of the turbine-generator plant and the nuclear steam supply system, fire protection, and other emergency cooling. Figure 3.3.1 is a flowsheet of the water system showing the water flow paths and rates.

Fresh water will be drawn from wells at a rate less than 370 gpm (0.82 cfs) for various uses in the station as shown in Fig. 3.3.1. These uses include a potable water supply and makeup for the station water supply. Spent demineralizer regenerants and sand filter backwash sludge will not be discharged into the reservoir, but into an evaporation pond.

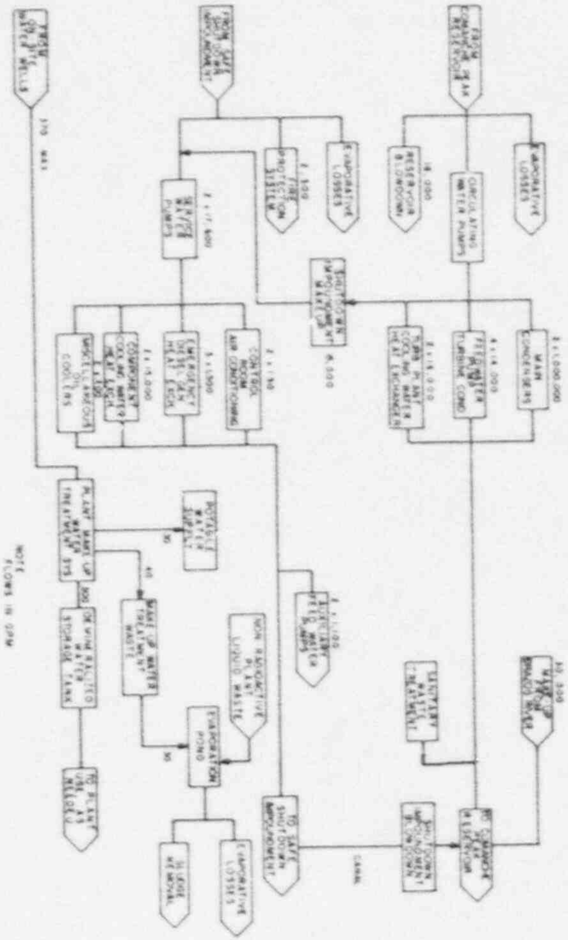

Fig. 3.3.1. Water system for CPSES.

Source: ER, Fig. 3.3-2.

Table 3.3.1. Predicted heat loadings for Squaw Creek Reservoir

Month	Plant load factor	Condenser heat load (10^9 Btu/hr)	Circulating water flow rate (10^6 gpm)	Circulating water temperature rise (°F)
January	0.70	10.9	1.65	13.2
February	0.70	10.9	1.65	13.2
March	0.50	7.8	1.10	14.2
April	0.50	7.8	1.10	14.2
May	0.70	10.9	1.65	13.2
June	0.90	14.0	2.20	12.7
July	0.90	14.0	2.20	12.7
August	0.90	14.0	2.20	12.7
September	0.90	14.0	2.20	12.7
October	0.70	10.9	1.65	13.2
November	0.50	7.8	1.10	14.2
December	0.50	7.8	1.10	14.2

3.4 HEAT DISSIPATION SYSTEM

3.4.1 General description

Circulating water for the station will be drawn from and returned to the Squaw Creek Reservoir, which is shown in Fig. 3.4.1. A small dam within the reservoir will provide a safe shutdown impoundment for the station. The purpose of this impoundment is to provide an ultimate heat sink for dissipating the reactor afterheat in case there is insufficient water in the main reservoir. The station service water will be taken from and returned to this impoundment for all operating conditions.

Runoff in the Squaw Creek watershed will not be sufficient to accommodate the natural and induced evaporative water losses in the Squaw Creek Reservoir. Makeup water will, therefore, be pumped to Squaw Creek Reservoir from Lake Granbury, located a few miles northeast of the site. Some of the water in Squaw Creek Reservoir will be returned to Lake Granbury to limit the buildup of dissolved solids.

3.4.2 Station cooling system description

The station cooling system will have the circulating water intake and discharge shown in Fig. 3.4.1 and a service water intake and discharge located in the safe shutdown impoundment.

Details of the circulating water intake structure are given in Fig. 3.4-5 of the ER. Eight 275,000-gpm-capacity pumps will provide the desired 2,200,000 gpm flow. The actual number of pumps

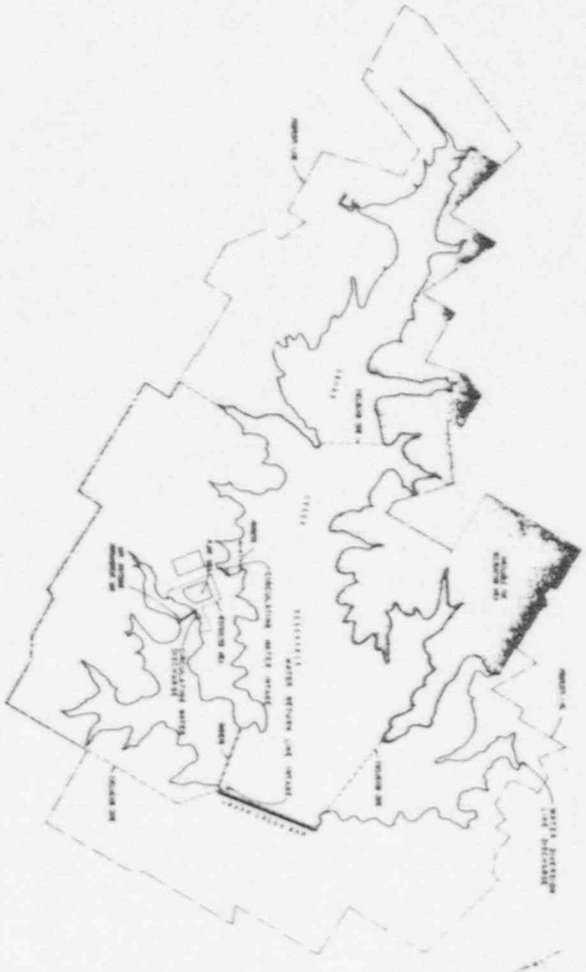

Fig. 3.4.1. Circulating water intake and discharge for CPSES. Based on information from the ER (Figs 3.4-10a and 3.4-16) and the PSAR (Fig. 2.1.2-2).

operating at any given time may vary, depending on the station operating conditions. The invert of this structure will be at 736 ft above mean sea level, and the water level in the reservoir will vary from 770 to 775 ft above mean sea level.

The water will pass from the reservoir through trashracks, removing larger debris, into 12 distribution bays containing traveling screens, which will remove the smaller debris. When the debris collected on the traveling screens results in a reduction in the differential pressure across the screens, they will be rotated and sprayed clean by wash pumps. Debris washed off the screens will be collected in a trough and flushed into a trash pit. The staff has calculated the velocities of the circulating water within the circulating water intake structure, and they are shown in Table 3.4.1.

Table 3.4.1. Water velocities in the circulating water intake structure calculated by the staff

A. Maximum number of running pumps: 8

Average number of running pumps each month:

Month	Number	Month	Number
January	6	July	8
February	6	August	8
March	4	September	8
April	4	October	6
May	6	November	4
June	8	December	4

B. Water velocities

	Number of pumps running	Water velocity (ft/sec) for reservoir water level of – 770 ft	775 ft
1. Approach to trashrack	4	0.45	0.39
	6	0.67	0.58
	8	0.89	0.78
2. Through trashrack	4	0.67	0.58
	6	1.00	0.88
	8	1.34	1.17
3. Approach to traveling screens	4	0.60	0.52
	6	0.90	0.79
	8	1.20	1.05
4. Through traveling screens	4	1.20	1.05
	6	1.80	1.57
	8	2.40	2.10

The circulating water will be pumped from the intake structure through the steam condensers to the discharge structure. There is one duct running from the water intake structure to the condensers for each turbine-electric plant. After leaving the condensers, the circulating water flows into Squaw Creek Reservoir. Table 3.4.2 lists the water flow rates, velocities, static pressures, and holdup times in various parts of the circulating water system, and Fig. 3.4.2 is a schematic diagram of the points considered in Table 3.4.2. The values given in Table 3.4.2 are for periods when there is full circulating water flow. However, as discussed in Sect. 3.3, the plant will be operated at lower circulating water flow rates, given in Table 3.3.1, during many parts of the year. The velocities and holdup times in Table 3.4.2, therefore, must be adjusted accordingly during these times of operation.

Table 3.4.2. Flow conditions in the circulating water system at maximum flow rate

Location	Flow rate per unit (gpm)	Flow area per unit (sq ft)	Water velocity (ft/sec)	Static pressure (psig)	Time at condition (sec)	Accumulated time from intake (sec)
1. Circulating water pump discharge pipe (4 per reactor)	275,000	63.7	9.62	12.9	[illegible]	6
Inlet duct (1 per reactor)	1,100,000	250	9.80		73	79
2. Entrance				12.9		
3. Highest point				7.3		
4. Below water box				23.7		
5. Condenser water box and inlet pipes (4 per reactor)	256,250	78.7	7.25	12.9	3	82
Condenser tubes (1 per reactor)	1,025,000		7.0		7	8.9
6. Inlet				5.7		
7. Outlet				0		
8. Condenser water box and discharge pipes (4 per reactor)	256,250	78.7	7.25	5.2	3	92
Outlet duct	2,200,000	500	9.80		100	192
9. Below water box				15.0		
10. Highest point				-5.2		
11. Discharge to outfall structure				6.4		

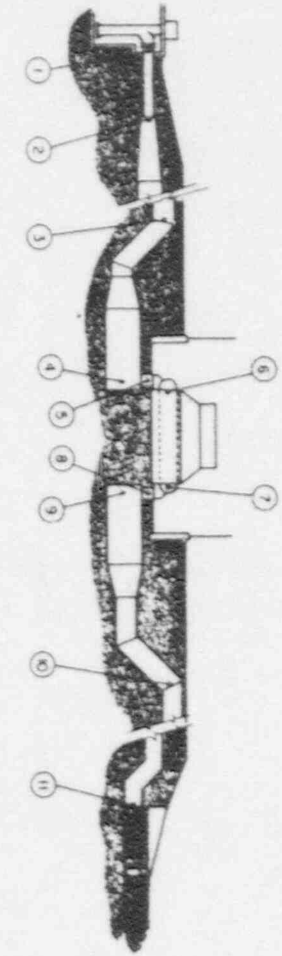

Fig. 3.4.2. Schematic diagram of the circulating water system for CPSES. The numbers refer to the locations listed in Table 3.4.2. Source: ER, Fig. 3.4-15.

From the condenser outlet to the discharge structure, the water temperature will be 14.7°F maximum above the inlet water temperature during the normal full load operation of the reactor. However, when the reactors are operated at partial loads as discussed above, this temperature rise can be less. Values of this temperature rise for these conditions are given in Table 3.3.1.

The warmed circulating water will be discharged as shown in Fig. 3.4.3. Assuming the maximum circulating water flow rate of 2,200,000 gpm and the minimum reservoir level of 770 ft above mean sea level, the velocity of the water will be 9.9 ft/sec at the entrance of the diverging portion of the tunnel, 6.7 ft/sec at the other end of this same tunnel, and 1.2 ft/sec at the downstream end of the canal.

Details of the water intake structure that will be built for pumping the service water from the safe shutdown impoundment are shown in Fig. 3.4-13 of the ER. This structure will be fitted with five pumps, each having a 16,000-gpm capacity. Two of these pumps will be running during the normal operation of the station; however, three pumps could be running during emergency shutdown conditions (ER, Amendment 1, p. 3.4-2a).

The service water will flow from the water impoundment to the service water pumps through a trashrack and through two distribution bays containing traveling screens. Normally both traveling screens will be used, but one of them could be out for maintenance at any time. The trashracks and the traveling screens will be of the same construction and for the same purposes as those for the circulating water intake. The velocities of the service water that will be pumped through this intake structure calculated by the staff are tabulated in Table 3.4.3.

During the operation of the station, the service water will be heated about 15°F and then discharged back into the safe shutdown impoundment about 1600 ft southwest of the service water intake structure (ER, Amendment 1, p. 3.4-2a). The service water discharge structure will consist simply of two 30-in.-diam pipes. During the normal operation of the station using 32,000 gpm service water, the velocity of the water discharging through these pipes will be about 7.7 ft/sec. During emergency conditions using 48,000 gpm water, it will be about 11.5 ft/sec.

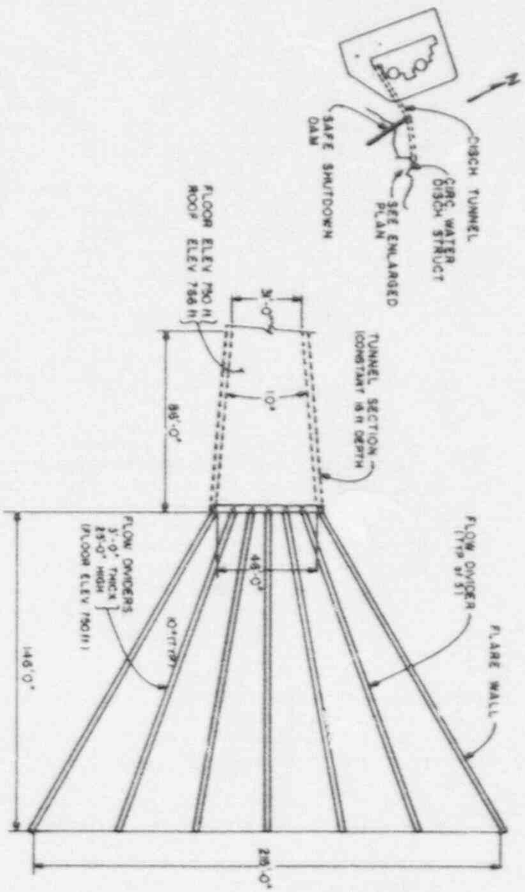

Fig. 3.4.3. Circulating water discharge for CPSES.
Source: ER, Fig. 3.4-5A.

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Table 3.4.3. Water velocities in the service water intake structure calculated by the staff

A. Service water flow rates (E.R., Amendment 1, p. 3.4-2a)

1. Normal operation
   Operating pumps: 2
   Flow rate: 32,000 gpm

2. Emergency operation
   Operating pumps: 3
   Flow rate: 48,000 gpm

B. Water velocities

	Water velocity (ft/sec) for reservoir water level of –					
	764 ft		770 ft		775 ft	
	Normal operation *	Emergency operation	Normal operation	Emergency operation	Normal operation	Emergency operation
1. Approach to trashrack		1.00	0.43	0.65	0.32	0.49
2. Through trashrack		1.62	0.65	0.97	0.49	0.73
3. Approach to traveling screens						
a. Two operating screens		1.49	0.59	0.89	0.45	0.67
b. One operating screen		2.97	1.19	1.78	0.89	1.34
4. Through traveling screens						
a. Two operating screens		2.97	1.19	1.78	0.89	1.34
b. One operating screen		5.94	2.38	3.57	1.78	2.67

* Only emergency operations will be allowed at this reservoir level.

3.4.3 Squaw Creek Reservoir

Squaw Creek Reservoir will be formed by damming Squaw Creek with an earth and rock filled structure. The dam will be located 4.3 miles upstream of the Squaw Creek-Paluxy River confluence, which is near the Paluxy River-Brazos River confluence. It will be about 4360 ft long and will extend upward from the creek bed elevation of 640 ft above mean sea level to a crest at 796 ft above mean sea level. Details of the reservoir topography are given in Fig. 3.4-12 of the ER.

Squaw Creek Dam is to have two spillways. The service spillway is to be 100 ft wide with a standard ogee crest at elevation 775 ft above mean sea level. The broad-crested emergency spillway is to be 2200 ft wide at elevation 783.0 ft above mean sea level.

The proposed dam and spillways are hydraulically and hydrologically designed to withstand the effects of a probable maximum flood (PMF). The Corps of Engineers[1] defines the PMF as the "hypothetical flood characteristics (peak discharge, volume, and hydrograph shape) that are considered to be the most severe 'reasonably possible' at a

particular location, based on relatively comprehensive hydrometeorological analyses of critical runoff-producing precipitation (and snow melt, if pertinent) and hydrologic factors favorable for maximum flood runoff."

The "critical runoff-producing precipitation" is considered to be the probable maximum precipitation, which is defined by the Corps of Engineers and the National Oceanic and Atmospheric Administration as "the theoretically greatest depth of precipitation for a given duration that is meteorologically possible over the applicable drainage area that would produce flood flows of which there is virtually no risk of being exceeded."[2]

In addition to use of the PMF, Corps of Engineers practice[1] requires concurrent consideration of wind waves and runup on the dam. The waves and runup are estimated using a 40 miles per hour (mph) overland wind speed of critical duration and direction coincident with the maximum PMF-induced reservoir elevation.

The staff concludes the above hydraulic and hydrologic design basis of Squaw Creek Dam are conservative. However, as with any such structure, some residual risks always remain. To further reduce these risks, the stability of the dam will be analyzed for construction, operating, and severe design conditions by recognized procedures such as used by the Corps of Engineers[3] to assure the integrity of the structure. Further, the applicant will initiate an inspection program[4] to assure the dam is built according to specifications and in compliance with the rules and regulations of the Texas Water Rights Commission.

The staff concludes that the hydraulic and hydrologic design bases for Squaw Creek Dam are conservative and that the procedures for design and construction are adequate.

For Squaw Creek below the dam, the applicant will maintain a minimum of 1.5 cfs flow by pumping water from Lake Granbury to a point about 100 yds downstream of the Squaw Creek Reservoir dam (ER, Amendment 2). The area and capacity curves for Squaw Creek Reservoir are shown in Fig. 3.4.4, and these values include the capacity and the area of the safe shutdown impoundment. The design reservoir operating level is between 770 and 775 ft above mean sea level, 775 ft being the level of the service spillway of the dam. It is anticipated that the reservoir level will never exceed 789.7 ft, which is below the dam's crest elevation of 796 ft. A summary of the volumes and the surface areas of the water in the reservoir at these elevations is given below.

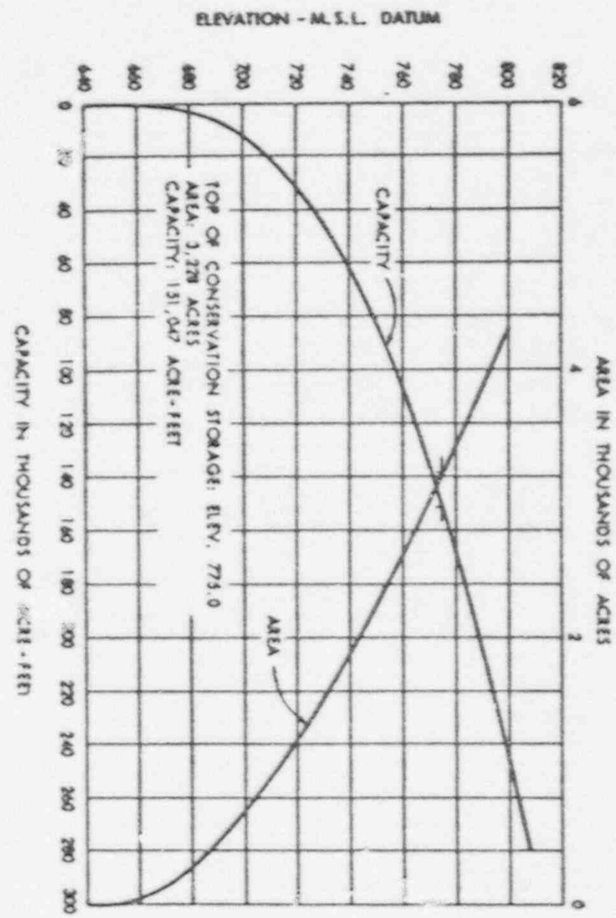

Fig. 3.4.4. Area and capacity curves for Squaw Creek Reservoir.
Source: PSAR, Fig. 2.4.3-1.

	Elevation	Acre-feet	Acres
Minimum operating level	770.0	135,360	3,043
Crest of service spillway	775.0	151,047	3,228
Crest of emergency spillway	783.0	178,077	3,539
Maximum high water level	789.7	202,850	3,863
Top of dam	796.0	228,191	4,184

During normal conditions with the reservoir water level being between 770 and 775 ft, the safe shutdown impoundment will contain between 382 and 558 acre-ft of water and will have a surface area between 30.8 and 39.8 acres.

3.4.4 Diversion water facilities

Makeup water for Squaw Creek Reservoir and for Squaw Creek just below the dam will be pumped from Lake Granbury through a 4-ft-diam pipe. The location of this diversion line is shown in Fig. 3.4-1 of the ER. Water will be pumped at rates up to 101 cfs (45,200 gpm), which is equivalent to a water velocity of 8.01 fps. The water intake for this line will be located about 4700 ft upstream of De Cordova Bend Dam, and details of this structure are given in Fig. 3.4-8 fo the ER. It will have four 33.6-cfs (15,100 gpm) pumps, normally only three of these will be operated at any one time. Water will be drawn into these pumps through screens located at about 663 ft above mean sea level, which is below the lake's maximum drawdown level of 675 ft above mean sea level. The velocity of the water approaching the screens is 0.49 fps, and the velocity of the water passing through the screens is 0.64 fps.

Water will be discharged from the diversion line into Squaw Creek Reservoir just northeast of the reservoir near Texas Highway 144 at an elevation of about 800 ft above mean sea level, as shown in Fig. 3.4.1. Details of the diversion line discharge structure are given in Fig. 3.4-10 of the ER. The energy of the jet of water flowing out of the pipe will be dissipated in the discharge structure, and the water will flow by gravity down to the reservoir.

Just upstream of the diversion line discharge, water will be diverted through an 8-in. line to Squaw Creek to maintain a flow of 1.5 cfs in the Creek. This water will discharge into Squaw Creek just below the Squaw Creek Reservoir dam.

Water will be returned to Lake Granbury through a 3-ft-diam return line to limit the buildup of dissolved solids in Squaw Creek Reservoir. The water velocity in this line will be 5.3 fps. The water will enter this line through one or more of the three portals in the return line intake structure located at the Squaw Creek Reservoir dam, as shown in Fig. 3.4.1. (Details of this structure are shown in Fig. 3.4-9 of the ER.) The staff calculated that the velocity of the water approaching these screens will be 0.73 fps and that for the water passing through the screen will be 0.91 fps.

In Lake Granbury, the return line outlet will be located about 500 ft upstream of De Cordova Bend Dam. The returning water will enter Lake Granbury horizontally through the end of the 3-ft-diam pipe located at an elevation of 670 ft above mean sea level.

3.5 RADIOACTIVE WASTE SYSTEMS

During the operation of Comanche Peak Steam Electric Station (CPSES) radioactive materials will be produced by fission and by neutron activation of corrosion products in the reactor coolant system. Small amounts of gaseous and liquid radioactive material produced will enter the station's waste streams. These streams will be processed and monitored within the station to minimize the quantity of radionuclides ultimately released to the atmosphere and to the Squaw Creek Reservoir (SCR).

The waste handling and treatment systems to be installed at the station are discussed in the applicant's Preliminary Safety Analysis Report and Environmental Report. In these documents, the applicant has prepared an analysis of his treatment systems and has estimated the annual radioactive effluents.

In the following paragraphs, the waste treatment systems are described and an analysis is given based on the staff's model of the applicant's radioactive waste systems. The staff's model has been developed from a review of available data from operating nuclear power plants, adjusted to apply over a 40-year operating life. The coolant activities and flows used in the evaluation are based on experience and data from operating reactors. As a result, the parameters used in the staff's model and the subsequent calculated releases vary somewhat from those given in the applicant's evaluation. The liquid source terms are calculated by means of a revised version of the ORIGEN code which is described in ORNL 4628, "Oak Ridge Isotope Generation and Depletion Code." The gaseous source terms are calculated by means of the STEFFEG code as described in the report, "Analysis of Power Reactor Gaseous Waste Systems," F. T. Binford, et al., 12th Air Cleaning Conference. The principal parameters used in the staff's source term calculations are given in Table 3.5.1. The bases for these parameters are given in WASH-1258, Vol. 2, Appendix B.

Table 3.5.1. Principal Parameters and Conditions Used in Calculating Releases of Radioactive Material in Liquid and Gaseous Effluents from Comanche Peak Nuclear Station

Parameter	Value/Unit
Reactor Power Level (MWt)	3558
Plant Capacity Factor	0.80
Failed Fuel[a]	0.25%
Primary System	
Mass of Coolant (lbs)	4.6×10^5
Letdown Rate to CVCS (gpm)	75
Shim Bleed Rate (gpm)	1.3
Leakage Rate to Secondary System (lbs/day)	110
Leakage Rate to Containment Building (lbs/day)	240
Leakage Rate to Auxiliary Building (lbs/day)	160
Frequency of Degassing for Cold Shutdowns (per year)	2
Secondary System	
Steam Flow Rate (lbs/hr)	1.5×10^7
Mass of Steam/Steam Generator (lbs)	8.5×10^3
Mass of Liquid/Steam Generator (lbs)	8.8×10^4
Secondary Coolant Mass (lbs)	2.5×10^6
Rate of Steam Leakage to Turbine Building (lbs/hr)	1.7×10^3
Steam Generator Blowdown Rate (lbs/hr)	9.1×10^3
Dilution Flow (gpm)	2.2×10^6
Containment Building Volume (ft^3)	2.5×10^6
Frequency of Containment Purges (per year)	4
Iodine Partition Factors (gas/liquid)	
Leakage to Containment Building	0.1
Leakage to Auxiliary Building	0.005
Steam Leakage to Turbine Building	1
Steam Generator (carryover)	0.01
Main Condenser Air Ejector	0.0005
Decontamination Factors (Liquids)	

	Boron Recycle	Equipment Drains	Drain Channels A & B
I	1×10^5	1×10^3	1×10^3
Cs, Rb	2×10^4	1×10^4	1×10^4
Mo, Tc	1×10^5	1×10^5	1×10^6
Y	1×10^4	1×10^4	1×10^5
Others	1×10^6	1×10^4	1×10^4

[a]This value is constant and corresponds to 0.25% of the operating power fission product source term.

Table 3.5.1 continued

	All Nuclides Except Iodine		Iodine
Waste Evaporator DF	10^4		10^3
BRS Evaporator DF	10^3		10^2
	Cation[b]	Anion[b]	Cs,Rb
Mixed Bed Demineralizer (Li_3BO_3)DF	10	10	2
Mixed Bed Demineralizer (H^+ OH^-)DF	10^2(10)	10^2(10)	2(10)
Cation Demineralizer DF	10^2(10)	1(1)	10(10)
Anion Demineralizer DF	1(1)	10^2(10)	1(1)

Note - For two demineralizers in series, the DF for the second demineralizer is given in parenthesis.

Removal by Plateout	Removal Factor
Mo, Tc	10^2
Y	10

Containment Building Internal Recirculation System	
Flow Rate	2.5×10^4 CFM
Operating Period/Purge	16 hrs
Mixing Efficiency	70%

[b]Does not include Cs, Mo, Y, Rb, Tc

3.5.1 Liquid wastes

The liquid radioactive waste treatment system will consist of process equipment and instrumentation necessary to collect, process, monitor, and recycle or dispose of potentially radioactive liquid wastes. Prior to releasing liquid waste, samples will be analyzed to determine the type and amounts of radioactivity present. Based on the results of the analyses, the wastes will be released under controlled conditions to the Squaw Creek Reservoir or retained for further processing. Radiation monitoring will automatically terminate liquid waste discharge if radiation measurements exceed a predetermined level in the discharge line. A simplified diagram of the liquid radwaste treatment systems is shown in Figure 3.5.1.

The liquid radioactive waste treatment systems will be divided into three principal systems which will be shared between Units 1 and 2: the Boron Recycle System (BRS), Drain Channel A (DCA), and Drain Channel B (DCB). Both the BRS and DCA will process high grade water from the reactor coolant system which will normally be recycled for reuse in the plant after treatment. DCB will process low grade water from floor drains, laundry, and shower drains which will not be generally suitable for reuse in the plant due to the high water quality requirements for primary coolant makeup. DCB will be discharged after treatment for radionuclide removal. The BRS will rely on an evaporator and an anion polishing demineralizer for radionuclide removal. DCA and DCB will each include waste evaporator (15 gpm). All three systems will process waste on a batchwise basis.

In addition to the three aforementioned systems, the Chemical and Volume Control Systems (CVCS) and the Steam Generator Blowdown Treatment Systems (SGBTS) are considered in the staff's evaluation. Both of these systems will be separate for Units 1 and 2. The CVCS will process reactor grade water through mixed bed, cation, and boron thermal regeneration demineralizers to maintain boron control and reactor coolant purity, and will be the principal input to the BRS. The SGBTS will maintain secondary coolant purity by means of a closed loop system which will cool and process the blowdown streams through cation and anion demineralizers, and return the treated blowdown to the secondary coolant system through the main condenser hotwell. Liquid leakage of secondary coolant to the turbine building will be collected by the turbine floor drain collection system and released without treatment.

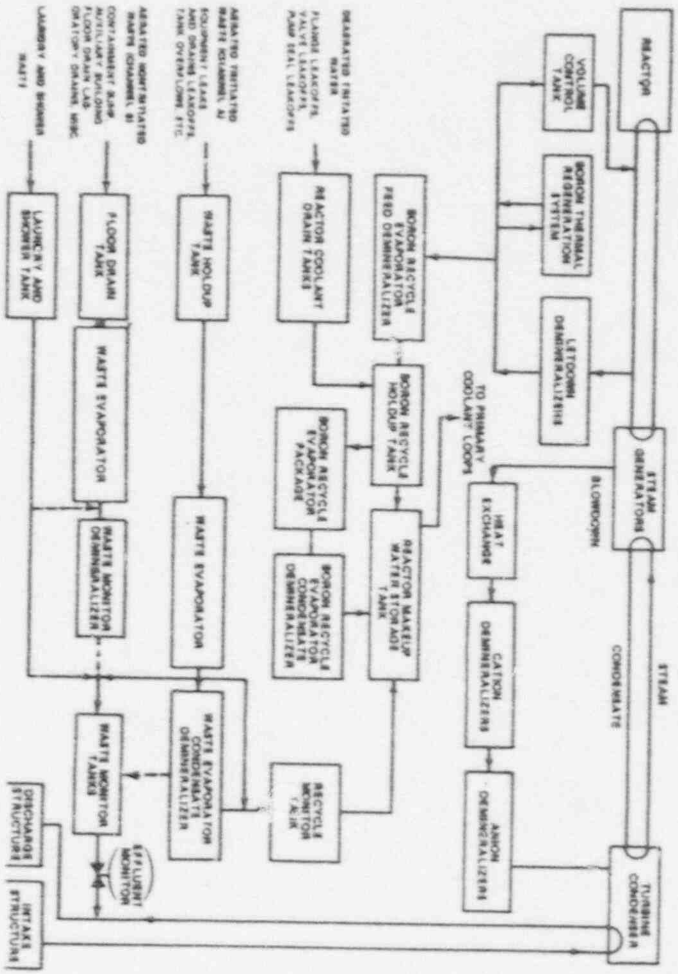

Fig. 3.5.1. Liquid waste treatment systems, Comanche Peak.

3.5.1.1 The boron recycle system (BRS)

Primary coolant will be withdrawn from the reactor coolant system at approximately 75 gpm and processed through the CVCS. The letdown stream will be cooled and reduced in pressure, filtered, processed through one of two mixed bed demineralizers, and stored in the volume control tank. A cation demineralizer will be used in addition to the mixed bed demineralizer approximately 10 percent of the time for lithium and cesium control. Radionuclide removal by the CVCS was evaluated by assuming 75 gpm letdown flow at primary coolant activity (PCA) through one mixed bed demineralizer (Li_3BO_3 form) and 7.5 gpm flow through one cation demineralizer in series with the mixed bed. The CVCS will be used to control the primary coolant boron concentration by passing a portion of the letdown stream through the boron thermal regeneration system and by diverting approximately 1 gpm of the treated letdown stream to the BRS as shim bleed. In the boron thermal regeneration system, boron will be either adsorbed from or desorbed into the letdown stream depending upon the stream temperature. Since the thermal regeneration demineralizer resins will desorb as well as adsorb radioactivity, the thermal regeneration system was not considered for radionuclide removal. However, use of the thermal regeneration system will reduce the quantity of liquid waste generated to maintain boron control.

Shim bleed from the letdown stream will be processed through one of two mixed bed demineralizers (Li_3BO_3 form) and routed to the recycle holdup tanks. Equipment drain wastes in the reactor containment will be collected in the reactor coolant drain tanks and transferred to the recycle holdup tank where it will be combined with the shim bleed. These two streams from each unit will form the principal inputs to the BRS and will be processed batchwise from the recycle holdup tanks. The staff calculated the shim bleed input activity by applying the decontamination factor (DF) for a mixed bed demineralizer in the Li_3BO_3 form to the shim bleed stream, assuming 1 gpm/reactor flow and CVCS output activity. The reactor coolant drain tank input flow to the BRS was assumed to be 300 gpd/reactor at PCA based on the applicant's assumption which the staff finds to be reasonable. Radioactive decay experienced during collection in the recycle holdup tank was calculated in the ORIGEN code. The collection time was calculated to be 21 days assuming the 112,000 gal recycle holdup tanks will be filled to 80 percent capacity using the combined shim bleed and reactor coolant drain tank flow rates from both reactor units. Radionuclide removal by the BRS was based on the parameters in Table 3.5.1 for an evaporator and an anion demineralizer in series. Additional credit for radioactive decay during processing was based on transferring the contents of the recycle holdup tank at the recycle evaporator flow capacity

(15 gpm). The staff assumed that equipment downtime and anticipated operational occurrences will result in approximately 10 percent of the evaporator condensate stream being discharged to the Squaw Creek Reservoir. The applicant assumed that the BRS stream will be recycled and did not specify a discharge fraction in his evaluation.

3.5.1.2 Drain channel A (DCA)

High purity wastes from equipment leakage, valve leakoffs, and tank overflows from Units 1 and 2 will be processed through DCA. Based on the parameters in Table 3.5.1 and information supplied by the applicant that the staff finds to be reasonable, the DCA input stream flow was calculated to be approximately 190 gpd/reactor at 0.43 PCA. Wastes from both units will be collected in the waste holdup tank. Assuming the 10,000 gal waste holdup tank will be filled to 80% capacity, the collection time was calculated to be 21 days. DCA wastes will be processed batchwise through the waste evaporator which will be shared with DCB. Normally the evaporator concentrate will be routed to the solid waste system. The evaporator condensate will normally pass through a polishing demineralizer and be collected in the recycle monitor tank for reuse. In the staff's evaluation it was assumed that equipment downtime and operational occurrences, will result in periods when DCA wastes will not be suitable for recycle. On this basis the staff estimates that approximately 10% of the DCA stream will be discharged over the life of the plant. The applicant assumed DCA to be completely recycled and did not have a liquid release from DCA in his evaluation. Releases values were calculated using the DF's given in Table 3.5.1 for a waste evaporator. Radionuclide removal by the polishing demineralizer was not included in the staff's calculations as the applicant indicated that its use will be optional. Calculations of radioactive decay during processing were based on processing the contents of the waste holdup tank at the waste evaporator flow capacity (15 gpm).

3.5.1.3 Drain channel B (DCB)

DCB will collect low purity wastes which will not be suitable for reuse after treatment. Wastes collected in the auxiliary building floor drains, containment sump, sample drains, and other sources of contaminated liquids which are not generally suitable for recycle will be collected in the floor drain and processed through the waste evaporator. Based on the parameters given in Table 3.5.1 and information supplied by the applicant in his evalution, the staff estimated the flow to the floor drain tank to be 1340 gpd/reactor at 0.05 PCA. The collection time in the 10,000 gal floor

drain tank was calculated to be 3 days, assuming the tank will be filled to 80 percent capacity. Radionuclide removal was calculated using the waste evaporator DF in Table 3.5.1. The processing time was based on processing the contents of the floor drain tank at the waste evaporator capacity. The evaporator condensate from DCB will be collected in the waste monitor tank, analyzed, and discharged.

Wastes from laundry and showers will be collected in the laundry and shower tank for analysis. Normally the wastes will be filtered and routed to the waste monitor tank, analyzed, and discharged. Based on the parameters given in Table 3.5.1, the staff assumed the laundry and shower tank activity will be equivalent to 10^{-4} μCi/cc and the release rate is expected to be 450 gpd/reactor.

Release values for DCB were based on discharging 100 percent of both DCB waste streams. The applicant also assumed 100 percent discharge of DCB wastes in his evalution. DCB will include a mixed bed demineralizer (waste monitor demineralizer) which may be used to further decontaminate the contents of the waste monitor tank at the discretion of the plant operator. Radionuclide removal by the waste monitor demineralizer was not factored into the staff calculations as it will be used primarily to reduce the effect of operational occurrences and not for routine processing.

3.5.1.4 Turbine building floor drains

Waste collected by the turbine building floor drain system will contain radioactive materials resulting from secondary system leakage as well as leakage from nonradioactive cooling systems. The applicant has indicated that these wastes will not be treated prior to discharge. Based on the parameters in Table 3.5.1 the staff assumed the activity discharged through the turbine building floor drain system will be due to secondary system condensate leakage at a rate of 5 gpm/reactor. The quantity of activity released through this path will be approximately 0.04 Ci/yr/reactor. The staff concludes that the release of the turbine building floor drain wastes must be monitored before release. The radiation monitoring will automatically terminate the discharge if radiation limits exceed a predetermined level.

3.5.1.5 Steam generator blowdown treatment system (SGBTS)

The SGBTS will process steam generator blowdown through heat exchangers and redundant, full capacity (50 gpm) cation and anion demineralizers. The treated blowdown condensate stream will be returned to the main condenser hot well for reuse. Therefore, the staff concludes the SGBTS has sufficient capacity to allow essentially total recycle of the blowdown stream to the secondary coolant system. The applicant assumed total recycle of the blowdown stream in his analysis.

3.5.1.6 Liquid waste summary

Based on the staff evaluation of the waste treatment systems using the parameters in Table 3.5.1 the releases of radioactive materials in the liquid wastes were calculated to be 0.3 Ci/yr/reactor, excluding noble gases and tritium (Table 3.5.2). Based on previous experience at operating reactors the staff estimates the tritium releases to be 350 Ci/yr/reactor. The applicant has estimated the releases to be 0.076 Ci/yr/reactor, excluding tritium, and 96 Ci/yr/reactor of tritium. The difference between the staff release values and those calculated by the applicant are due largely to the quantity of BRS waste and DCA waste recycled in the respective models. The staff assumed 10 percent of the BRS and DCA steams will be discharged over the life of the plant due to equipment downtime and anticipated operational occurrences whereas the applicant assumed total recycle of both steams.

3.5.2 Gaseous waste

The gaseous waste treatment and ventilation systems will consist of equipment and instrumentation necessary to reduce releases of radioactive gases and airborne particulates from equipment and building vents. The principal source of radioactive gaseous waste will be gases stripped from the primary coolant in the CVCS and BRS. Additional sources of gaseous wastes will be main condenser vacuum pump offgases, ventilation exhausts from the auxiliary, safeguards, fuel handling, and turbine buildings, and gases collected in the reactor containment building. The principal system for treating gaseous wastes will be the gaseous waste processing system (GWPS). The GWPS will collect and store gases stripped from the primary coolant in a continuously recirculating nitrogen loop containing recombiners, compressors, moisture separators, and ten pressurized storage tanks. The GWPS will be shared between Units 1 and 2. Offgases from the main condenser vacuum pump exhausts and building ventilation exhausts from the auxiliary, radwaste, fuel handling, safeguards, and containment buildings will be processed through HEPA filters and charcoal adsorbers prior to release. In addition, the containment atmosphere will be recirculated through filters and charcoal adsorbers prior to purging. Ventilation exhausts from the turbine buildings will be released without treatment. The steam generator blowdown treatment system will be cooled through heat exchangers to prevent flashing. The blowdown condensate will be collected in the condenser hotwell where degassing will occur due to the relatively low pressure in the condenser. The gaseous waste treatment systems are shown schematically in Fig. 3.5.2.

Table 3.5.2. Calculated Annual Releases of Radioactive Material in Liquid Effluents from Comanche Peak Steam Electric Station

Radionuclide	Release per Unit Ci/year	Radionuclide	Release per Unit Ci/year
Br-82	0.00007	Cs-134	0.0150
Br-83	0.00002	Cs-136	0.0046
Rb-86	0.00004	Cs-137	0.0097
Sr-89	0.00008	Ba-137m	0.0091
Y-91	0.00021	Ba-140	0.00008
Mo-99	0.0013	La-140	0.00008
Tc-99m	0.0013	Na-24	0.00001
Te-127m	0.00007	P-33	0.00006
Te-127	0.00007	Cr-51	0.00022
Te-129m	0.00030	Mn-54	0.00004
Te-129	0.00019	Mn-56	0.00003
Te-131m	0.00009	Fe-55	0.00023
Te-131	0.00002	Fe-59	0.00013
Te-132	0.0023	Co-58	0.00210
I-130	0.00021	Co-60	0.00028
I-131	0.18	Ni-63	0.00002
I-132	0.0033	Nb-92	0.00004
I-133	0.065	W-187	0.00008
I-135	0.0066	Np-239	0.00004
		Total (excluding tritium)	0.3

Tritium (H-3) ~ 350 Ci/year/unit

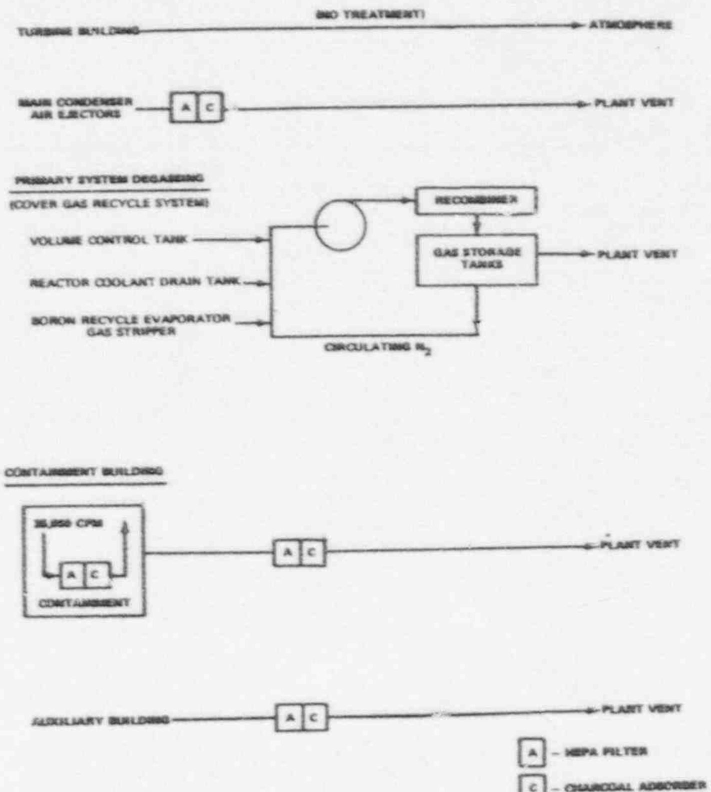

Fig. 3.5.2. Gaseous waste treatment systems, Comanche Peak.

3.5.2.1 Gaseous waste processing system

The gaseous waste processing system will be designed to collect and process gases stripped from the primary coolant in the Unit 1 and 2 CVCS, the BRS, and miscellaneous tank cover gases. The GWPS will contain a constant inventory of nitrogen which will be continuously recirculated as a carrier gas to transport radioactive gases removed from the primary coolant. Hydrogen cover gas from the volume control tanks and reactor coolant drain tanks, and gases stripped in the BRS degasifer will enter the nitrogen loop. The hydrogen will carry with it small amounts of radioactive gases removed from the primary coolant. The hydrogen will be combined with stoichiometric amounts of oxygen and be removed as water vapor. The radioactive gases remaining will have a negligible effect on the overall gaseous inventory. The nitrogen and radioactive gases will be alternately collected and stored in one of eight pressurized storage tanks. The storage tanks will collect, store, and release gases to the loop in rotation to allow short lived radionuclide decay. After holdup, the nitrogen, containing long-lived radionuclides, will be reused in the loop. In this manner, short-lived radionuclides will decay during storage and long-lived radionuclides will accumulate in the system. Two additional storage tanks, containing low-activity nitrogen, will only be used during the latter stages of degasification preceding cold shutdowns to remove hydrogen from the primary coolant. The applicant considered the system to be capable of retaining radioactive gases over the life of the plant and considered system leakage as the only release mode.

The staff considers the GWPS to be capable of long-term gaseous waste storage but does not agree that it will be feasible to retain the wastes over the life of the plant without periodic discharges. The advantages of storage after short-lived radionuclide removal will be relatively minor in terms of long-lived radionuclide decay. Calculations by the staff are based on release after 90 days holdup which will leave Kr-85 (10.7 yr half life) as the predominant radionuclide. The staff calculated the WPCS releases to be 990 Ci/yr/reactor for noble gases and negligible for iodine. Based on 100 scfy leakage the applicant estimated that 1200 Ci/yr/reactor of noble gases and a negligible amount of iodine will be released from the GWPS.

3.5.2.2 Containment purges

Radioactive gases will be released inside the reactor containment when primary system components are opened or when minor leaks occur in the primary system. The gaseous activity will be sealed within the containment during normal operation but will be released periodically during containment purges. Prior to purging, the containment atmosphere will be recirculated through HEPA filters and charcoal adsorbers for particulate and iodine removal. Following recirculation the containment will be purged through HEPA filters and charcoal adsorbers to the atmosphere. The airborne activity was calculated based on the parameters for primary coolant leakage to the containment in Table 3.5.1. Radionuclide removal was based on 16 hours of recirculation system operation, 70% mixing efficiency, and a DF of 10 for both the recirculation charcoal adsorber system and the purge charcoal adsorber system. It was assumed that the containment would be purged 4 times per year. The preceding assumptions are based on the parameters given in Table 3.5.1. The staff calculated the containment purge releases to be 21 Ci/yr/reactor of noble gases and 0.0005 Ci/yr/reactor of iodine-131. The applicant estimated a release of 19 Ci/yr/reactor of noble gases and 0.0009 Ci/yr/reactor of iodine-131.

3.5.2.3 Auxiliary, safeguards, fuel handling, and turbine building vent releases

Radioactive gases will be released to the auxiliary, safeguards, and fuel handling buildings due to leakage from primary system components. In the staff evaluation the gaseous releases to these buildings were assumed to be combined, since the ventilation treatment provided for each will be essentially the same. The ventilation systems will be designed to ensure that air flow will be from areas of low potential to areas having a greater potential for the release of airborne radioactivity. Ventilation air will be exhausted through HEPA filters and charcoal adsorbers for particulate and iodine removal. The staff's calculated releases were based on the auxiliary building leakage rate and iodine partition factor listed in Table 3.5.1 and a charcoal adsorber DF of 10 for iodine. Based on these parameters, the staff calculated the auxiliary building releases to be 170 Ci/yr/reactor of noble gases and 0.0075 Ci/yr/reactor for iodine-131. The applicant estimated the releases to be 590 Ci/yr/reactor of noble gases and 0.007 Ci/yr/reactor of iodine-131.

Radioactive gases will be released to the turbine building due to secondary system steam leakage. The turbine building ventilation system exhausts will not be treated prior to release. The staff assumed that there would be 1700 lbs/hr/reactor of steam leakage to the turbine building and assumed that all of the noble gases and iodine remain airborne. On this basis the staff calculated the turbine building vent release to be negligible for noble gases and 0.026 Ci/yr/reactor for iodine-131. The applicant estimated the turbine building release to be negligible for noble gases and 0.016 Ci/yr/reactor for iodine-131.

3.5.2.4 Steam releases to the atmosphere

The turbine bypass capacity to the condenser will be 40 percent. Staff analysis indicates that steam releases to the environs due to turbine trips and low-power-physics testing will have a negligible effect on the calculated source term.

3.5.2.5 Main condenser offgas releases

Offgas from the main condenser vacuum pump exhausts will contain radioactive gases resulting from primary to secondary system leakage. Iodine will be partitioned between the steam and liquid phases in the steam generators and between the condensable and noncondensable phases in the main condensers and vacuum pumps. The major fraction of iodine present in the vacuum pump exhaust will be removed by charcoal adsorbers prior to release to the plant vent. Based on the parameters listed in Table 3.5.1, the staff considered 110 lb/day/reactor of primary to secondary leakage, partition factors of 0.01 and 0.0005 for iodine in the steam generators and main condenser vacuum pumps, respectively, and a charcoal adsorber DF of 10 for iodine. The staff assumed that all of the noble gases entering the steam generators due to primary system leakage will be released to the plant vent. The steam generator blowdown will be recycled to the condenser hotwell where any gases present will be removed and processed with the main condenser offgas through charcoal adsorbers. The blowdown will be cooled by heat exchangers prior to reductions in pressure to prevent gaseous releases due to flashing. The gaseous contribution to the main condenser offgas due to the blowdown will be negligible. The staff calculates the main condenser vacuum pump releases to be approximately 170 Ci/yr/reactor for noble gases and 0.011 Ci/yr/reactor for iodine-131. The applicant estimated this release to be 550 Ci/yr/reactor for noble gases and 0.003 Ci/yr/reactor for iodine-131.

3.5.2.6 Gaseous waste summary

Based on the parameters given in Table 3.5.1, the total radioactive gaseous releases are calculated to be approximately 1300 Ci/yr/reactor of noble gases and 0.044 Ci/yr/reactor of iodine-131. the principal sources and isotopic distributions are given in Table 3.5.3. The applicant has calculated an overall release of approximately 2300 Ci/yr/reactor of noble gases and 0.026 Ci/yr/reactor of iodine-131.

In his evaluation, the applicant applied a lower gas stripping efficiency in the volume control tanks than that used by the staff in its evaluation. This affected the calculated primary coolant

Table 3.5.3. Calculated Annual Releases of Radioactive Materials in Gaseous Effluents from Comanche Peak Steam Electric Station

Ci/year/unit

Radionuclide	Decay Tanks	Building Ventilation			Blowdown Vent	Air Ejector Offgas	Total
		Reactor	Auxiliary	Turbine			
Kr-83m	a	a	1.3	a	a	1.3	2.5
Kr-85m	a	a	5.7	a	a	5.8	12
Kr-85	970	a	a	a	a	a	970
Kr-87	a	a	3.8	a	a	3.8	7.6
Kr-88	a	a	11	a	a	11	22
Kr-89	a	a	a	a	a	a	a
Xe-131m	12	a	a	a	a	a	13
Xe-133m	a	a	3	a	a	3	6.2
Xe-133	5	21	130	a	a	130	280
Xe-135m	a	a	a	a	a	a	1.8
Xe-135	a	a	13	a	a	13	26
Xe-137	a	a	a	a	a	a	1.3
Xe-138	a	a	3	a	a	3	6.1
I-131	a	4.6×10^{-4}	7.5×10^{-3}	2.6×10^{-2}	a	1.1×10^{-2}	4.4×10^{-2}
I-133	a	4.5×10^{-4}	9.8×10^{-3}	1.7×10^{-2}	a	7.2×10^{-3}	3.4×10^{-2}

a denotes less than 1 Ci/yr/unit noble gases and less than 10^{-4} Ci/year/unit of iodines.

concentrations of noble gases and is the major factor in the differences between the staff calculated release values and those calculated by the applicant.

3.5.3 Solid waste

Solid waste containing radioactive materials will be generated during station operation. Solid wastes will be categorized as "wet" or "dry" based upon the need for moisture absorption and solidification during processing. The solid waste system will consist of a waste drumming subsystem for wet solid waste and a waste baling subsystem for dry solid waste.

Wet solid wastes will consist mainly of spent demineralizer resins, filter sludges, evaporator bottoms, and chemical drain tank effluents. These wastes will be combined with a cement-vermiculite mixture to form a solid matrix and sealed in 55-gal steel drums. The majority of the radioactivity entering the liquid waste streams will be removed by demineralizers, evaporators, or filters and become wet solid wastes. The staff considered these wastes to be stored for 180 days for radioactive decay prior to shipment offsite.

Dry solid wastes will consist of ventilation air filters, contaminated clothing and paper, and miscellaneous items such as tools and laboratory glassware. Dry solid wastes will be compressed into 55-gal drums using a baling machine. Since dry solid wastes will contain much less activity than wet solid wastes, the staff did not consider the need for onsite storage of dry solid wastes in its evaluation.

3.5.3.1 Solid waste summary

Based on the staff's evaluation of similar reactors and operating reactor data, it is estimated that approximately 600 drums of wet solid waste containing approximately 12 Ci/drum, and 450 drums of dry solid waste containing less than 5 Ci total, will be shipped offsite annually due to the operation of each reactor. Greater than 90% of the radioactivity associated with the solid waste will be longlived fission and corrosion products, principally Cs-134, Cs-137, Co-58, Co-60, and Fe-55. The applicant estimates that approximately 1060 drums of wet solid wastes, ranging from 0.04 to 240 Ci/drum, and 120 drums of dry solid waste (no estimate of activity content) will be shipped offsite annually.

All containers will be shipped to a licensed burial site in accordance with AEC and DOT regulations. The solid waste system will be similar to systems which the staff has evaluated and found to be acceptable in previous license applications.

3.6 CHEMICAL AND BIOCIDAL EFFLUENTS

3.6.1 Chemical wastes

3.6.1.1 Chemical effluents

The chemicals used and their method of disposal are given in Table 3.6.1.

Hydrazine and cyclohexylamine are added to the steam system in small quantities to scavenge oxygen and adjust pH, respectively. Any leakage from the steam system of water containing hydrazine and cyclohexylamine will be discharged from the station with turbine building drains into the Squaw Creek Reservoir. Hydrazine residuals will be in the 50 to 100 parts per billion range, and cyclohexylamine residual concentrations will not exceed 10 ppm. The turbine building drain discharge is estimated to be 5 to 10 gpm. When this is mixed with the 2,200,000 gpm of circulating water, the concentrations of these two chemicals will be less than 50 parts per trillion. Sodium phosphate will be used in steam generators for control of dissolved solids and pH. The steam generator blowdown is continuously routed through the blowdown processing system. It is filtered and demineralized for recycle as condensate. The regenerants for these demineralizers are routed to the evaporation pond. Boric acid is continuously reused in the primary water system or is disposed of as solid waste.

Table 3.6.1. Chemicals used during operation of CPSES

Chemical	Amount used (lb/day)	Disposal
Sulfuric acid	[illegible]	Evaporation pond
Sodium hydroxide	530	Evaporation pond
Hydrazine	10	Squaw Creek Reservoir
Cyclohexylamine	0.24	Squaw Creek Reservoir
Boric acid	100	Solid waste
Sodium phosphate	4.5	Removed in blowdown recycle
Lithium hydroxide	0.06	Evaporation pond
Detergents	30	Evaporation pond
Chlorine	1650	Squaw Creek Reservoir

Some copper will be released to Squaw Creek Reservoir as a result of the very slow corrosion of the condenser tubes. The staff estimates that the increase in concentration will be less than one part per billion (ppb). This compares with an existing concentration of 0 to 4 ppb.

The staff estimates that 60,000 lb of trisodium phosphate will be used for cleaning equipment prior to startup. This will be sent to the evaporation pond.

The predicted characteristics of the blowdown from Squaw Creek Reservoir to Lake Granbury and the characteristics of Lake Granbury are given in Table 3.6.2. The applicant must obtain a permit from the Texas Water Quality Board for discharge of this blowdown to Lake Granbury. The applicant has received a permit from this agency (Sect. 1.2). The increase in concentration of the total dissolved solids is a direct result of the evaporation of water from Squaw Creek Reservoir. Assuming complete mixing, the average increase in total dissolved solids concentration in Lake Granbury resulting from the blowdown will be between 2 and 3%.

Calculations were made for the applicant on the dispersal of the CPSES thermal effluent, the redistribution of dissolved oxygen, and the increase and distribution of the dissolved solids in Squaw Creek Reservoir[1] and Lake Granbury.[2] The staff checked the thermal calculations and the water evaporation and reviewed the assumptions and methods employed in making the calculations. The staff review of the thermal calculations will be discussed in Sect. 5.3. The staff concludes that the results of the above calculations are reasonable and are adequate for use in assessing the chemical impact. The distribution of the dissolved solids in Squaw Creek Reservoir is indicated in Fig. 3.6.1. The effect on Lake Granbury is given in Table 3.6.3. Similar distributions for dissolved oxygen are given in Fig. 3.6.2 and Table 3.6.4, respectively.

3.6.1.2 Evaporation pond

An evaporation pond consisting of two independent sections is proposed for disposal of some chemical waste. The two sections will be man made, and each section will have an area of 6 acres and a depth of 11 ft. The size is based on an input of 23,000 gal/day of effluent from makeup water treatment and 5,000 gal/day of treated

Table 3.6.2. Lake Granbury water quality and the predicted characteristics of the Squaw Creek Reservoir discharge to Lake Granbury

Constituent or characteristic[a]	Lake Granbury			Squaw Creek Reservoir discharge to Lake Granbury			
	Normal range 1	Average 2	Maximum[b] 3	Normal range[c] 4	Average 5	Maximum[d] 6	Data source
Physical							
Color (color units) (Alpha Pt-Co standard)	0–100	38	100	—[e]	—	—	M
Odor	—	—	—	—	—	—	
Temperature (surface, July–August), °F	84–90	86	90	87–94	91	97	M,W
Turbidity (JTU)	0–75	10	—	—	—	—	M
Microbiological							
Coliform orga[illegible], colonies/100 ml	250–1100	—	—	—	—	—	G
Fecal coliforms, [illegible]nies/100 ml	0–2	—	—	—	—	—	G
Inorganic chemicals							
Alkalinity (total as $CaCO_3$), mg/liter	95–180	121	364	195–242	218	378	M
Ammonia, mg/liter	0.1–0.4	0.2	0.4	0.32–0.40	0.36	0.61	M
Arsenic, µg/liter	0–10	0	—	—	—	—	G
Barium	—	—	—	—	—	—	
Boron, mg/liter	0.17–0.23	0.19	0.41	0.30–0.38	0.34	0.58	G
Cadmium, µg/liter	—	0	—	—	—	—	G
Chloride, mg/liter	228–670	500	1090	807–1000	900	1530	G
Chromium (hexavalent), µg/liter	—	0	—	—	—	—	G
Copper, µg/liter	0–2	0	—	—	—	—	G
Dissolved oxygen, mg/liter	0.5–10.0	—	—	—	—	—	M
Fluoride, mg/liter	0.2–0.4	0.3	0.7	—	0.5	0.9	G
Hardness (total as $CaCO_3$), mg/liter	350–500	429	935	—	772	1312	M
Iron (filterable), mg/liter	<0.01–0.13	0.02	0.04	—	0.04	0.07	G
Nitrates plus nitrites, mg/liter	0.001–0.07	0.06	0.13	—	0.11	0.19	G,U
pH (range)	6.8–9.0	7.5	—	7.0–9.0	—	—	M
Phosphorus (total), mg/liter	0.01–0.75	0.03	0.07	0.04–0.06	0.05	0.09	G,U
Selenium	—	—	—	—	—	—	
Silver	—	—	—	—	—	—	
Sulfate, mg/liter	170–338	326	711	526–653	587	998	U
Total dissolved solids (filterable residue), mg/liter	704–1720	1310	2855	2130–2630	2374	4036	G
Uranyl ion	—	—	—	—	—	—	
Zinc, mg/liter	0–0.07	0.03	0.07	0.04–0.06	0.05	0.09	G

Table 3.6.2 (continued)

Constituent or characteristic[a]	Lake Granbury			Squaw Creek Reservoir discharge to Lake Granbury			
	Normal range 1	Average 2	Maximum[b] 3	Normal range[c] 4	Average 5	Maximum[d] 6	Data source
Organic chemicals[f]							
Phenols	0–0.002	—	—	—	—	—	G

[a]Constituents as in Table II-1 of *Water Quality Criteria*, Federal Water Pollution Control Administration, U.S. Department of the Interior, 1968. Constituent omitted when no data were available.

[b]The maximum values (dry year) of chemical constituents in Lake Granbury (column 3) are obtained from the average values (column 2) by applying a factor of 2.18 which was derived from the ratio of total dissolved solids levels in Lake Whitney for October 1956/September 1957 (L. S. Hughs, U.S.G.S., *Chemical Composition of Texas Surface Waters, 1957*, Bulletin 5915, Texas Board of Water Engineers, November 1959).

[c]The normal range of values for chemical constituents in Squaw Creek Reservoir is based on the variation in total dissolved solids levels predicted for the data period 1948 to 1971 (Freese, Nichols & Endress, *Engineering Report on Squaw Creek Reservoir*, prepared for Texas Utilities Services, Inc., 1972).

[d]The average concentrations predicted for Squaw Creek Reservoir (column 5) are based on a normal concentration factor of 1.8 (W) applied to the average values for Lake Granbury (column 2). The maximum values (column 6) are predicted by assuming a dry year concentration factor of 2.25 (W) and a makeup rate of 64,600 acre-ft/year for one year with Lake Granbury chemical constituents at their maximum values (column 3) and 26,400 acre-ft/year blowdown with Squaw Creek Reservoir chemical concentrations calculated by averaging the values in columns 3 and 5.

[e]Dashes indicate that there are insufficient data on which to base an estimate at this time.

[f]Pesticide and herbicide information available at present is insufficient for predicting the levels that may occur in Squaw Creek Reservoir water. Data currently being collected by Fred S. Guthery, Texas A & M University, will be valuable for estimating the quantities of pesticide and herbicide residues that may be potentially available for release to Squaw Creek Reservoir water.

Data sources: (ER, Amendment 2, Table C.14-1).
M – John O. Mecom, *A Limnological Survey of Lake Granbury, Texas*, Southern Methodist University, 1972.
W – Water Resources Engineers, Austin, Texas. Personal communication with Dr. James H. Duke, Jr., 10/3/73.
G – U.S. Geological Survey, Water Resources Division, Austin, Texas. Unpublished water quality data on Lake Granbury for the period 9/22/70 to 5/23/72.
U – Prof. John E. Ubelaker, Department of Biology, Southern Methodist University. Lake Granbury water quality data, 6/19/73.

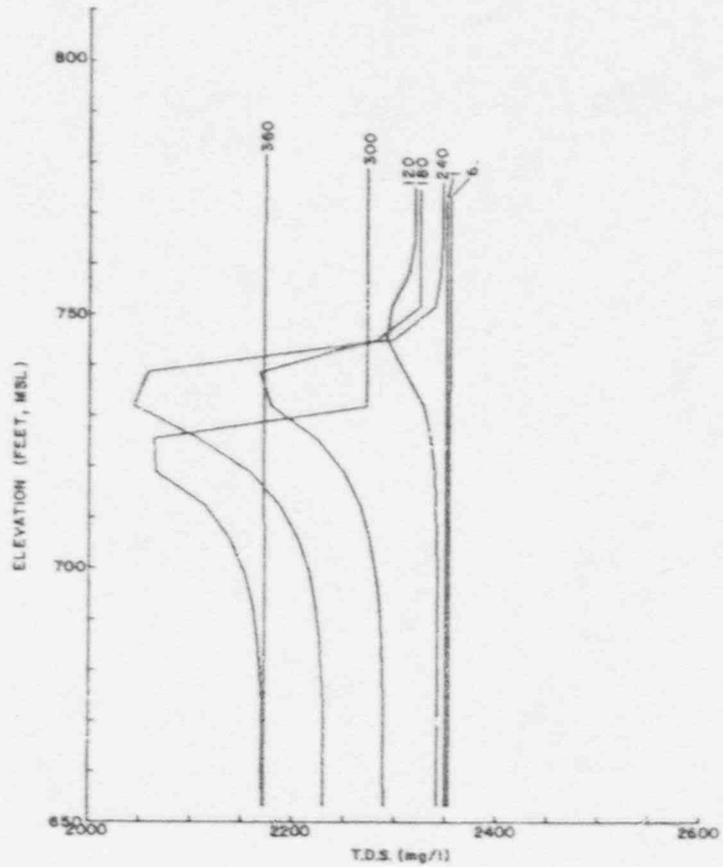

Fig. 3.6.1. Distribution of dissolved solids in Squaw Creek Reservoir.
Source: J. H. Duke, Jr., "A Technical Assessment of the Impact of the Comanche Peak Steam Electric Station on the Proposed Squaw Creek Reservoir," report prepared by Water Resources Engineers, Inc., for Texas Utilities Services, Inc., Nov. 15, 1973, Fig. 5, Part D.
(Parameter varying for each curve is day of the year)

Table 3.6.3. Volumes of water within total dissolved solids contours in the discharge plume in Lake Granbury

Month	Discharge TDS (mg/liter)	TDS at discharge elevation (mg/liter)	TDS contour (mg/liter)	Volume within contour (ft^3)
January	2369	1214	2200	120
			2000	230
			1800	350
			1600	590
			1400	1,700
February	2336	1225	2200	80
			2000	210
			1800	300
			1600	540
			1400	3,000
March	2347	1245	2200	110
			2000	240
			1800	340
			1600	550
			1400	3,700
April	2334	1264	2200	80
			2000	190
			1800	310
			1600	600
			1400	4,400
May	2272	1293	2200	50
			2000	170
			1800	320
			1600	650
			1400	6,500
June	2224	1274	2200	20
			2000	170
			1800	29?
			1600	550
			1400	3,200
July	2181	1376	2000	180
			1800	330
			1600	720
			1400	7,500
August	2106	1383	2000	100
			1800	280
			1600	690
			1400	7,300
September	[illegible]	1578	2000	100
			1800	380
			1600	12,300
October	2059	1217	2000	100
			1800	180
			1600	410
			1400	3,100
November	2261	1215	2200	50
			2000	180
			1800	280
			1600	490
			1400	1,600
December	2199	1087	2000	140
			1800	250
			1600	380
			1400	710
			1200	5,100

Source: A. E. Johnson and J. H. Duke, Jr., "An Analysis of the Effects of the Squaw Creek Reservoir Blowdown Plume on Lake Granbury," Water Resources Engineers, Inc., Austin, Tex., Nov. 30, 1973, Table V.

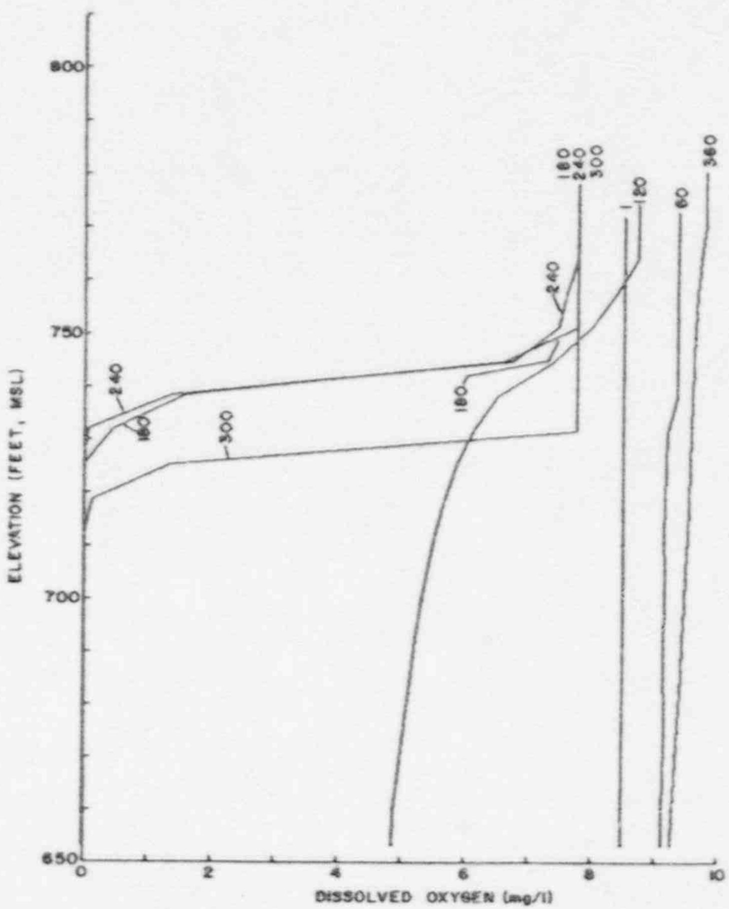

Fig. 3.6.2. Distribution of dissolved oxygen in Squaw Creek Reservoir.
Source: J. H. Duke, Jr., "A Technical Assessment of the Impact of the Comanche Peak Steam Electric Station on the Proposed Squaw Creek Reservoir," report prepared by Water Resources Engineers, Inc., for Texas Utilities Services, Inc., Nov. 15, 1973, Fig. 5, Part C (Parameter varying for each curve is day of the year)

Table 3.6.4. Volumes of water within dissolved oxygen contours in the discharge plume in Lake Granbury

Month	Discharge DO (mg/liter)	DO at discharge elevation (mg/liter)	DO contour (mg/liter)	Volume within contour (ft^3)
January	8.9	10.8	a	a
February	9.3	10.3	a	a
March	9.0	9.3	a	a
April	6.0	4.7	6.0	3500
May	2.7	1.0	2.0	b
			4.0	b
			6.0	b
June	0.0	0.6	2.0	b
			4.0	b
			6.0	b
July	0.0	5.8	2.0	2000
			4.0	b
			6.0	b
August	0.0	5.9	2.0	2000
			4.0	4000
			6.0	b
September	0.0	7.1	2.0	80
			4.0	120
			6.0	1200
October	1.2	7.9	2.0	40
			4.0	90
			6.0	250
November	8.6	9.3	a	a
December	9.6	9.0	a	a

[a]Dissolved oxygen concentration always greater than 5.0 mg/liter.
[b]Results affected by nonlinear stratification.

Source: A. E. Johnson and J. H. Duke, Jr., "An Analysis of the Effects of the Squaw Creek Reservoir Blowdown Plumes on Lake Granbury," Water Resources Engineers, Inc., Austin, Tex., Nov. 30, 1973, Table IV.

sewage. In addition there would be an input of 64,000 gal/year of effluent from steam generator blowdown treatment and 300,000 gal/year of chemical cleaning waste. This is about 31 acre-ft/year input. The average net evaporation (rainfall minus evaporation) in this area is about 3.5 ft/year (Sect. 5.3). The net evaporation from an area of 12 acres would therefore be adequate for the input. The 11-ft depth has a 1-ft margin for solids accumulation and a 39-in. allowance for a rainstorm.

To prevent groundwater contamination the applicant plans to line the pond bottom and sides with an impervious liner. If necessary, sludge can be removed to a landfill site to gain additional capacity. The evaporation pond will be located behind the main switchyard and will be fenced in to prevent animals from using it as a water source.

The staff concludes that the evaporation pond size is adequate.

3.6.2 Biocides

The circulating water system and service water system of CPSES will be treated by the shock chlorination method. At periodic intervals, small doses of chlorine will be injected into the circulating water system to prevent the growth of algae and bacterial slime on the surfaces of the circulating water tunnel and the condensers. The bleed line to the service water intake structure provides chlorination to the service water pumps and the service water heat exchangers.

Chlorine will be injected into the circulating water ahead of each traveling water screen. One chlorine diffuser will be located ahead of each traveling screen.

The applicant anticipates that chlorination will only be required for two 30-min periods per day. The applicant estimates that 1650 lb of chlorine will be required per day if the chlorine demand is 2 ppm and 3 ppm is added to the circulating water of the unit being treated to exceed the demand. The concentration of chlorine in the discharge from two units when only one unit is being treated will be 0.5 ppm. The applicant estimates that the chlorine concentration would remain in the 0.14 ppm to 0.18 ppm range for 17 to 21 hr after discharge. The staff believes that this is unacceptable and can be reduced by controlling the rate of chlorine addition and measuring the chlorine concentration in

the discharge. The staff will require that the applicant monitor the total residual chlorine at the point of discharge and control the rate of addition to achieve a total residual chlorine concentration of 0.1 ppm or less at the point of discharge to the reservoir. (Refer to Sect. 11.6.1).

3.7 SANITARY WASTES AND OTHER EFFLUENTS

3.7.1 Sanitary wastes

The applicant must obtain a permit from the Texas State Department of Health for construction and operation of the sanitary systems. The applicant has contacted this agency regarding plans for this project (ER, p. 12.0-2).

3.7.1.1 Construction phase

The applicant must obtain a permit from the Texas State Department of Health for sanitary waste disposal during construction. The waste must be transported to an approved sanitary facility until a permit for the onsite facility is obtained.

3.7.1.2 Operation phase

Sanitary wastes from the station are treated onsite by an extended aeration sewage plant. The effluent will be chlorinated for disinfection and odor reduction prior to release. The estimated volume of sanitary waste is 5000 gal/day. The staff concludes that the sanitary waste disposal will meet State standards.

3.7.2 Combustion effluents

The applicant must obtain a permit from the Texas Air Control Board for discharge of gaseous effluents. The applicant has been in contact with this agency (ER, Sect. 12.0).

Products of combustion will be discharged to the atmosphere during operation of the emergency diesel generators and diesel-driven fire pumps. Both of these diesel units are tested periodically to assure proper functioning o' the emergency systems. Estimates of the running time and exhaust effluents are given in Table 3.7.1. The exhaust is untreated prior to release to the environment.

Table 3.7.1. Gaseous effluents from plant diesel operation

1. Type and number of units	
a. Emergency diesel generators	4
b. Diesel fire pump	1
2. Test	
a. Frequency	1 test each per month
b. Duration	2 hr maximum
3. Total pollutants released to atmosphere, lb/year[a]	
a. SO_2	2,160
b. Hydrocarbons	2,550
c. NO_x	20,300
d. CO	5,200

[a]Based on 24 hr running time per year per engine, using 0.3% sulfur fuel oil.

The staff concludes that the diesel units can be operated as proposed in a manner that will meet State standards.

The auxiliary boiler is electric.

Brush being cleared will be stacked in piles and burned during the construction phase. The applicant will obtain all local, State, and Federal permits required (ER, Sect. 4.1.1.1.2).

3.7.3 Other effluents: solid waste

Nonradioactive solid waste will be accumulated in waste receptacles at the station. These wastes will be removed in bulk from the site to an approved landfill by a commercial carrier.

3.8 TRANSMISSION SYSTEMS

An extensive description of the transmission lines is given by the applicant in the ER (ER, Sect. 3.9). A summary description is given below.

Four new transmission line connections will be required. Two of these will be parallel lines extending generally to the northeast to tie into the system at the De Cordova Bend Steam Electric Station switchyard. The other two will be short lines connecting CPSES with the Weatherford Parker-Venus 345-kV transmission line being planned for 1978 installation.

The route of these lines is indicated in Fig. 3.8.1 and also in Fig. 3.8.2. Other information on the lines is given in Table 3.8.1. The total acreage for the above lines is 483.3.

The transmission lines run parallel to the rail spur line to CPSES for about 1 mile after leaving the CPSES switchyard before three of the transmission lines cross the rail spur line. There are no other rail line crossings by the lengths of transmission lines listed in Table 3.8.1. As shown in Fig. 3.8.1, however, the extension of the 345-kV line to Weatherford does cross the Atchison, Topeka and Santa Fe rail line about 3 miles west of Granbury.

The CPSES-De Cordova transmission lines parallel Farm Road 201 for about 1 mile, as shown in Fig. 3.8.1. The right-of-way also runs more or less parallel to State Highway 144 for about 1.9 miles at a distance of approximately 3/4 to 1/4 mile. The lines will cross the highway at an angle about 8 miles south of Granbury and will continue to be visible from the highway as they extend northeast across this relatively flat countryside.

These lines will then cross the Brazos River three times downstream of De Cordova Bend Dam, the last crossing being just below the dam. The lines will then join other lines (not part of this project) and require a combined 600- to 735-ft-wide right-of-way which crosses Lake Granbury to reach the De Cordova switchyard.

With respect to the middle section of the CPSES-De Cordova transmission line right-of-way, the general alignment map (Fig. 3.8.2) indicates that the transmission line right-of-way will parallel the rights-of-way for the makeup and blowdown pipelines for a distance of about 1.8 miles. The pipelines will lie within the 230-ft transmission line right-of-way.

There are no large communities close to the proposed transmission lines. The CPSES-De Cordova transmission lines appear to be rout within approximately 1,200 ft of a residental area, from which th will be visible. This is a 250-acre residential development in its

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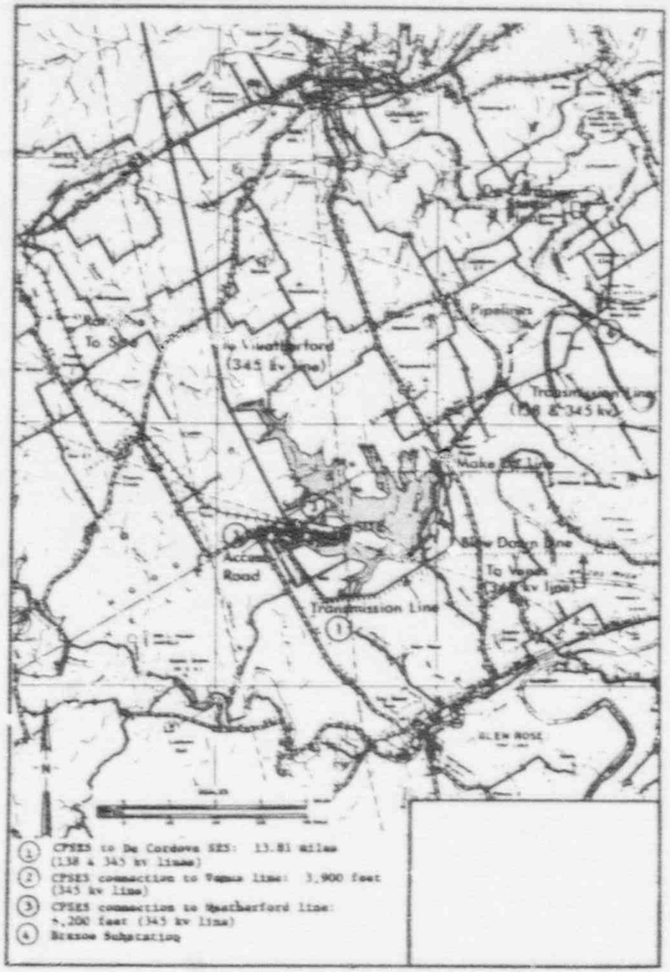

Fig. 3.8.1. CPSES transmission line right-of-way alignment.
Source: ER, Fig. 3.9-1.

1 CPSES to DeCordova SES: 13.81 miles (138 & 345 kv lines)
2 CPSES connection to Venus line: 3,900 feet (345 kv line)
3 CPSES connection to Weatherford line: 4,200 feet (345 kv line)
4 Brazos Substation
Road or highway designation

Fig. 3.8.2. General location of CPSES transmission lines and other lines.
Source: ER, Fig. 4.0-1.

Table 3.8.1. Transmission lines

Line	Voltage (kv)	Distance (miles)	Towers[a]	Width of right-of-way (ft)	Acreage
CPSES–De Cordova (double circuit)	345	13.81	LS	230 (parallel lines)	453.5[b]
CPSES–De Cordova	13[illegible]	13.81	W[c]		
CPSES–Weatherford	345	0.8	LS	170	16.4
CPSES–Venus	345	0.74	LS	150[d]	13.4

[a]Towers: LS = lattice steel; W = wood.

[b]Includes 1.26 miles of 600- to 735-ft right-of-way.

[c]Towers lattice steel for last 2.3 miles.

[d]Parallel to De Cordova lines.

early planning stages. The planned transmission line right-of-way has been so routed as to bypass the prospective residential area, which is relatively close to the planned right-of-way for approximately 1 mile before the first crossing of the Brazos River toward the De Cordova switchyard from CPSES.

The CPSES-De Cordova lines will pass within 900 ft of Hopewell Cemetery, which is considered a historical feature. An archaeological reconnaissance of the rights-of-way area will be made prior to construction of the lines (ER, p. 2.3-2).

3.9 TRANSPORTATION CONNECTIONS

3.9.1 Railroad spur

A railroad spur will be constructed to the site from the nearest existing line, the Atchison, Topeka and Santa Fe Railroad between Fort Worth and Brownwood. The spur line will connect at Tolar, northwest of the site, as shown in Fig. 3.8.1. The spur line will

be 10.2 miles in length and will use a 150-ft-wide right-of-way. The 185 acres of land included in this are 56% cultivated land, 40% rangeland, 2% woodland, and 2% miscellaneous. Accessibility to parts of some farms may be reduced. Several farm roads will be crossed, the most important of which is Farm to Market Road 51. A permit is required from Hood County to cross county roads. Authority to cross Farm to Market Road 51 must be obtained from the Texas Highway Department.

The spur line must meet the construction requirements of the State of Texas Railroad Commission and the crossing of Farm to Market Road 50 must conform to the requirements of the Texas Highway Department.

The proposed line is not near any historical site.

3.9.2 Access road

A permanent access road will be constructed from the site to Farm Road 201, as shown in Fig. 3.8.1. The access road right-of-way will be 75 ft wide and the length 2.1 miles. The 19 acres included in this are 84% rangeland and 16% cultivated. The road does not cross in areas of known historic or archaeological sites.

3.9.3 Pipelines

3.9.3.1 Makeup water pipeline

A 48-in.-diam pipeline is required to transport water from Lake Granbury to Squaw Creek Reservoir, as discussed in Sect. 3.3. This underground line will be 4.97 miles in length and will use a 25-ft-wide right-of-way. The route is shown in Fig. 3.8.2. The 15 acres included in this are 47% cultivated, 33% rangeland, and 20% woodland. The only nearby historic site is Hopewell Cemetery which is 900 ft north of the right-of-way.

3.9.3.2 Return water pipeline

A 36-in.-diam pipeline is required to return blowdown from Squaw Creek Reservoir to Lake Granbury, as discussed in Sect. 3.3. This underground line will be similar to and parallel to the 48-in. line above, except the 36-in. line will continue around the lower end of Squaw Creek Reservoir to remove water from near the dam. This longer line is 8.21 miles in length and will also require a 25-ft-wide right-of-way. Fifteen of the twenty-five acres of right-of-way is identical to that for the 48-in. line. The remainder is 80% rangeland and 20% cropland.

Since the makeup and return pipelines will go under State Highway 144 and several other roads in Hood County, a permit will be required from this county. Placement of the lines under State Highway 144 will require a permit from Texas Highway Department.

There are no recorded archaeological sites in the rights-of-way.

3.9.3.3 Pipeline relocations

About 4.8 miles of new line will be required to relocate an existing 6-in. gas pipeline affected by CPSES. The relocated line will go along the western boundary of CPSES property. About 4 miles of new line will be required to relocate an existing 26-in. crude oil line. The relocated line will go along the southwest boundary of CPSES property. A total of 25 acres is expected to be affected in these two relocations. All of the land required for relocation is on CPSES property, and most of this is grazing land.

3.9.3.4 Gas pipelines under Squaw Creek Reservoir

An existing 36-in. gas line and a new parallel line of the same size will pass under the upper end of Squaw Creek Reservoir. These lines, which will be under as much as 35 ft of water, will be anchored to remain submerged.

REFERENCES FOR SECTION 3.4

1. U.S. Army Corps of Engineers, "Policies and Procedures Pertaining to Determination of Spillway Capacities and Freeboard Allowances for Dams," EC 1110-2-27, August 1966.

2. U.S. Atomic Energy Commission, "Regulatory Guide 1.59 — Design Basis Floods for Nuclear Power Plants," August 1973.

3. Texas Utilities Generating Company, *Comanche Peak Steam Electric Station, Preliminary Safety Analysis Report.*

4. Texas Utilities Generating Company, *Comanche Peak Steam Electric Station, Environmental Report*, p. 7.2-4.

REFERENCES FOR SECTION 3.6

1. J. H. Duke, Jr., "A Technical Assessment of the Impact of the Comanche Peak Steam Electric Station on the Proposed Squaw Creek Reservoir," report prepared by Water Resources Engineers, Inc., for Texas Utilities Services, Inc., Nov. 15, 1973.

2. A. E. Johnson and J. H. Duke, Jr., "An Analysis of the Effects of the Squaw Creek Reservoir Blowdown Plumes on Lake Granbury," report prepared by Water Resources Engineers, Inc., for Texas Utilities Services, Inc., November 1973.

4. ENVIRONMENTAL EFFECTS OF SITE PREPARATION AND OF STATION AND TRANSMISSION FACILITIES CONSTRUCTION

4.1 IMPACTS ON LAND USE

The total land area involved in the construction (both temporary and permanent facilities) of the CPSES and related facilities is given in Table 4.1.1.

4.1.1 Station site and Squaw Creek Reservoir dam

The areas affected by construction of the station and the Squaw Creek Reservoir dam are indicated in Fig. 4.1.1. Much of the 400-acre peninsula on which the station is located will be leveled. Extensive excavation will be required for the buildings and the evaporation pond. About 50 acres of the above 400 acres are within the rights-of-way of the access road, railroad spur, or transmission lines. All of the peninsula will undergo at least light clearing. The clearing and earthwork will result in the creation of dust and smoke from construction equipment.

A significant impact of the project is construction of the 159-ft-high, 4360-ft-long dam across Squaw Creek. The borrow areas for materials for this earth and rock fill dam are as indicated in Fig. 4.1.1. There will be much traffic of large earth-moving equipment and temporary storage of materials. The earthwork for this dam and the smaller safe shutdown dam across Panther Branch are given in Table 4.1.1. No dredging is anticipated to be required.

Dam construction will involve temporary disruption and scarring of a significant area adjacent to the dam in the course of site preparation activities such as clearing, grading, and excavation. Land use in this area will also be affected by construction of temporary roads. Local drainage and runoff control will be established in the area of the damsite to reduce adverse impacts on the lower course of the stream. Considerable dust will be raised during construction. Most of the adverse effects of dam construction are temporary and can be controlled in such a way as to facilitate rehabilitation and replanting of disrupted areas around the dam.

The applicant provided the following information in regard to the amount of material and its movement (ER, Sect. 4.1.1.1.3). A very large amount of sand, gravel, cement, and steel will be hauled onto the station site in addition to the large amount of earth and rock that will be moved onsite in connection with grading and foundation work for the station and construction of the dam. The estimated

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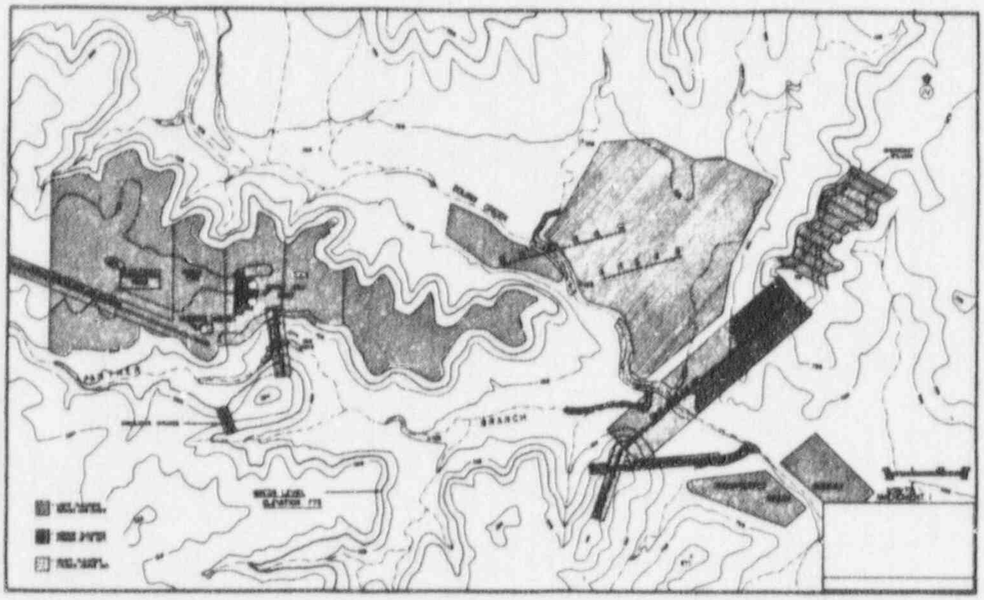

Fig. 4.1.1. Areas affected by construction of CPSES and the Squaw Creek Reservoir dam.
Source: ER, Fig. 4.0-1a.

Table 4.1.1. Land area used and earthwork at CPSES

Facility	Completed area (acres)	Land area affected by construction (acres)	Earthwork (cu yd)	
			Excavation	Fill
Station site (not including reservoir or rights-of-way)	350	350	2,600,000	200,000
Permanent buildings	8			
Switchyard	12			
Evaporation pond	12			
Access road	19[a]	19[a]	50,000	50,000
Railroad spur	185[a]	185[a]	150,000	150,000
Water lines to Granbury[b]		40[a]	100,000	70,000
Relocated pipelines[b]		24[a]	30,000	20,000
Transmission lines[c]		439[a]		
Squaw Creek Reservoir (SCR) (elevation 775 ft above MSL)	3228	3228		
SCR dam and spillway	100	215	1,600,000	5,100,000
Safe shutdown dam			340,000	510,000
Total		4500	4,870,000	6,100,000

[a] Right-of-way.
[b] Underground.
[c] 483 less 44 over water.

amount of material is given in Table 4.1.2. These amounts will require from 50 to 55 truck deliveries per day on average, assuming 22- to 25-ton-capacity or 36-ton gross weight vehicles.

Table 4.1.2. Estimated construction material for CPSES

	Truckloads per month	Tons per month	Estimated total tons
Sand	340	7,650	183,000
Cement	158	3,550	85,200
Aggregate	555	12,500	300,000
Steel (rebar)	46	1,050	25,200
Total	1,099	24,750	594,000

The sand will be hauled from the Cleburne area over U.S. 67 to Glen Rose and north on FM 201 (and the access road) to the site. The cement will move over the same route. The aggregate will come from Bridgeport via Weatherford on FM 51 to FM 201 and onto the site. Steel will move from Dallas via U.S. 67 to Glen Rose and FM 201 to the station. About half of the tonnage will move through Glen Rose north on FM 201 to the site with the remainder moving southward on FM 51 to the intersection with FM 201 and south to the site (via the access road). Traffic on the Glen Rose route will not move through the center of the town but will stay on the main route, which circumvents the built-up area of the community.

The movement of this tonnage over farm roads FM 201 and 51 will have a significant impact on traffic levels (previously quite low) and on local road maintenance requirements. Truck operations will be handled and scheduled in such a way as to minimize impacts on or interference with local traffic movements, but it is evident that the local road maintenance requirements will increase substantially. Traffic control measures will be implemented as required to control truck traffic and assure safe operations in the vicinity of small local communities (or concentrations of houses), presently uncontrolled intersections in rural areas, and school bus pickup points.

4.1.2 Squaw Creek Reservoir site

Squaw Creek Reservoir will have a total surface area of 3228 acres at its design water level of 775 ft above mean sea level. The predominant land use in the reservoir area is cattle grazing; however, about 940 acres is improved cropland, and 320 acres is mixed juniper woodland. The reservoir area also contains six farmhouses and an abandoned crushed stone quarry. Three pipelines cross the site; two of these, a 6-in. gas line and a 26-in. crude oil line, must be relocated around the reservoir and station site, and the third, a 36-in. gas line that crosses the upper reaches of the reservoir, will be anchored to remain submerged.

The applicant states that generally, during the clearing phase, brush will be stacked in relatively small piles and allowed to dry, then burned during favorable environmental conditions. A continuous fire watch will be maintained, and should wind and/or weather conditions change unfavorably, adequate facilities will be available for extinguishing the fire (ER, Sect. 4.1.1.1.2).

The residue from the fire, along with other debris not burned, will be buried in the reservoir area with a minimum of 18 in. of earth cover. This and other earthwork will result in formation of considerable dust. While the dust raised in site preparation is a significant factor with respect to local air quality, the disposal of brush and debris accumulated in clearing operations may contribute further to air pollution. In any event, this problem is a temporary and controllable adverse effect of reservoir site preparation. The staff recommends that all debris should be cleared from the stream below the dam after construction is completed.

An investigation revealed that some historic and prehistoric remains will be directly or indirectly affected by the construction of the reservoir. These sites are located and discussed in the ER, Sect. 2.3.2. A number of sites or buildings of local historical interest are situated near the reservoir site. The exact program for preservation or excavation of identified sites has not yet been finalized. However, the applicant will initiate a program in cooperation with appropriate State agencies to insure that significant resources are not lost, as far as is practicable (ER, Sect. 4.1.1.5).

4.1.3 Transmission lines

The area affected by the transmission lines is described in Sect. 3.8. The construction will not affect any historical sites or existing public parks. The impact on Lake Granbury will be primarily aesthetic. There are no buildings in the rights-of-way

The staff believes that transmission line construction can be accomplished without a significant long-term or permanent adverse effect on agricultural production along the right-of-way and adjoining properties. A small area of land will be taken out of production permanently (land occupied by transmission line tower bases located at intervals of 600 to 1,600 ft).

During construction, temporary disruption of agriculture will result from the movement of vehicles along the right-of-way and the temporary storage of tower materials. After completion of construction, the ground surface will be graded, planted, or otherwise treated or prepared so that the effects of vehicular movement will not cause erosion or will not affect restoration to agricultural use (ER, Sect. 4.2.1.1). There appears to be little requirement for the construction of access roads which would require additional land to be taken out of production permanently.

4.1.4 Railroad spur line

The rail spur line and the area affected are described in Sect. 3.9. The right-of-way is flat to very gently rolling terrain. Only a small amount of cut and fill will be required in preparation of the right-of-way and grade. No major stream crossings are required. The minor tributary streams crossing the right-of-way will require simple bridging structures. The staff does not expect that the construction activity or the movement of heavy equipment and materials required in construction will cause any serious or permanent disruption of present land uses. During construction of the rail line a substantial tonnage of railroad ballast and rail, in addition to other materials, will be required. For example, in January, February, and March of 1975, 1,100 to 1,200 tons of ballast per month will be trucked to the rail line. This represents perhaps 50 truckloads per month or 2 to 3 truckloads per day moving from Bridgeport to Weatherford and thence on FM 51 and 201 to the vicinity of the rail line and the plant. In April, May, and June, 1,600 to 1,800 tons of rail per month will be trucked into the area by way of main routes to Granbury, and on to the construction site by truck over FM 51 and FM 201 (ER, Sect. 4.1.1.1.4).

4.1.5 Access road

The access road is described in Sect. 3.9. The road construction will affect 19 acres of mostly rangeland. Less than one-half of this will be paved.

4.1.6 Makeup and return pipelines

The two pipelines and the areas affected are described in Sect. 3.9. Both of the pipelines are underground. The acres disturbed and the estimated excavation required are given in Table 4.1.1. The applicant states that once the pipelines are laid, the ground will be replanted, probably to native or adaptive grasses, which will provide erosion control and provide for some grazing. Judging from aerial photographs of other pipeline rights-of-way, cultivation will be restored along a portion of the right-of-way where the pipeline crosses cultivated lands.

4.1.7 Pipeline relocations

The two lines to be relocated are described in Sect. 3.9. The impact will be similar to that of the construction of the makeup pipeline.

4.1.8 Conclusion

The staff concludes that the impacts on land use are extensive but that the applicant will reduce them to an acceptable level.

4.2 IMPACTS ON WATER USE

The filling of Squaw Creek Reservoir will require a maximum withdrawal of 158,400 acre-ft over 36 months from Lake Granbury at 4400 acre-ft/month (52,800 acre-ft/year).[1] Assuming a volume of 155,000 acre-ft for Lake Granbury,[2] this is a consumptive use of 34% of the lake volume per year, or approximately 3% per month. The 1971 runoff to Lake Granbury was 395,466 acre-ft.[3] Thus there will be a maximum withdrawal of 13.4% of the average annual flow for each of three years to fill Squaw Creek Reservoir. The Texas Water Rights Commission has approved the diversion of 165,300 acre-ft over three years for this purpose during periods of high runoff (refer to Sect. 2.2.3.2 and to ER, Sect. 4.1.2.5). The staff concludes that this withdrawal will not have an adverse impact on other water use in Lake Granbury.

Construction of diversion and return facilities on Lake Granbury will necessitate the closing off of an additional small portion of lake area. Because this is near the De Cordova Bend Dam and the return discharge will be in the area already closed to boating, the staff concludes that this will not have an adverse impact on the recreational use of the lake. Siltation which might occur as a result of construction is also not expected to affect water use.

Squaw Creek supports only some limited fishing; therefore there should not be a great impact on recreational use of the creek. There also should not be an adverse impact on the use of Squaw Creek water by wildlife or stock. The safe limits of total dissolved solids for livestock are presented in Table 4.2.1. It can be seen that the limits are much greater than the 1200 ppm total dissolved solids concentration that will be released into Squaw Creek. EPA gives the maximum acceptable level for livestock drinking water as 3000 ppm soluble salts,[4] which is also higher than the level that will occur in the creek.

Table 4.2.1. Proposed safe limits of salinity for livestock

Animal	Threshold total dissolved solids concentration (ppm), mainly NaCl
Poultry	2,860
Swine	4,290
Horses	6,435
Dairy cattle	7,150
Beef cattle	10,000
Sheep (adult, dry)	12,000

Source: Federal Water Pollution Control Administration, *Water Quality Criteria*, report of the National Technical Advisory Committee to the Secretary of the Interior, Apr. 1, 1968.

The applicant notes in the ER (ER, Sect. 4.1.2.7) that existing groundwater levels indicate that the water table gradient in the Glen Rose formation is inclined toward Squaw Creek from a groundwater divide some distance to the west, where groundwater levels exceed 900 ft above mean sea level. The groundwater level near the impoundment is higher than the maximum operating pool elevation. The effect of the impoundment will be to raise the groundwater level in the Glen Rose formation and decrease the flow gradient toward the impoundment. The applicant also notes in the ER that the top of the Twin Mountains aquifer (the major groundwater source in the area) below the impoundment is at elevation 500 to 600 ft. The lowest elevation of the impoundment floor is 650 ft. Between the impoundment floor and the top of the aquifer, there is at least 40 to 50 ft of fine-grained soil and Glen Rose formation; this precludes any significant seepage to the Twin Mountains formation that would alter the existing groundwater conditions. No significant water level changes in the Twin Mountains formation are expected due to the creation of Squaw Creek Reservoir (ER, Sect. 4.1.2.7).

Piezometers have been installed by the applicant in selected borings at the station site. The continuing observations of the piezometers indicate that the quantity of groundwater inflows can be handled by an open sump in the lowermost excavation level. The influence of dewatering on local waters will be limited to within a few hundred feet of the excavations. No other groundwater users will be affected (ER, Sect. 4.1.2.7).

4.3 EFFECTS ON ECOLOGICAL SYSTEMS

4.3.1 Terrestrial

Table 4.3.1 presents a summary of the changes in acreage of the vegetation communities as a result of construction on the site. Of the 3950 acres estimated to be affected, approximately 90% of the alteration will be related to Squaw Creek Reservoir. The reservoir will have an impact on five of the vegetation communities of the project area.

Table 4.3.1. Changes in acreage of the vegetation communities as a result of construction on the site

Vegetation community	Preconstruction acreage	Postconstruction acreage	Percent loss
Juniper-Threeawn Uplands			
Cleared	2526	2120	16
Uncleared	424	414	2
Juniper–Hairy Grama Slopes	1410	945	33
Broomweed Benches	869	678	22
Upper Riparian	3000	438	85
Lower Riparian	346	30	91
Total	8575	4625	46

4.3.1.1 Station site

Construction of the station will occur on a peninsula formed by the reservoir (ER, Fig. 2.7-2c). The acreage of the peninsula is approximately 400 acres, all of which is included in the construction zone for the station. The exact configuration of the station facilities has not been established; however, Fig. 4.0-1a of the ER indicates the general extent of the direct impact area. The actual layout of the station upon completion is expected to occupy about 200 acres. Most of the construction site area will be cleared and heavily graded, resulting in a substantial change in topography (ER, Fig. 2.7-2b).

Activities such as clearing, grading, excavating, filling, and stockpiling will result in the accelerated erosion of soils. Water erosion occurs when there is extensive runoff of precipitation over exposed land surfaces. The kind of soil and the type of vegetation growing on it have a major effect on the amount of precipitation that runs off. Mechanical disturbances on a watershed, along with its topography and shape, also affect the runoff rate. Reducing the water absorptive and holding capacity of land by removing its natural vegetation during land clearing and grading accelerates and increases the volume of runoff.

Construction of the station will occur on Tarrant series stony clay. These soils have rapid to medium runoff and a moderate water intake rate. When vegetation is removed, erosion may be severe. The applicant has indicated that actions to mitigate the adverse effects of site preparation on the soils and local drainage will be implemented. Specific details have not been provided, but generally, surface drainage from cuts, fills, borrow areas, and spoils areas will be controlled by ditches, dikes, berms, and sedimentation basins. During the first eight months of construction, such structures will be essential in erosion control. After that time the dam will be closed across Squaw Creek, resulting in a large settling pond catching runoff from areas above the dam. Since the construction period is expected to extend for about eight years, the staff recommends certain preventive techniques, such as seeding, will be required in addition to these corrective techniques for effective erosion control.

The vegetation community of the station site is cleared Juniper-Threeawn Uplands. Construction of the station will result in a 16% loss of this vegetation type from the project area. Although Juniper-Threeawn Uplands is the most commonly occurring vegetation type on the site, the direct impacts of construction on this type will be confined primarily to the station site. Since many species

composing this type are considered invader species and indicators of overgrazing (Tables A-1 and A-2), clearing this acreage of Juniper-Threeawn Uplands may be considered a minor impact on the native flora of the site. Approximately half of the peninsula will be occupied by the station and associated facilities; the remainder will be available for habitat restoration. Grasses will be effective in erosion control as well as determining the initial course of succession of the vegetation community. If native grasses are not planted, reinvasion and dominance of species such as threeawn, broomweed, bull nettle, and mesquite is expected. The staff recommends seeding with native grasses, both during and following construction, as appropriate.

Construction activities will have a direct effect on the consumer populations of the site. Clearing, excavating, filling, and grading will kill many of the less mobile species, such as terrestrial invertebrates, terrestrial amphibians and reptiles, and small mammals in the area of that activity. Because of the dry, upland nature of the station site, amphibians will be encountered only infrequently; however, these uplands are preferred habitats of several reptiles. Most birds and mammals will leave the immediate vicinity of construction as activities increase.

An indirect effect of construction activites on consumer populations occurs through loss of suitable habitat. Many of the less mobile and/or highly territorial consumer species such as some reptiles, many breeding birds, and certain small mammals will be unsuccessful in relocating suitable habitat. Even though junipers are a dominant tree on the plant site, no habitat suitable for breeding by the golden-cheeked warbler is expected to be directly affected by station construction.

4.3.1.2 Squaw Creek Reservoir

The primary impact of construction will be the inundation of terrestrial ecosystems in the creation of a reservoir of 3228 surface acres. Construction of the Squaw Creek Reservoir dam and spillway will require about 100 acres. Prior to inundation, the reservoir area will be cleared of trees. The amount of clearing will be consistent with the recommendations of the Texas Parks and Wildlife Department. Areas denuded of vegetation will have increased wind erosion, especially on sandy soils. In addition to this source, construction equipment will raise dust. Dust raised during reservoir site preparation combined with smoke from vegetation and debris burning may result in local air pollution. The extent of this problem will vary according to local atmospheric conditions at the time of burning.

After vegetation clearing and while the reservoir is filling, some water erosion is expected on the upland soils, which are susceptible to water erosion. Because of gentle slopes and moderate permeability, the alluvial soils are less subject to erosion. Much of the reservoir site is on alluvial soils. During the period of reservoir site preparation, erosion of the cleared areas will be minimized by use of shallow trenches selectively placed to control runoff. A general outline of water control during construction is found in Fig. 4.0-1b of the ER.

To the maximum extent possible, rock and earth fill for the dam will be obtained from the reservoir site, thus minimizing the construction impacts on the areas surrounding the reservoir. Dam construction will permanently alter the damsite itself as well as cause temporary disturbance of the area adjacent to the dam due to the operations of large earth-moving equipment and temporary storage of materials. The applicant has indicated that dam construction will be controlled in a way to facilitate rehabilitation and replanting of disrupted areas around the dam.

The construction of the dam and reservoir will result in direct, permanent impacts on five vegetation communities (Table 4.3.1). The direct impact of inundation will be the least in the Juniper-Threeawn Uplands, with only about 2% of the acreage of this type on the site being eliminated. Of the slope-type vegetation, about 22% of the Broomweed Benches and about 33% of the Juniper-Hairy Grama Slopes will be covered. The vegetation of the slopes is not unique and is, to a large extent, composed of invader species which have replaced the native grasses. The vegetation growing on the slopes reduces soil erosion and is used by certain consumers as cover and forage in the transition between upland and riparian communities. Approximately 2560 acres of the Upper Riparian community will be covered. About one-third of this area has previously been cleared and used for agriculture; 850 acres of Upper Riparian vegetation will be destroyed. The site has 346 acres of Lower Riparian vegetation, 316 of which will be inundated. Considering all of the flora of the site, the vegetation of the riparian ecosystems is the most diverse and stable and has the highest carrying capacity.

Both amphibians and aquatic reptiles live in and near Squaw Creek. Because of the gradual filling of the reservoir, the slow transition from stream to lake habitat should have a minimal impact on these consumers, especially the more aquatic species. Other amphibians and reptiles living in riparian vegetation will suffer loss of suitable habitat and therefore will likely be eliminated. Bird densities generally were observed to be higher in the riparian areas than in the uplands. Many birds are dependent upon riparian

vegetation to provide summer nesting and winter feeding habitat. Destruction of this habitat will result in displacement of such birds; many will not survive due to increased competition. The small mammals of the site appeared to prefer the uplands over a riparian habitat (Table 2.7.5); however, several species of medium-sized mammals prefer bottomland habitat.

The inundation of the Squaw Creek riparian communities is the most significant negative impact on the terrestrial ecosystems of the site. The applicant has estimated that construction of Squaw Creek Reservoir will eliminate approximately 5% of the riparian communities similar to Squaw Creek within Hood and Somervell counties. Riparian vegetation can occur in this part of Texas only along usually flowing streams where sufficient moisture is available to support tree growth. In areas such as Hood and Somervell counties, where rainfall is sparse and drainage patterns are not extensive, riparian vegetation is quite limited. Because of the scarcity of this vegetation, consumer species displaced from the Squaw Creek riparian will cause increased competition in other riparian areas, probably exceeding the carrying capacities of those areas.

A positive impact on terrestrial ecosystems will be the suspension of cattle grazing. Heavy grazing pressure over many decades has drastically reduced the density of original, climax vegetation and has encouraged invasion of plant species of low productivity, nutritional value, and/or palatability. In areas where the soils have not severely deteriorated by erosion and leaching, the removal of livestock grazing will permit increased productivity of the climax grasses, such as little bluestem. The rate at which the prairie can be restored is dependent on factors such as (1) density and distribution of native grasses, (2) density of invader species, (3) condition of the soil, and (4) climatic factors, primarily rainfall.[1-3] Where the brushy stage of retrogression is well advanced, brush clearing is required for the successful reestablishment of prairie grasses. In areas disturbed during site preparation and construction, the staff recommends that brush clearing of small dense juniper and mesquite thickets be done in such areas to the extent possible so as to promote the growth of prairie grasses.

4.3.1.3 Access road, railroad spur, and pipelines

A permanent 1.9-mile access road will extend from Farm Road 201 to the station site on the peninsula. A 10.2-mile railroad spur will be constructed from Tolar to the station site. The general locations of both are indicated in Fig. 4.0-1 of the ER. The access road and railroad spur are discussed together, since the access road runs parallel with the end of the railroad spur. Construction of the access road is expected to affect about 19 acres, of which approximately 8 acres will be eliminated by a permanent paved road with a 30-ft right-of-way. Construction of the railroad spur will affect about 185 acres, with about 38 acres being permanently altered. Species composition, frequency, and coverage of producer species on the proposed access road right-of-way will be similar to those determined for the railroad spur. Aerial photographs showing the proposed road and railroad rights-of-way are presented in Figs. 4.1-2a and -2b (ER). A summary of land use classifications keyed to these photographs is found in Tables 4.1-1 and 4.1-2 (ER). Land use classifications include uncleared grazing land, cleared grazing land, cultivation, woodlands, and hedgerow. Cultivated land is a significant proportion (about 60%) of the land use along these rights-of-way. Grasses typical of both cleared and uncleared grazing lands are threeawns and hairy tridens; common forbs and woody species are elbow bush, cedar elm, and juniper. Because of the arid climate and previous brush control practices, many tree species are aggregated in "tree islands" known as mottes or along hedgerows. These rights-of-way are expected to encounter no more than 5% of such areas.

A 48-in.-diam makeup water pipeline will be constructed from Lake Granbury to Squaw Creek Reservoir. A 36-in.-diam return water pipeline will parallel the makeup pipeline and will have an additional 3.2-mile section. With 25-ft rights-of-way the total land affected by these pipelines is about 40 acres. Detailed classification of land use along the rights-of-way is found in Fig. 3.9-6 and Tables 4.1-3 and 4.1-4 of the ER. About half of the land along these rights-of-way is in cultivation. The next most common is grazing land. Pipeline construction requires removal of vegetation along the right-of-way. The trenching operation is expected to remove topsoil layers and replace it with subsoils. Subsoils are deficient in organic matter and nutrients necessary for vegetative growth; thus the pipeline rights-of-way will have decreased productivity. There are existing pipeline corridors crossing the site where little or no revegetation has occurred after as long as 12 years. The applicant has indicated that following filling and leveling of the trench, reseeding with native grasses will be undertaken. The staff recommends additions of organic matter or selected fertilizers to correct the subsoil deficiencies. Stockpiling topsoil during excavation with subsequent reapplication would also help minimize loss of production in the disturbed area.

Two of the three existing pipelines crossing the property will be relocated near the periphery. Both existing lines and proposed reroutings are shown in Fig. 4.0-2 (ER). In some areas these rerouted pipelines will parallel transmission line rights-of-way, thus permitting use of adjacent corridors. The pipeline realignments primarily cross upland grazing lands along the southwest edge of the site. The construction of these rerouted pipelines will be similar to the construction of the new pipelines discussed previously; likewise the same techniques for vegetative restoration will be required.

4.3.1.4 Summary evaluation of construction impacts on terrestrial systems

The construction of CPSES will result in the significant alteration of about 4300 acres of the terrestrial ecosystems of Hood and Somervell counties. Of this, some 3400 acres required for the Squaw Creek dam and reservoir and 200 acres for the station site will be permanently altered. The water quality conditions predominating over the period of cooling-water use of the reservoir can be expected to result in changes in soil chemistry and other characteristics.

The construction will result in the disturbance of five vegetation communities, the greatest impact being the virtual elimination of the riparian communities along Squaw Creek. In view of the reproductive capability and growth rate characteristics of most of the species and the current successional status of the communities, a restoration of the upland vegetation communities is possible, assuming satisfactory soil conditions and sufficient time. However, restoration of the riparian communities is highly unlikely.

Construction activities will have direct impacts on certain consumer populations; however, indirect impacts through loss of habitat will be more significant. The construction of the reservoir will result in the total displacement of terrestrial consumers from the areas involved. Such displacement increases competitive pressure and, subsequently, population regulation through elimination of individuals. The biotic potential of some species is such that loss of individuals has little long-term effect on population structure and stability. For certain other species, notably the avian and mammalian top carnivores (see Sects. 2.7.1.3 and 6.1.3.1), the loss of even a few individuals may have a long-term effect on the population of that area.

The staff concludes that the conversion of approximately 3228 acres of terrestrial environment into an aquatic environment due to the construction of Squaw Creek Reservoir is a significant adverse impact on the terrestrial ecosystems of that area. The acceptance of this impact will be determined by weighing it against the beneficial uses of the reservoir discussed in Sect. 10. When compared to the impacts from the construction of the reservoir, construction of the station and accessory facilities, such as the access road, railway spur, and pipelines, will result in much less severe impacts on terrestrial ecosystems.

4.3.1.5 Transmission lines

The physical details of the transmission systems have been discussed in Sect. 3.8. A detailed description is found in Sect. 3.9 of the ER. The general alignment of these lines is indicated in Fig. 3.9-1 of the ER. A summary of land use classification of transmission line rights-of-way is presented in Table 4.3.2. The basic objective of the applicant in constructing the transmission lines will be to retain as much existing vegetation as possible along the rights-of-way without interfering with the erection and maintenance of the lines. Because of the nature of the terrain and vegetation and the short distances required, both the CPSES-Venus circuit and the CPSES-Weatherford circuit are expected to have relatively little impact on terrestrial ecosystems. The only extensive transmission line construction will be a distance of 13.81 miles from CPSES to the De Cordova SES switchyard, requiring a total of 453 acres. The ER presents aerial photographs of the CPSES-De Cordova right-of-way in Figs. 3.9-6A through -6D; Table 3.9-1 contains a detailed land use classification keyed to the aerial photographs. The acreage of each land use and percent distribution among classifications is summarized in Table 4.3.3.

About 71% (Table 4.3.3) of the total acreage of the corridor is cultivated land and grazing land where little or no right-of-way clearing will be required. Riparian vegetation that will be crossed includes Squaw Creek in one location and the Brazos River in three locations. Cedar elm, bur oak, juniper, pecan, and American elm are common tree species in these riparian woodlands. Typical treatment of riparian vegetation in the right-of-way is shown in Fig. 3.9-17 of the ER. These procedures are expected to lessen the impacts on the riparian vegetation. Construction of the transmission lines will disturb some wildlife habitat and therefore will have some effect on the wildlife of the area. The most significant effects are expected where the most clearing of vegetation is required. The applicant has indicated that, wherever possible, transmission line routing will avoid clumps of mature junipers, the nesting sites of the golden-cheeked warbler. With selective clearing, pruning, and replanting, the adverse impacts on wildlife should be minimized.

The predominant character of the terrain along this proposed corridor is level to gently rolling. Nowhere along the right-of-way does steepness or accessibility of terrain present requirement for construction of roads for vehicular access.

The applicant has indicated that practices for minimizing the potentially adverse effects of transmission line construction will be implemented. These plans and practices are summarized

Table 4.3.2. Summary land use classification of transmission line rights-of-way

I. CPSES–De Cordova switchyard (13.81 miles)

A. CPSES–De Cordova (Benbrook Junction) (12.55 miles, 230-ft right-of-way)

Use	Linear feet	Percent of right-of-way	Acreage
Cultivated land	15,365	23	80.5
Cleared grazing	22,263	34	118.5
Uncleared grazing	12,098	18	63.0
Woodland and riparian	13,236	20	70.0
River and reservoir crossing	2,620	4	14.0
Other (roads, streams)	692	1	3.5
Total	66,274	100	349.9

B. CPSES–De Cordova (Benbrook Junction to switchyard) (1.26 miles, 600–735 ft right-of-way)

Use	Linear feet	Percent of right-of-way	Acreage
Cultivated land	2,950	44	45.6
Cleared grazing	930	14	14.5
Woodland and riparian	160	2	2.1
Reservoir crossing	1,899	29	30.0
De Cordova plant site	726	11	11.4
Total	6,665	100	103.6

II. CPSES-Venus circuit (3900 ft; parallels CPSES–De Cordova right-of-way, adding 150 ft)

Use	Linear feet	Percent of right-of-way	Acreage
Cleared grazing	2,407	62	8.3
Uncleared grazing	1,403	36	4.8
Woodland and riparian	90	2	0.3
Total	3,900	100	13.4

III. CPSES-Weatherford circuit (4200 ft, 170-ft right-of-way)

Use	Linear feet	Percent of right-of-way	Acreage
Cleared grazing	4,200	100	16.4

IV. Total land requirements for transmission line rights-of-way

Use	Acres	Percent
Cultivated land	126.1	26
Cleared grazing	158.1	33
Uncleared grazing	67.8	14
Woodland and riparian	72.4	15
River and reservoir crossing	44.0	9
Industrial (De Cordova plant)	11.4	2
Other	3.5	1
Total	483.3	100

Source: ER; modified by the staff.

Table 4.3.3. Acreage in each land use and the percentage distribution of land among land use classifications along the 13.81-mile Comanche Peak–De Cordova transmission line

Use	Acreage, CPSES to Benbrook Junction (12.55 miles), 230-ft right-of-way	Acreage, Benbrook Junction to De Cordova yard (1.26 miles), varying right-of-way	Total acreage, CPSES to De Cordova	Percent distribution
Cultivated land	80.5	45.6	126.1	28
Cleared grazing	118.9	14.5	133.4	29
Uncleared grazing	63.0		63.0	14
Woodland and riparian	70.0	2.1	72.1	16
Major water crossings	14.0	30.1	44.0	10
De Cordova plant site		11.4	11.4	2
Other (roads, streams)	3.5		3.5	1

Source: ER; modified by the staff

in Sect. 4.5. The staff concludes that if these measures are taken, the adverse impacts of transmission line construction will be minimized.

4.3.2 Construction effects on aquatic systems

The construction of CPSES will have adverse impacts on the aquatic communities of Squaw Creek and Lake Granbury through three major activities: (1) the construction of Squaw Creek Dam, (2) construction of the diversion pump station and return line outlet on Lake Granbury, and (3) the initial filling of Squaw Creek Reservoir.

4.3.2.1 Construction of Squaw Creek Dam

1. Dam construction will result in two-thirds of the length of Squaw Creek being changed from a stream habitat to a lake habitat, and a significant change in the species composition of upper Squaw Creek will thus take place.

Although Squaw Creek Reservoir will probably not develop a biota specifically the same as that in Lake Granbury, the staff presumes that it will undergo a developmental cycle similar to that which has occurred in other reservoirs.[4-6] Figure 4.3.1 shows the typical pattern of colonization that occurs in a new reservoir. Certain organisms in Squaw Creek (obligate rheophilic species) may not be able to survive in the impoundment, due to lack of suitable habitat or reproductive conditions. Species reduction may occur in the following fish species: the stoneroller, the

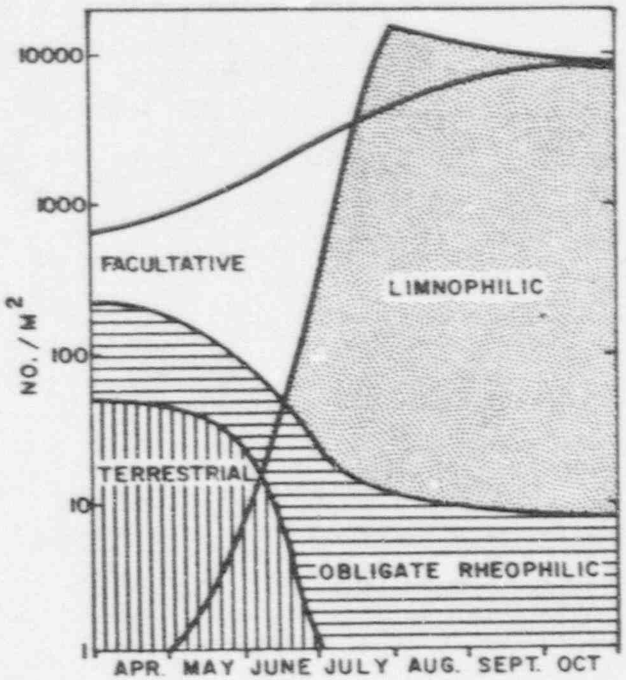

Fig. 4.3.1. Typical pattern of colonization in a new reservoir.
Source: C. G. Paterson and C. H. Fernando, "The Macro-Invertebrate Colonization of a Small Reservoir in Eastern Canada," Verh Internat. Verein Limnol. 17: 122-136 (November 1969).

orange-throat darter, the plains killifish, slough darter, black-striped topminnow, and the bullheads; along with such benthic organisms as *Simulium* and most of the stonefly, caddis fly, and mayfly species. Other organisms (facultative species), however, are able to live in both stream and lake habitats and will dominate the fauna of the reservoir during its early stages of development. This group includes the gastropods, odonates, midge larvae, and fish such as sunfish, shiners, channel catfish, logperch, and mosquitofish. Finally a true limnophilic fauna develops, composed of fish such as gar, drum, buffalo, crappie, shad, and carp, and benthic organisms such as the burrowing mayfly *Hexagenia*,[7-8] the dipteran *Chaoborus*,[9-11] and the beetle *Berosus*.[5]

Construction of Squaw Creek Reservoir will result in the establishment of approximately 3200 acres of new aquatic habitat. During the initial stages of reservoir development, newly inundated soils and vegetation supply a large quantity of nutrients, yielding a great initial surge in biotic production. A large supply of food organisms, in addition to an abundance of spawning sites and a low population density, stimulates the development of large fish populations. In new Texas reservoirs, game fish (usually largemouth bass and channel catfish stocked by the State) exhibit very high growth rates during the first one to two years.[12,13] After this initial peak, a decline in game fish productivity occurs, with a concurrent increase in rough fish species, until by the fourth or fifth year they usually make up approximately 75% of the total fish weight in the reservoir.[12] The decline in the fishery is often followed by a low level of recovery and then stabilization.[12,14-16] No major reservoir in Texas, however, has been successfully rejuvenated to its original game fish productivity,[12] probably because the State has no native sport fish which is adapted to large reservoirs, with the possible exception of the white bass.

A reservoir will be more productive, in terms of aquatic biomass, than an intermittent stream, and from a fisheries management viewpoint, the impact will thus be beneficial. The creation of the reservoir is done at the cost of removing approximately 5% of the stream habitat in the two-county area. This value is based on the applicant's estimate of loss of riparian vegetation (Sect. 4.3.1.2; ER,) and on staff estimates of stream length from ER Fig. 2.5-3.

2. Flow in Squaw Creek will be maintained during construction by relocating a portion of the stream until closure of the dam. The organisms present in the cutoff segment of the channel that are not able to move into another area will be destroyed. The staff concludes that the impact of the relocation will not be significant compared with the length of stream that will be lost due to impoundment.

3. The construction of the dam will have both temporary and permanent effects on the stream biota below the dam. The temporary effects will be primarily as the result of downstream siltation arising from excavation and the movement of heavy equipment in the vicinity of the creek. Siltation could affect the biota of Squaw Creek by (a) increasing turbidity and reducing light penetration, (b) causing mechanical or abrasive damage, and (c) blanketing the stream bottom, thus smothering benthic organisms and fish eggs and eliminating habitats and spawning areas.[17-22]

It appears that there is a two-year period during which siltation from dam construction could affect lower Squaw Creek (Fig. 4.1-1, ER). This is a sufficiently long period of time that interference with the growth and reproduction of stream species could occur. All the fish in Squaw Creek are spring spawners, with some spawning beginning in winter and continuing into late summer (Table B-4).

The staff concludes that, in view of the erosion and sedimentation controls to be used by the applicant (ER, Fig. 4.[illegible]b), the effects of siltation on Squaw Creek and also in the Paluxy and Brazos rivers will be minimized. Recovery from any adverse impacts will occur after construction is completed.

Permanent effects on lower Squaw Creek will arise from alterations in flow volume, duration, and quality of the water entering the creek downstream from the dam. Upon closure of the dam, flow will be maintained below Squaw Creek Dam by diverting 1.5 cfs (1090 acre-ft per year, or 91 acre-ft per month) from the makeup line and discharging it approximately 100 yd below the dam (ER, Sect. 4.1.2.4). This flow is only 13% of the long-term average annual runoff and is less than the minimum average monthly flow of 157 acre-ft. It would be expected, however, that values less than this would occur 26% of the time (Table 2.5.1). Although this flow will probably not be sufficient to maintain the present character of the stream, the continuous releases will have a stabilizing effect by reducing the erosion and scouring associated with floods. A more stable substrate will result in higher production of periphyton and benthic invertebrates, which in turn will benefit the fish population.[23-27]

Makeup water for both Squaw Creek Reservoir and releases to lower Squaw Creek will be drawn from Lake Granbury at elevation 663, approximately

30 ft below normal surface level and 8 ft above bottom. The release water will have a total dissolved solids level of approximately 1200 ppm, will vary in temperature from 50°F in January to 82° in August, and in dissolved oxygen concentration from 10 ppm in January to less than 2 ppm from May through August.[28,29] Dissolved oxygen levels less than 1 ppm have been observed in July.

For a diversified warm-water biota, the dissolved oxygen concentration should be above 5 ppm.[30] Fish can tolerate low oxygen concentrations for limited periods of time but are stimulated to avoid them.[31,32] Persistent nonlethal levels of dissolved oxygen can adversely influence fish activity and have detrimental effects on growth rates, appetite, and larval development.[33,34]

Many aquatic insect larvae in Squaw Creek are extremely sensitive to dissolved oxygen levels (stoneflies, mayflies), while others are quite tolerant (midge larvae, *Psychoda* larvae).[35–40] Adverse effects from low-oxygen releases might occur only during summer, and it is likely that these releases will be reoxygenated within a short distance from the discharge. The staff concludes that the impact on the dissolved oxygen in Squaw Creek will not be significant.

During times of stratification in Lake Granbury, it is possible that the releases into Squaw Creek will contain hydrogen sulfide resulting from the reduction of the sulfates in the reservoir by anaerobic bacteria. Little toxicity information is available for the fish species in Squaw Creek, and data show that the effects vary widely among species. Concentrations between 1 and 6 ppm have been reported lethal to sunfish, carp, minnows, and suckers, with carp and suckers generally more resistant.[41,42] Poor channel catfish production in acid northeast Texas lakes has been attributed to the presence of sulfides, but it has also been noted that bluegill are common in acid waters where substantial amounts of hydrogen sulfide are found.[43] Reaction times to sulfides are much shorter than the survival times for sticklebacks.[31] If this information holds for other fish species, it can be assumed that if high hydrogen sulfide levels do occur below the Squaw Creek Dam, fish will avoid this area. The maximum acceptable concentration of H_2S for aquatic organisms is 0.002 ppm.[44] The oxygenation of the releases will oxidize any H_2S in the water, and the staff concludes that this will cause no significant impact.

Releases from Lake Granbury will have approximately the same temperature fluctuations as occur in the stream. Temperatures in Squaw Creek normally vary 20°C or more throughout a year. Data

for 1973 show a range of 53°F in December to a maximum of 88°F in August.[45,46] The staff concludes that there will be no adverse impact on the temperature regime in Squaw Creek.

An impact on the biota of lower Squaw Creek could result from the higher ionic content of the releases from Lake Granbury. Whereas the average total dissolved solids content of the creek is approximately 275 ppm, the releases will contain approximately 1200 ppm.

The quantity of dissolved solids influences an aquatic community in two basic ways: (1) by limiting the supply of nutrients and (2) by determining the chemical density of the water.[30,47–53]

Data available on the salinity tolerances of some fish in Squaw Creek show that species such as bluegill, bass, mosquitofish, golden shiner, and fathead minnow can tolerate salt concentrations far above 1200 ppm.[41,42,54–57]

Some of the fish species have been found over a wide range of salinities,[58,59] and most Texas freshwater fishes can live in waters with salinities above 5 parts per thousand.[58–60] Studies on rivers receiving brine wastes from oil fields, which raise the salt content of the water to and above that of seawater, show that many fish species in Squaw Creek can live in waters having salinities far in excess of those that will occur (Tables 4.3.4 and 4.3.5).[61–64] No information, however, is available on the stoneroller and the orangethroat darter, the two most abundant species.

Benthic organisms also appear to be quite tolerant of high salinities (Table 4.3.4) and should be able to adapt to concentrations in Squaw Creek.[38–40,62,65,66] Freshwater insects quickly colonize brackish ponds with salt contents up to 10,000 ppm.[36] A portion of the Big Wichita River, with total dissolved solids levels greater than twice those of Lake Granbury (2500–3700 ppm), supports a very large insect fauna, including midges, odonates, caddis flies, stoneflies, and beetles.[64]

Available data show that the aquatic macrophytes and the phytoplankton in Squaw Creek will also be able to tolerate 1200 ppm total dissolved solids.[30,39,55,67,68] The microcrustacea appear to be the least tolerant of the aquatic invertebrates (Table 4.3.4).[62,69,70]

On the basis of data which have been examined, the staff concludes that the biota of Squaw Creek will be able to adapt to the total dissolved solids concentration of the releases from Lake Granbury. The microcrustacea will be the most susceptible to adverse effects, but the 1200 ppm level appears to be within a safe range. The releases into the lower creek will be diluted by vadose and groundwater coming to the surface, and this will reduce the impact.

Table 4.3.4. Median toxicity thresholds for invertebrates and fishes in brine waters at a 96-hr exposure

Each group is in order of decreasing tolerance

Species	Median toxicity threshold (ppm)				
	Dissolved solids	Hardness (as $CaCO_3$)	NaCl	Cl	Na
Fish					
Plains killifish	23,072	4,054	18,783	12,717	6,964
Mosquito fish	15,344	2,678	12,690	8,592	4,098
White crappie	12,564	2,308	10,439	7,068	3,642
Bluegill	11,350	1,991	9,349	6,330	3,019
Green sunfish	11,330	1,961	9,349	6,330	3,019
Channel catfish	11,124	1,954	9,317	6,308	2,989
Red shiner	10,506	1,846	8,803	5,960	2,843
Black bullhead	10,300	1,810	8,569	5,802	2,767
Largemouth bass	9,476	1,665	7,346	5,380	2,746
Fathead minnow	8,858	1,557	7,212	4,883	2,329
Benthic organisms					
Cambarus (crayfish)	17,922	3,149	12,834	10,353	5,194
Dragonfly	14,832	2,606	10,620	8,568	4,298
Damselfly	14,832	2,606	10,620	8,568	4,298
Hexagenia (mayfly)	10,506	1,846	7,761	6,069	3,045
Tubificid worm	10,094	1,774	7,456	5,831	2,925
Hyalella azteca	7,828	1,376	6,048	4,522	2,269
Baetidae (mayfly)	7,416	1,303	5,478	4,284	2,149
Physa (snail)	6,386	1,122	4,530	3,689	1,851
Zooplankton					
Diaptomus clavipes	6,592	1,158	4,780	3,808	1,910
Daphnia pulex	3,708	652	2,785	2,142	1,075

Source: H. P. Clemens and W. H. Jones, "Toxicity of Brine Water from Oil Wells," *Trans. Amer. Fish. Soc.* 84: 97–109 (1954).

Table 4.3.5. Highest concentration in which fish species was collected

Species	Chloride concentration (ppm)	
	Clemens and Jones	Lewis
Plains killifish	19,520	29,975
Red shiner	8,319	4,295
Fathead minnow	7,859	4,295
Green sunfish		3,816
Black bullhead		2,201
Largemouth bass		1,384
Channel catfish		1,384

Sources: H. P. Clemens and W. H. Jones, "Toxicity of Brine Water from Oil Wells," *Trans. Amer. Fish. Soc.* 84: 97–109 (1954); L. D. Lewis, "A Story of the Effects of Salt Water on Fresh-Water Fish in the Big Wichita River System," mimeographed report to board of directors of Wichita County Water Improvement Districts No. 1 and 2, Texas, pp. 1–8, 1952, as reported by Clemens and Jones.

Another factor related to the construction of the dam is the possibility that Squaw Creek Reservoir might overflow into Squaw Creek through the emergency spillway during periods of excessively high rainfall. The applicant has estimated that the average occurrence of a spill is once in 150 years (ER, p. 3.4-1a). The only spill occurring during the reservoir operation study,[71] which covered the period from 1948 through 1971, was one of 1,536-acre-ft in May of 1957. This overflow would be greater than the total annual release into the stream and would have a total dissolved solids level of 2500 ppm which is twice that of releases from Lake Granbury. The probability of a spill is so remote, however, that the effects are considered to be minimal.

4.3.2.2 <u>Construction of the diversion pump station and return line outlet on Lake Granbury</u>

Impacts of the construction of the diversion pump station and return line outlet on Lake Granbury will arise from dredging and the associated turbidity and siltation. The amount of material disturbed for the diversion pump station will be 3000 cu yd (1 acre of bottom) and that for the return outlet will be 400 cu yd (0.1 acre) (ER, Amendment 2). A total of 1.1 acres of benthic habitat will be affected, which is only 0.013% of the total bottom area of the lake (8500 acres). The organisms within the immediate area will be destroyed by the construction process. The benthic population in this area, however, is so low compared with the rest of the lake[29] that the effect is estimated to be negligible.

Siltation will be a temporary impact arising from construction. The effects in Lake Granbury will be the same as those described above for Squaw Creek. Although adults can move out of the affected area, many of the common fish species in the lake spawn over aquatic vegetation and have eggs that adhere to plants (Table B-4). Although spawning activity in the area is probably limited (refer to Sect. 2.7.2.2), any that might occur will be affected if shoreline vegetation is covered with silt. If a maximum of 1% of spoil material drifts away from the dredging site,[72] this will amount to only 34 cu yd, which would cover an area of only 0.25 acre to a depth of 1 in. The staff considers this impact to be negligible.

The construction of the facilities on Lake Granbury will result in some shoreline erosion, which will add to the siltation effects of construction. The major construction activity will occur within 200 ft of the shore. During the spring and early summer, increased densities of adult fish might be in nearshore waters, and the more susceptible eggs and larvae might also be present. During the summer, the bottom of Lake Granbury has a low dissolved oxygen content or is completely anaerobic, and increased siltation would aggravate this condition.

If preconstruction surveys indicate that spawning does occur in this area, adverse impacts would be reduced if construction activities were minimized during the spring and summer months (Refer to Sect. 11.6.5).

4.3.2.3 Initial filling of Squaw Creek Reservoir

Of the water needed to fill Squaw Creek Reservoir, 96% will be diverted from Lake Granbury (ER, Sect. 5.1.3). The conservative estimate estimate is that the filling process will take 36 months and require a total of 158,400 acre-ft of water from Lake Granbury at 4400 acre-ft/month (ER, Sect. 3.3). Assuming a volume of 155,000 acre-ft for Lake Granbury,[29] the filling of Squaw Creek Reservoir will thus require more water than the total volume of Lake Granbury, although it will be withdrawn at a rate of only 3% per month.

In the area of the diversion structure, maximum phytoplankton and zooplankton populations (averaged over depth) have been found to be 9,900,000 organisms/liter in July and 42 organisms/liter in May.[29] A conservative total of organisms withdrawn from this area of Lake Granbury for the filling of Squaw Creek Reservoir is thus

1.93×10^{18} phytoplankters and 8.19×10^{12} zooplankters. Using limited data on plankton compositions,[29] cell volumes,[73] zooplankton weights,[74] and comparative species sizes,[36,75] the staff calculated the withdrawal to be equivalent to 30,000,000 lb of phytoplankton and 1,100,000 lb of zooplankton. Based on the average plankton populations of the entire lake (refer to Sect. 2.7.2.2), staff estimates find these quantities to be 171% of the phytoplankton population and 46% of the zooplankton population of Lake Granbury over the 36 months, or 4.75% of the phytoplankton per month and 3.8% of the zooplankton per month. Most of these withdrawals will be made only during periods of high flow (ER, Sect. 4.1.2.5), and the staff concludes that the impact on the biota will not be significant.

4.3.2.4 Brush-clearing

In addition to the effects on Squaw Creek and Lake Granbury, the brush-clearing scheduled to be carried out during preparation of the reservoir bed will have a potential effect on the aquatic production possible in Squaw Creek Reservoir. The procedure to be followed (ER, Sect. 4.3.1.2; Sect. 4.1.1.1.2) reduces the possibility of high nutrient buildup resulting from vegetation decomposition after inundation;[76,77] however, the presence of standing timber or brush shelters can improve the fishery in the reservoir. Fish apparently are attracted either by the shelter or spawning habitat provided or by the food organisms which become attached to the vegetation.[11,77-81]

It appears that productivity could be enhanced by leaving timber standing in arms of deep reservoirs.[82] Since the reservoir will not have a large littoral area for benthic production and fish spawning, it is the recommendation of the staff that vegetation be left standing in some coves to provide this type of habitat (Refer to Sect. 4.3.1.2).

4.4 IMPACTS ON PEOPLE

The applicant sponsored extensive studies on the economic and social effects of plant construction and reported the results in Sects. 4 and 8 of the ER and in a Supplemental Report.[1]

4.4.1 Physical impacts

The applicant estimates that within the CPSES site there are no more than 40 persons in perhaps six to eight farm households that will be displaced by the project and believes that the proposed alignments of the rights-of-way for the railroad, road, pipelines, and transmission lines have been located in such a way that no additional farm homes and households will be displaced (ER, Sect. 4.1.1.3).

Construction activity, particularly in the early stages of site preparation, will involve clearing, heavy excavation, and grading. These activities will be accompanied by blasting, some reduction of local air quality, and potential for water pollution. The site is sufficiently remote that the noise of blasting and machinery should be only a minor nuisance to local population. The air pollution resulting from airborne dust and possibly smoke may at times (depending on season and daily weather conditions) create a nuisance for short periods to local inhabitants (ER, Sect. 4.1.1.3).

The applicant indicated in the ER (p. 4.1-16) that construction activity potentially could have a serious impact on local water quality. Pollution of groundwater resources, as well as surface stream flows, will be controlled. With the large concentration of workers at the site, provisions must be made for sanitary treatment and disposal of sewage to preclude any pollution of water resources. The applicant is aware of this and must obtain a permit for sewage disposal from the State of Texas Department of Health.

Truck traffic of construction material was discussed in Sect. 4.1. In addition, the construction workers (1150 average for peak year) will greatly increase the traffic in the area. The impact on the local roads, as previously discussed in Sect. 4.1, will be significant. The frequency of accidents is expected to increase during the peak period of construction. The makeup and blowdown pipelines will cross State Highway 144, and there will be a short period of traffic slowdown for this construction. The construction of the railroad spur will affect traffic on Farm-to-Market Road 51 where they cross. Much of the construction traffic will go through Glen Rose. Fortunately, the main road through Glen Rose bypasses the principal business and residential section of this small community.

The staff concludes that the applicant is aware of the physical impacts and is capable of reducing them to an acceptable level.

4.4.2 Population growth and construction worker income

The applicant has estimated the distribution of the residences of the project work force in 1975 (ER, Table 8.1-7). It is estimated that 25% of the work force will reside in Somervell and Hood counties, that another 25% will live in adjacent counties, and that the rest will be residents of other more distant counties

in the region (see Fig. 2.1.1). Of the total estimated work force, an estimated 770 would be from within the region (670 from outside Somervell and Hood counties — mainly from Fort Worth and Dallas); only 100 would come from Somervell and Hood counties. About 330 employees, or 30% of the total, would move into the region from more distant areas (as other major projects terminate in those areas), and most of these would relocate in Somervell and Hood counties. It is estimated that 35 "local hires" and 75 relocated employees would reside in Somervell County and that 65 "local hires" and 100 relocated employees would reside in Hood County. Using the Texas statewide average of 3.17 persons per household, the increase in population would be 238 in Somervell County and 317 in Hood County. The estimated increase in school-age children would be 44 in Somervell County and 59 in Hood County.

It can be shown that the increase in population resulting from the influx of construction workers is only about one-fourth of the expected annual increase in Hood County but is about two and one-half times that expected in Somervell County. The number of construction workers will decrease after 1977.

The estimated project annual payroll within the six-county area and that outside in the expected peak construction year is given in Table 4.4.1.

The staff concludes that the growth and income will be most significant in Somervell and Hood counties. The resulting impacts are assessed in the following subsections.

4.4.3 Impact on community services

The availability of housing in Hood and Somervell counties and the surrounding four counties (see Fig. 2.1.1) was studied and the results reported.[1] There is predicted to be available housing in the six-county area for those (about one-half of the total) construction workers expected to live in this area. Many of the workers will live in mobile homes. The development of mobile home parks has been slow in Somervell County. Glen Rose has one with about 100 spaces for transients and 65 spaces for permanent renters. Another park with 120 spaces is being planned. A 12-unit apartment house is under construction in Glen Rose, the first in town. Granbury has four apartment houses with a total of about 40 units.

The availability of domestic water and sewage disposal in Hood and Somervell counties was also studied and reported.[1] The Granbury municipal water system is considered adequate for that city's

Table 4.4.1. Estimated project payroll contributions to disposable income in region during CPSES construction phase for peak year and total

In thousands of dollars

Area	1977	Total for all years
Local impact area		
Somervell County	$ 1,681.5	$ 9,811.1
Hood County	2,522.2	14,716.5
Parker County	1,151.8	6,720.6
Johnson County	1,219.1	7,113.1
Bosque County	916.4	5,347.1
Erath County	916.4	5,347.1
Subtotal	$ 8,407.4	$49,055.5
Other counties in region[a]	$ 8,407.3	$49,055.4
Total region	$16,814.7	$98,110.9

Note: Estimates derived from employment schedule and wage rates developed in Sect. 8.1.3 of ER on basis of data provided by Brown & Root, Inc. (general contractors for the CPSES), and on projected location of construction worker residences (see Sect. 8.1.3.1-b and Table 8.1-7 of ER), which were prepared on the basis of field survey and contractor-supplied data. Values for disposable income were derived from ER Table 8.1-6; payrolls were reduced by 21% to account for withheld taxes, social security contributions, and other elements of nondiscretionary wage income.

[a]Other counties are Tarrant, Dallas, McLennan, and Hill, as shown in Fig. 2.1.1.

Source: ER Table 8.1-3.

needs during the construction period. The city has no plans to extend water service beyond city limits. The Granbury sewage system, which was designed for a population of 5000, may require expansion during the construction period. The new Hood County residences outside of Granbury will have to rely on individual wells or water systems provided by developers and on septic tanks for sewage disposal.

The planned expansion of the Glen Rose municipal water supply will provide adequate capacity during the CPSES construction period. The sewage system in Glen Rose is currently operating at capacity. Any new Glen Rose residences will require additional sewage capacity and an extension of the water and sewage lines. The new Somervell County residences outside of Glen Rose will have to rely on individual water systems and septic tanks.

Glen Rose shares a common dump with Somervell County for solid waste disposal. Granbury does likewise with Hood County. Only the cities provide collection service.

The law enforcement staff in both Hood and Somervell counties will require expansion, in particular to maintain traffic control necessary during construction.

The CPSES project construction should not add significantly to the fire protection facility requirements in Hood County. There will be a need for an increase in facilities in Somervell County during construction of CPSES.

One major impact on county and city services in Hood and Somervell counties is road maintenance. The traffic and loads will increase by an order of magnitude over current levels on FM 201. State highway 144 and Federal highways 67 and 377 will also have increased traffic levels. The Texas Highway Department plans to improve FM 201 to accommodate an increased load.

The staff concludes that there will be a need for increased services in Somervell and Hood counties. The financing of the increased services is discussed below.

4.4.4 Impact on local institutions

The applicant will pay property taxes on CPSES to the following local taxing jurisdictions within Hood and Somervell counties: County of Hood, Granbury Independent School District, Tolar Independent School District, County of Somervell, and Glen Rose Independent School District. The State of Texas law forbids one taxing jurisdiction from transferring tax revenues to another. Accordingly, should a city, which does not include CPSES within its boundaries, experience indirect costs attributable to activities of the station, there is no provision for the county government to divert tax revenues paid by the applicant on the CPSES facilities within the unincorporated areas of the county. The CPSES construction effort will have significant indirect impacts on the cities of Glen Rose and, to a lesser extent, Granbury, but neither community has taxing authority with respect to the plant. The State law does, however, permit counties to provide various services within incorporated city limits, including those relating to streets, waste disposal, water and sewage treatment, and hospitals (ER, Sect. 8.1.4.1).

The applicant states that preliminary information indicates that the total valuation of the CPSES will approximate $577,896,000 when completed. With valuation assessed at 20% (for county and

State tax purposes), the CPSES would have a tax valuation of $115,579,000. Without further adjustment to this valuation, this would mean that CPSES would have a tax valuation more than ten times as great as the present valuation of Somervell and Hood counties combined (ER, Sect. 8.1.4.3). In addition there would be a tax liability on the railroad spur and the transmission lines associated with CPSES. There will be an increase in tax revenues as construction progresses, but in the first few years the revenues may not be sufficient for the increased services needed.

The applicant mentioned (ER, Sect. 8.1.4.4) that the shortfalls in revenues in Glen Rose are most likely to arise in connection with the extension of water and sewer lines to new housing developments and, possibly, with the servicing of new debt incurred to finance the expansion of water and sewage facilities. The potential cost of these, much of which will be attributable to CPSES, is not known. At the minimum, several hundred thousand dollars of capital outlay will be involved. The city had $87,000 in outstanding general obligation bonds as of March 1973, amounting to almost 6% of the current assessed value of real and personal property in the city. No revenue bonds or floating debt is outstanding. Total income of the water and sewer system in 1972 was $48,000 (ER, Sect. 8.1.4.4).

The City of Glen Rose may be able to take advantage of the State law that permits a county government to provide the services mentioned previously. This approach would thus permit some of the CPSES-generated Somervell County tax revenues to be used directly in meeting increased community service requirements in Glen Rose generated by CPSES workers. The same might be true for the city of Granbury and Hood County.

Hood County will also receive considerable tax revenue from the applicant on the De Cordova Steam Electric Station.

The Glen Rose and Granbury Independent School Districts will be able to accommodate the increased enrollment expected during the construction of CPSES.[2,3] Small increases in enrollment will occur in the Tolar Independent School Districts and are also expected to be accommodated.

The staff visited with local officials of Somervell and Hood counties during a site visit[4] in August 1973. The officials of both counties were aware of the potential local impacts which might result from construction of CPSES. The sentiment and attitude expressed appeared to be in favor of the station.

The applicant notes in the ER that in Somervell and Hood counties there is some risk that the proximity of this number of construction workers may overstimulate expansion of such activities as retail sales, mobile home park development, and various other consumer services. In such a situation the decline in induced income and employment as CPSES construction work diminishes may impose hardships on local residents if not compensated for by other factors. It is believed, however, that careful planning by civic leaders and businessmen will forestall the adverse impacts of such changes on the local economy (ER, Sect. 8.2.2.3).

The U.S. Department of Agriculture, Soil Conservation Service, states in an environmental statement[5] on the Paluxy River Watershed, Erath, Hood, and Somervell Counties, Texas, that:

> "The basic problems related to the economic sector are the high unemployment rate and the extent of underemployment, especially in the agricultural sector. There is a definite need for expansion and development of employment opportunities in the watershed area."
>
> "About 16 percent of the families in the 3-county watershed area were listed in the below poverty level class in the 1970 census. An expansion of the local economy is needed to raise income levels, especially those of the families now below the poverty level."

The staff concludes that the applicant has identified the major impacts and has shown the capability[3] of insuring that local jurisdictions receive financial aid in sufficient time to provide the services required for CPSES construction-related effects to the extent that the impacts will be acceptable .

4.4.5 Impact on recreational capacity of area

Squaw Creek Reservoir could have facilities available after it is filled for daily recreational visitor use, but the applicant states in the ER (ER, Sect. 8.1.5) that the area surrounding the reservoir would not be available to development of water-oriented housing as in the case of Lake Granbury. The general policy of the applicant is to make a reservoir available to governmental agencies for recreational development, provided that all developments and uses are fully compatible with the primary purposes of power generation and water resource management. For additional discussion of the nature of demand for water-oriented recreational facilities in the greater Dallas-Fort Worth region, see Sect. II of the Supplemental Report.[1]

Construction of the intake and discharge facilities for the makeup and return pipelines to Squaw Creek Reservoir will only affect recreational use in Lake Granbury for a short time in the construction area.

Withdrawal of water from Lake Granbury will be avoided as much as possible during low-flow periods. Major fluctuations in level of water in the lake with the filling of Squaw Creek Reservoir will thus be averted (ER, Sect. 4.1.2.7).

The staff concludes that there will be no significant impact on recreation during construction.

4.5 MEASURES AND CONTROLS TO LIMIT ADVERSE EFFECTS DURING CONSTRUCTION

4.5.1 Applicant commitments

The following is a summary of the commitments made by the applicant to limit adverse effects during construction of the proposed station. References are to the Environmental Report.

1. Measures will be taken to minimize the sedimentation and contamination of lower Squaw Creek during site preparation and construction.

   a) Drainage from borrow areas, fills, etc., will be controlled by ditches, berms, and sedimentation basins (ER, p. 4.1-3).

   b) Selectively placed shallow trenches will be used to minimize erosion from cleared areas (ER, p. 4.1-4).

   c) Local drainage and runoff control will be used in the area of dam construction (ER, p. 4.1-3).

   d) Temporary impoundments will control direct pollution and sediment flow into lower Squaw Creek (ER, p. 4.1-3).

   e) Sanitary treatment and disposal facilities for sewage will be provided.

2. Upon closure of the dam, lower Squaw Creek will receive sufficient water to preserve the present character of aquatic life. This will be accomplished by maintaining a flow of 1.5 cfs in lower Squaw Creek. (ER, p. 4.1-20).

3. Withdrawal of water from Lake Granbury for filling of Squaw Creek Reservoir will be avoided to the extent possible during low flow periods (ER, p. 4.1-23).

4. Attempts will be made to minimize the extent, density, and duration of dust dispersal (ER, p. 4.1-3a).

5. Rock and earth fill for the dam will be obtained from the reservoir site to the maximum extent possible, thus minimizing the construction impacts on the areas surrounding the reservoir (ER, p. 4.1-4).

6. Waste materials from transmission line construction will be properly disposed of offsite (ER, 4.2-6).

7. Little, if any, permanent access road construction will be necessary for transmission line construction and maintenance (ER, 4.2-6).

8. Vehicle movements along transmission line rights-of-way will be handled in a way to minimize effects that could cause erosion, retard restoration of ground cover, or preclude resumption of agricultural use (ER, 4.2-6).

9. During transmission line construction and operation, no widespread chemical spraying will be done and the use of herbicides will be carefully controlled (ER, p. 4.2-6).

10. Vegetation clearing along transmission line rights-of-way will be limited and selective (ER, p. 4.2-6).

11. Whenever possible, transmission line routing will avoid clumps of mature junipers, the nesting sites of the golden-cheeked warbler (ER, p. 4.2-5a and 5b).

12. Transmission line rights-of-way will be replanted to restore ground cover and agricultural use (ER, p. 4.2-6).

13. Right-of-way routes for pipeline relocations and diversion pipelines will be reseeded with native or adaptive grasses for erosion control or returned to cultivation (ER, pp. 4.1-6a and 8).

14. Most of the surface area of the plant site will be improved and planted following construction (ER, p. 4.1-3).

15. Vegetation will be cleared from the reservoir site and burned, and the residue will be buried at least 18 in. deep. All required permits to burn vegetation will be obtained, and burning will be done only under favorable conditions, with a continuous fire watch and adequate extinguishing facilities (ER, p. 4.1-3).

16. Dam construction will be controlled in a way to facilitate rehabilitation and replanting of disrupted areas around the dam (ER, p. 4.1-5).

17. A program for preservation or excavation of archaeological sites will be initiated with State agencies (ER, p. 4.1-17).

18. Truck operations will be handled and scheduled in such a way as to minimize impacts on or interference with local traffic movements (ER, 4.1-4a).

19. Traffic control measures will be implemented as required to control truck traffic and assure safe operations in the vicinity of small local communities (or concentrations of houses), presently uncontrolled intersections in rural areas, and school bus pickup points (ER, 4.1-4a).

20. The alignment of the railroad right-of-way will also minimize effects on field patterns (ER, p. 4.1-5a).

21. The applicant will initiate an inspection program to assure that the dam is built according to specifications and in compliance with the rules and regulations of the Texas Water Rights Commission (ER, pp. 7.2-4 and 5).

22. The applicant will cooperate with the appropriate state agencies to develop plans for reforesting the Squaw Creek Reservoir shoreline (Refer to Sect. 11.3.2(2)).

4.5.2 Staff evaluation

Based on a review of the anticipated construction activities and the expected environmental effects therefrom, the staff concludes that the measures and controls committed to by the applicant, as summarized above, are adequate to ensure that adverse environmental effects will be at the minimum practicable level if combined with the following additional precautions:

1. During construction on the station site, extensive seeding programs shall be undertaken for preventive erosion control. For seeding of areas temporarily disturbed, use of certain horticultural varieties may be most effective. For permanent

seeding, native prairie grasses are preferable. Seeding with native grasses will be effective in long-term erosion control as well as determining the initial course of succession of the vegetation community (refer to Sect. 4.3.1.1).

2. Brush clearing of small, dense juniper and mesquite thickets shall be done in areas disturbed during site preparation and construction so as to promote where possible the growth of prairie grasses (refer to Sects. 4.3.1.2 and 11.5.10).

3. In areas where excavation operations remove topsoil and replace it with subsoil, organic matter or selected fertilizers shall be added as necessary to correct subsoil deficiencies and thus promote revegetation (refer to Sect. 4.3.1.3).

4. During the first year of construction, the applicant shall make monthly turbidity and total suspended solids measurements in lower Squaw Creek to determine the effectiveness of erosion and runoff controls. If the results of this monitoring indicates that the erosion and runoff controls are not limiting siltation in lower Squaw Creek, the applicant shall consult with the Texas Department of Parks and Wildlife to determine whether corrective actions (such as reduced construction activity) are necessary to mitigate adverse impact on spawning in Squaw Creek.

5. Vegetation shall be left standing in some coves of the reservoir to provide habitat for benthic organisms and for fish spawning and shelter. The amount of clearing will be consistent with the recommendation of the Texas Parks and Wildlife Department (refer to Sects. 4.3.1.2 and 4.3.2.4).

6. All debris shall be cleared from the stream below the dam after construction is completed (refer to Sect. 4.1.2).

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5. ENVIRONMENTAL EFFECTS OF OPERATION OF THE STATION AND TRANSMISSION FACILITIES

5.1 IMPACTS ON LAND USE

5.1.1 Station operation

The primary impact on land use will be the change in 3228 acres from agricultural use to a cooling reservoir. The restriction of use of the remaining land in the 8876-acre site is also of concern. The breakdown of the land use is given in Table 5.1.1. The previous use of this land and the impacts of construction were discussed in Sects. 4.1 and 4.3. About 940 acres of the land covered by the reservoir is cropland. About 100 acres of the land in the railroad spur and access road rights-of-way is cropland. The cropland under the transmission lines and over the pipelines is considered by the staff to still be useful for crop production.

Table 5.1.1. Impact on land use during operation of CPSES

Facility	Acres
Station site (not including reservoir)	350[a]
Buildings, 8 acres	
Switchyard, 12 acres	
Evaporation pond, 12 acres	
Squaw Creek Reservoir (at 775 ft above MSL)	3228
SCR dam	60
Transmission lines (400 + 39[b])	439[c]
Railroad spur (169 + 16[b])	185[c]
Access road (10 + 9[b])	19[c]
Makeup pipeline (15 + nil[b])	15[c,d]
Blowdown pipeline (15 + 10[b])	25[c,d]
Subtotal	4321
Land owned by applicant in 8876-acre site but not covered by above CPSES facilities	5164
Total land	9485

[a]400 acres less 50 acres within rights-of way.
[b]Within 8876-acre site.
[c]Total within right-of-way including that on the site.
[d]Underground.

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Rangeland predominates in the area, occupying 60% of the area covered by the reservoir and 71% of the land surrounding the reservoir. The value of agricultural production estimated for the year 1973 on the reservoir site is $151,300. That on the station site is estimated to be $9,900. That on the railroad spur and access road areas is estimated to be $5,000. The total of about $166,000 compares with the 1971 combined crop and livestock sales of $6,841,000 in Somervell and Hood counties (ER, Tables 2.2-7 and 2.2-8). The staff does not feel that this loss is significant.

About six to eight farm households will be displaced from the site. The number of people affected represents less than one-half of one percent of the population of Hood and Somervell counties.

5.1.2 Transmission lines

The transmission lines will result in the continued use of 439 acres of land described in Sect. 4.1. The crop production under the lines is not expected to be significantly affected. There will be a loss of about 72 acres of woodland. There will be some aesthetic impact on a 250-acre residential area in the planning stages. The applicant has routed the lines around this area to reduce the impact.

5.2 IMPACTS ON WATER USE

5.2.1 Surface water

During operation, CPSES will withdraw a maximum of 64,660 acre-ft/year (an average of 52,600 acre-ft/year) from Lake Granbury and will return approximately 26,400 acre-ft/year. There will thus be a maximum consumptive use of 38,260 acre-ft/year, which, assuming a volume of 155,000 acre-ft for Lake Granbury,[1] is 24% of the lake's volume. According to Table 2 of ref. 2, the 1971 runoff to Lake Granbury was 395,466 acre-ft. The maximum consumptive use will thus be 9.7% of the average annual flow into the lake. This withdrawal is covered by the applicant's allocation from the Brazos River Authority and has been approved by the Texas Water Rights Commission (ER, Sect. 3.4.4).

The operation of CPSES will not have an adverse impact on recreational use of Lake Granbury. The area of the diversion and return facilities will be closed off, but since the return discharge will lie in the area just above De Cordova Bend Dam which is already closed to boating, this should not hamper recreational activity. The changes in water quality in a small area adjacent to the blowdown discharge will not adversely affect water use in Lake Granbury (refer to Sect. 5.5.2).

Squaw Creek Reservoir will have potential for recreational use. The reservoir will be made available to the Texas Parks and Wildlife Department for recreational development, but plans are still in the preliminary stages.[3]

The use of surface water fr[illegible] the Brazos River and tributaries requires the authorizat[illegible] [illegible]e Brazos River Authority and the Texas Water Rights Commis[illegible] [illegible]se regulatory organizations have been assured that adequa[illegible] [illegible]ies exist to provide an annual yield at Lake Granbury of [illegible] acre-ft, coincident with other lawful uses authorized by these [illegible]rganizations. Of this yield, about 38,000 acre-ft would be used by CPSES.

The staff has also reviewed the applicant's analyses of water supply. At the staff's request, the applicant provided details of the water availability studies (ER, Sect. 3.4.4).

Under the 1950-1957 drought conditions (incl[illegible]es the most severe conditions of record) and the applicant's assumptions (ER, Sect. 3.4.4), Lake Granbury would provide a firm yield of 70,000 acre-ft per year while utilizing only the upper 51% of the available conservation storage volume.

The staff concludes that there will be a sufficient supply of water for the operation of CPSES during a drought at least as severe as the drought of record. The issuance of a permit by the local and State regulatory bodies to consumptively use water implies equitable apportionment of surface water.

5.2.2 Groundwater

The applicant reported that the CPSES will utilize about 330 gpm from the Twin Mountain formation, which underlies the station (PSAR, Amendment 4, Sect. 2.4.13.2). The applicant has not yet adequately documented the capability of the formation to yield the required supplies without adverse effects. Examples of adverse effects could include (1) excessive drawdown, thus denying supplies to neighboring wells, and (2) demand that exceeds the safe yield of the aquifer.

The applicant has concluded that adverse effects, such as mentioned above, would not occur. The staff has insufficient data with which to concur. The staff has required well testing to support the applicant's contentions. The results of the test(s) would identify the zone of influence of the well field and its potential for adversely affecting neighboring wells and will aid in establishing the safe yield of the aquifer. Since groundwater mining would be unacceptable to the staff, the applicant would be required to obtain water from other sources (refer to Sect. 11.6.?).

5.2.3 Water quality standards

Texas Water Quality Board standards,[4] which are approved by the Region VI Environmental Protection Agency Office, indicate there are no temperature requirements for privately owned reservoirs that are constructed principally for industrial cooling purposes and are financed by the entity. Squaw Creek Reservoir is such a water body.

The standards state that the Lake Granbury temperature cannot exceed 93°F. This temperature is defined as the average temperature from the surface to the bottom of the lake outside of the mixing zone except the times when the lake is stratified. When the lake is stratified, these standards state that this temperature is the average in the epilimnion, that is, the average from the surface to the thermocline. The thermocline is defined to be the plane of the maximum rate of temperature decrease. This standard is met readily for the CPSES since both the applicant's analyses (discussed in Sect. 5.3.1) and the staff's analysis (discussed in Sect. 5.3.2) show that during the summer months, the water being returned to Lake Granbury from Squaw Creek Reservoir will have lower temperatures than the ambient lake temperatures.

The Texas Water Quality Board standards[4] also state that for freshwater impoundments, such as Lake Granbury, the temperature rise beyond the mixing zone cannot exceed 3°F. The standards state that normally the mixing zone should be limited to no more than 25% of the cross-sectional area and/or the volume of the flow of the stream, leaving at least 75% free as a zone of passage. Both the applicant (Sect. 5.3.1) and the staff (Sect. 5.3.2) showed that the water discharging into Lake Granbury from Squaw Creek Reservoir will be mixed essentially within 200 ft of the point of discharge. Less than 10% of the river cross-sectional area and/or flow volume would be affected, and the standards would be met.

The staff also evaluated the chemical alteration resulting from operation of CPSES on Squaw Creek Reservoir and the resultant blowdown effect on Lake Granbury. The staff concludes that CPSES and Squaw Creek Reservoir can be operated in a manner that will permit compliance with the above standards.

5.3 EFFECTS OF OPERATION OF HEAT-DISSIPATION SYSTEM

5.3.1 Applicant's thermal analyses

A number of studies have been performed by the applicant predicting the behavior of Squaw Creek Reservoir and its impact on Lake Granbury during the operation of the Comanche Peak Steam Electric Station.[1-7] The most recent study of Squaw Creek Reservoir behavior predicted the temperature distributions in the reservoir water using hydrological and meteorological data for a "normal" year (1971) and a "drought" year (1956).[5] Vertical temperature distributions in the reservoir were determined by the method of Orlob and Selna[8,9] using diffusion constants determined from temperature profiles measured in Lake Granbury.[4]

Assuming that the station circulating water intake is at 748 ft above mean sea level and the blowdown line inlet is at 720 ft above mean sea level,[4] the applicant found that the reservoir surface and circulating water intake temperatures would reach their maximum about the end of August. The values of these temperatures and the dates on which they would have been reached are shown in Table 5.3.1. Two cases were calculated for each of the years considered. One was for 100% of the induced heat load over 100% of the surface and the other was for 70% of the induced heat load over 88% of the surface. Differences in temperature for these variations in heat load are not great. The temperatures for the drought year 1956 would be lower than those for the normal year 1971 since the rate of water evaporation is higher during a drought year, resulting in lower pond temperatures. Variation of these and the blowdown water temperatures for the normal year with 70% of the induced

Table 5.3.1. Predicted maximum Squaw Creek Reservoir surface and circulating water intake temperature

Case	Date	Temperature (°F)	
		Surface	Circulating water intake
1971 – 100% heat load over 100% of surface area	August 28	96.4	94.6
1971 – 70% heat load over 88% of surface area	August 28	94.1	92.4
1956 – 100% heat load over 100% of surface area	August 16	91.7	90.5
1956 – 70% heat load over 88% of surface area	August 16	90.4	89.1

Source: J. H. Duke, Jr., *A Technical Assessment of the Impact of the Comanche Peak Steam Electric Station on the Proposed Squaw Creek Reservoir*, report prepared by Water Resources Engineers, Inc., for Texas Utilities Services, Inc., Nov. 15, 1973.

heat load over 88% of the surface are shown in Fig. 5.3.1. Predicted vertical temperature profiles for different days are shown in Fig. 5.3.2. The effect of increasing the load factor of the station to 1.00 on the reservoir surface temperature is shown in Table 5.3.2.

Table 5.3.2. Increase in Squaw Creek Reservoir surface temperature due to increasing plant load factor to 100% on August 1

1971 year case with 70% heat load over 88% of surface area

Date	Surface temperature (°F)		Temperature increase (°F)
	For Table 3.3.1 plant factors	For 100% plant factor	
July 29	89.2	89.2	0.0
August 28	94.1	95.6	1.5
September 27	85.2	86.7	1.5
October 27	78.0	81.4	3.4
November 26	66.8	72.0	5.2
December 26	60.7	67.3	6.6
December 31	61.1	68.5	7.4

Source: J. H. Duke, Jr., *A Technical Assessment of the Impact of the Comanche Peak Steam Electric Station on the Proposed Squaw Creek Reservoir*, report prepared by Water Resources Engineers, Inc., for Texas Utilities Services, Inc., Nov. 15, 1973.

Surface temperature distributions for Squaw Creek Reservoir were calculated for the station operating during the normal year.[5] The applicant assumed that all of the heat gained by the circulating water passing through the station would be dissipated at the pond surface in these calculations. The near-field water behavior was assumed to be that described by the model of Stolzenbach and Harleman,[10] and the far-field water behavior was assumed to be that described by the model of Masch and Associates.[11] Interfacing between the two regions was assumed by the applicant to be the point where the surface temperature gradients predicted by the two models are identical.

Results of the applicant's calculations using these models for a normal year (1971) are shown in Fig. 5.3.3. The Squaw Creek Reservoir surface temperature profiles for August 1971 are predicted to be those shown in Fig. 5.3.4. The station circulating water

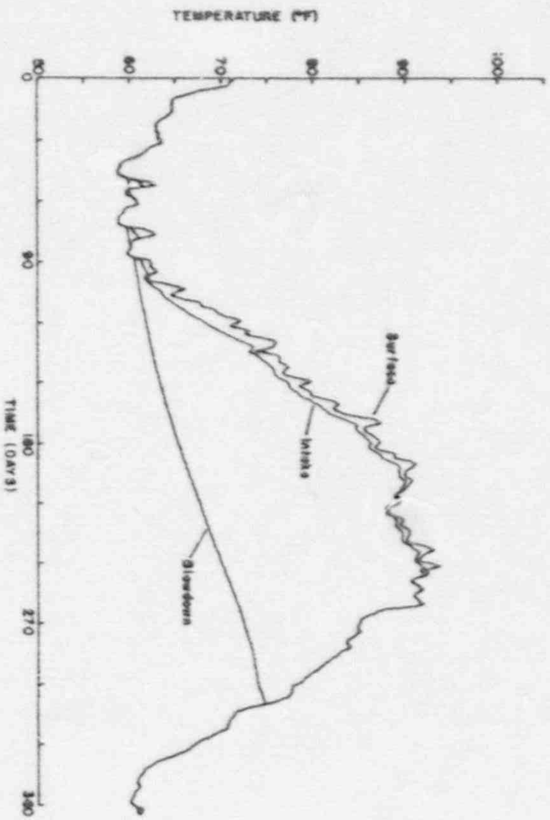

Fig. 5.3.1. Temporal variation of temperature in Squaw Creek Reservoir for 70% heat load dissipated over 88% of surface area. (Normal year)
Source: J. H. Duke, Jr., "A Technical Assessment of the Impact of the Comanche Peak Steam Electric Station on the Proposed Squaw Creek Reservoir," report prepared by Water Resources Engineers, Inc., for Texas Utilities Services, Inc., Nov. 15, 1973, Fig. 5, Part A

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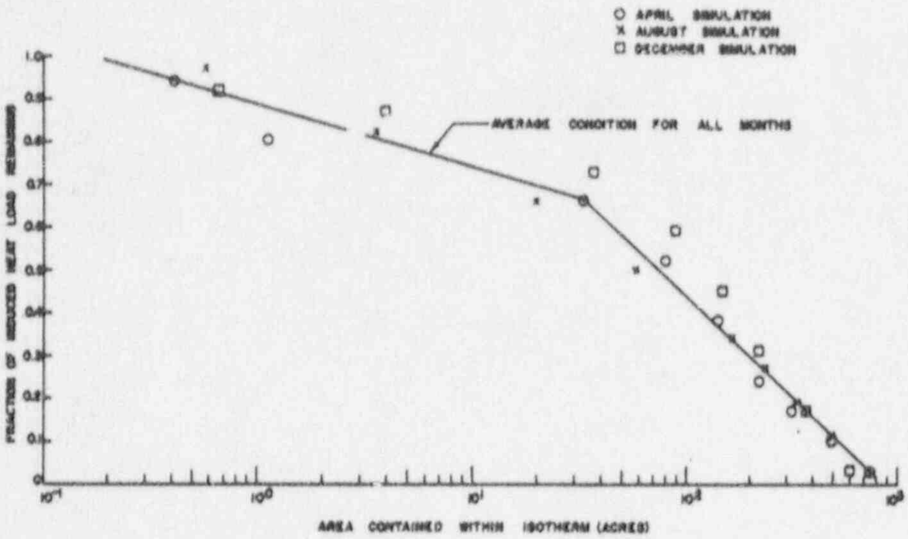

Fig. 5.3.3. Relation of residual heat load to surface area of Squaw Creek Reservoir.
Source: J. H. Duke, Jr., "A Technical Assessment of the Impact of the Comanche Peak Steam Electric Station on the Proposed Squaw Creek Reservoir," report prepared by Water Resources Engineers, Inc., for Texas Utilities Services, Inc., Nov. 15, 1973, Fig. 13.

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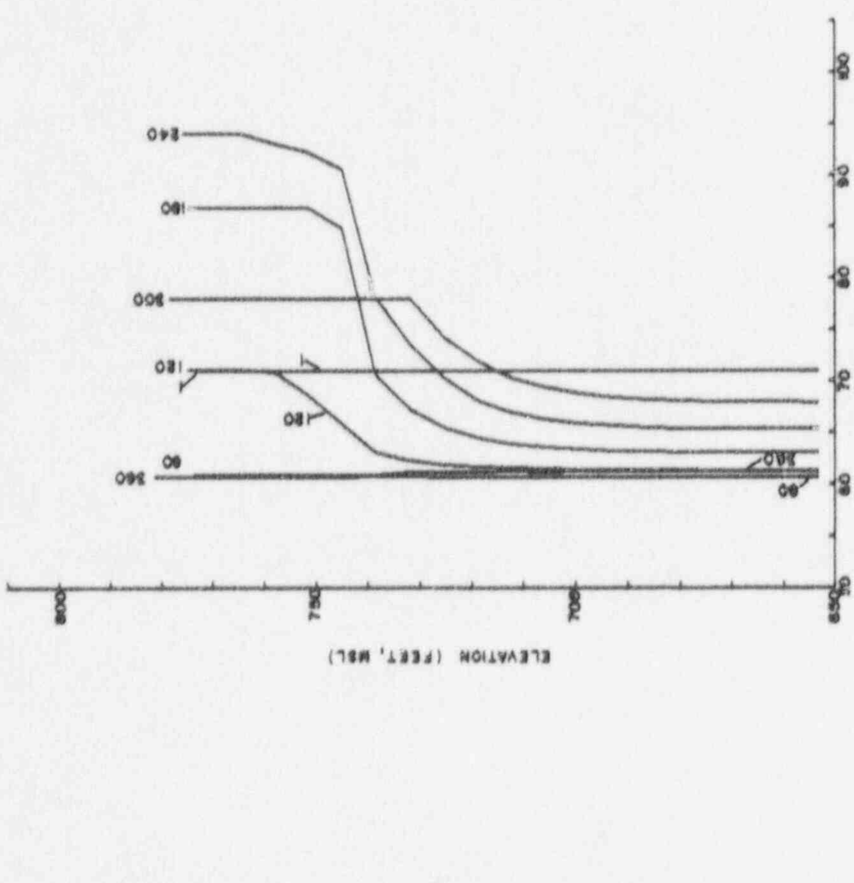

Fig. 5.3.2. Vertical reservoir temperature distribution for 70% heat load dissipated over 88% of surface area (Normal year).
Source: J. H. Duke, Jr., "A Technical Assessment of the Impact of the Comanche Peak Steam Electric Station on the Proposed Squaw Creek Reservoir," report prepared by Water Resources Engineers, Inc., for Texas Utilities Services, Inc., Nov. 15, 1973, Fig. 5, Part B.

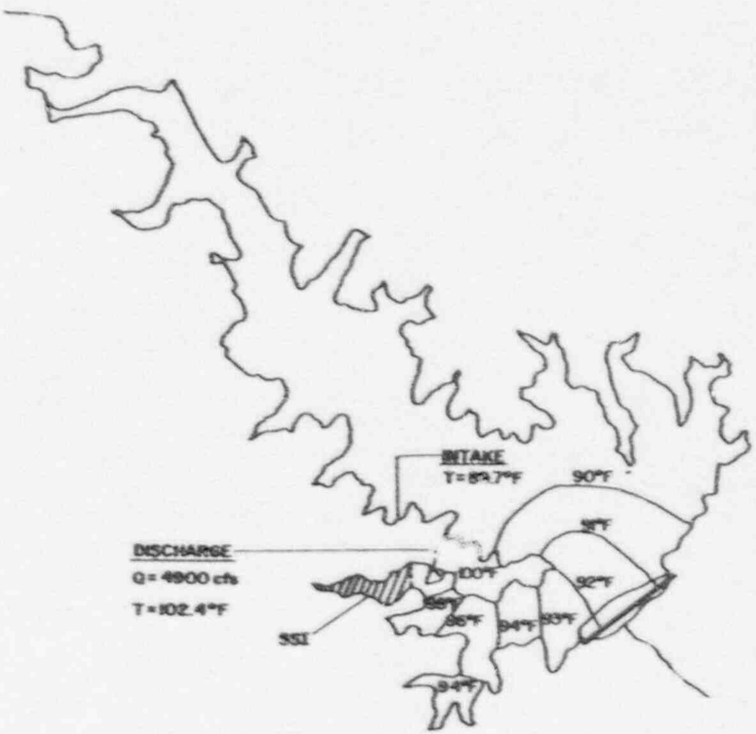

Fig. 5.3.4. Surface isotherms in Squaw Creek Reservoir for August 1971.
Source: J. E. Duke, Jr., "A Technical Assessment of the Impact of the Comanche Peak Steam Electric Station on the Proposed Squaw Creek Reservoir," report prepared by Water Resources Engineers, Inc., for Texas Utilities Services, Inc., Nov. 15, 1973, Fig. 11.

intake and discharge temperatures calculated by these models were slightly lower than those calculated by the vertical temperature behavior model.[5]

Consumptive use of water for Squaw Creek Reservoir using 1948–1971 hydrological and meteorological data has been estimated by the applicant[7] to be those values shown in Table 5.3.3. "Average" year results in this table are defined to be averages of the 1948–1971 results. The applicant found that the maximum natural evaporation from the pond would have occurred in 1956 and defined this as the "dry" year. The applicant also found that the minimum natural evaporation would have occurred in 1968, and defined this as the "wet" year. Miscellaneous water use includes the water necessary to maintain a water flow of 1.5 cfs in Squaw Creek downstream of the dam as discussed in Sect. 3.4.3.

Table 5.3.3. Estimated values of water availability and use in Squaw Creek Reservoir

In acre-feet per year

	Dry year (1956)	Average year (1948–1971)	Wet year (1968)
Power plant cooling use	20,780	20,780	20,780
Other miscellaneous uses	2,400	2,400	2,400
Natural evaporation loss	17,180	10,970	7,290
Squaw Creek runoff	2,100	8,260	22,200
Lake Granbury diversions	64,660	52,600	35,243
Returned to Lake Granbury	26,400	26,400	26,400
Net diversions from Lake Granbury (diversions minus returns)	38,260	26,200	8,843

Source: Freese, Nichols and Endress, Consulting Engineers, *Engineering Report on Squaw Creek Reservoir*, report prepared for Texas Utilities Services, Inc., 1972.

Although the Squaw Creek Reservoir blowdown water will be of relatively low temperature, as shown in Fig. 5.3.1, it will contain higher concentrations of dissolved solids. The effect that this water blowdown would have on Lake Granbury has been estimated by the applicant for the normal year (1971).[6] The applicant used Koh and Fan's model[12] to analyze the effluent conditions when Lake Granbury's level is 690 ft above mean sea level, and the results of this analysis for the water temperatures are shown in Table 5.3.4.

Table 5.3.4. Effect of Squaw Creek Reservoir water blowdown on Lake Granbury at a water level of 690 ft above mean sea level

Volumes of water within temperature plume contours

Month	Squaw Creek Reservoir blowdown temperature (°F)	Lake Granbury temperature at discharge elevation (°F)	Temperature contour (°F)	Volume within contour (ft^3)
January	64.4	51.1	64	40
			60	250
			56	400
February	62.b	56.5	62	100
			60	180
			58	600
March	61.5	58.4	60	300
			58	25,000
April	62.7	6[illegible].9	62	20,000
May	64.1	69.[illegible]	68	400
June	66.1	77.[illegible]	68	120
			72	200
			76	a
July	68.4	86.6	72	120
			76	140
			80	180
			84	a
August	70.8	88.9	72	60
			76	140
			80	180
			84	2,000
			88	a
September	73.1	79.4	74	160
			76	240
			78	750
October	74.6	72.1	74	150
			73	240
November	67.3	58.6	66	120
			64	180
			62	250
			60	1,300
December	61.4	54.5	60	120
			58	160
			56	800

[a] Results affected by nonlinear stratification.

Source: A. E. Johnson and J. H. Duke, Jr., *An Analysis of the Effects of the Squaw Creek Reservoir Blowdown Plumes on Lake Granbury*, report prepared by Water Resources Engineers, Inc., for Texas Utilities Services, Inc., Nov. 30, 1973.

When Lake Granbury is down to its maximum drawdown level of 675 ft above mean sea level, the applicant used the Stolzenbach and Harleman model[10] again to predict the blowdown plume behavior in Lake Granbury. It was found for the case of Lake Granbury's level being 690 ft above mean sea level that the discharge was only buoyant for the months of January and November. These were the only cases considered for the 675-ft lake level, and the results of this analysis are shown in Table 5.3.5.

Table 5.3.5. Effect of Squaw Creek Reservoir water blowdown on Lake Granbury at a water level of 675 ft above mean sea level

Volumes of water within temperature plume contours

Month	Squaw Creek Reservoir blowdown temperature (°F)	Lake Granbury surface temperature (°F)	Temperature contour (°F)	Volume within contour (ft^3)
January	64.4	53.8	64	50
			62	150
			60	300
			58	400
			56	1700
November	67.3	59.6	66	120
			64	200
			62	400
			60	2400

Source: A. E. Johnson and J. H. Duke, Jr., *An Analysis of the Effects of the Squaw Creek Reservoir Blowdown Plumes on Lake Granbury*, report prepared by Water Resources Engineers, Inc., for Texas Utilities Services, Inc., Nov. 30, 1973.

Based on a study of the De Cordova Steam Electric Station thermal effluents,[13] the applicant concluded that there would be minimal interaction between that station and CPSES.

5.3.2 Staff's thermal analysis

The staff determined the water temperature distributions and the amount of water evaporated in Squaw Creek Reservoir using the model of Ryan and Harleman.[14] The staff used hydrological and meteorological data for years 1954-1956 and 1971; 1954-1956 was assumed to be the "drought" period and 1971 the "average" year.

Assuming that the power plant circulating water intake is at 754 ft above mean sea level and the blowdown line inlet is at 718 ft, the staff found that the reservoir surface and circulating water intake temperatures would reach their maximum about the end of August. The staff calculated that the circulating water intake temperatures at this time would be 89.4°F using 1971 data and 88.1°F using 1956 data. The staff calculated the variation of the intake temperature during the average year to be as shown in Fig. 5.3.5. Also shown in this figure are the temperatures of the water entering the blowdown line and of the water discharging from the station. Except for the reservoir blowdown water temperatures, these temperatures are slightly lower than those calculated by the applicant. The staff concurs that the applicant's Squaw Creek Reservoir blowdown water temperatures are correct when considering the details in the applicant's and the staff's analyses.

Vertical temperature profiles in the reservoir calculated by the staff for the average year are shown in Fig. 5.3.6. They are generally of the same shape although of slightly lower magnitudes compared with those of the applicant in Fig. 5.3.2. Surface reservoir temperatures calculated by the staff for day 240 of the average year are tabulated in Table 5.3.6. As can be seen from a plot of these results in Fig. 5.3.7, the staff's results are somewhat higher than those of the applicant shown in Fig. 5.3.3. The applicant's analysis shows that all of the induced heat load would be dissipated within about 900 acres of the reservoir surface. At the same location, the staff calculated that 0.39 of the induced heat load would remain (about 5°F increase in the surface temperature). At the outer edge of a 1500-acre area (about half of the reservoir surface), the staff predicted that the difference between the surface temperature and the circulating water intake temperature would be about 2°F.

The effect of increasing the plant factors above the anticipated mode of operation during the average year given in Table 3.3.1 was investigated by the staff. Two cases were investigated, which are more severe than those considered by the applicant.

Surface water temperatures at the edge of a 1550-acre reservoir surface area for these and the anticipated mode of operation of the station are tabulated in Table 5.3.7. Like the applicant's results shown in Table 5.3.2, there would be little significant temperature increase in the reservoir surface temperatures until the end of October. By the end of the year, both the applicant's and the staff's analyses show that the higher plant factors would result in a 6 to 7°F surface temperature increase.

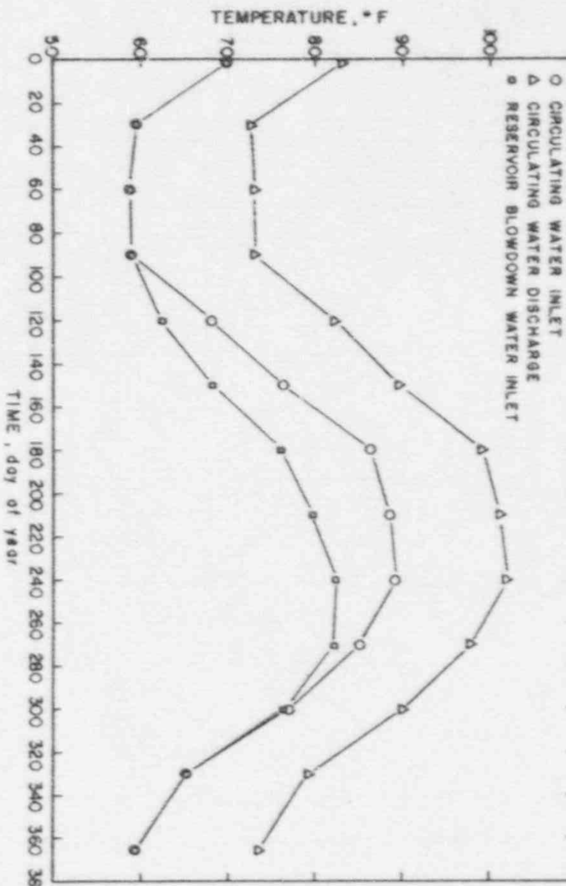

Fig. 5.3.5. Staff estimate of the variation of the circulating water intake and discharge temperatures during an average year.

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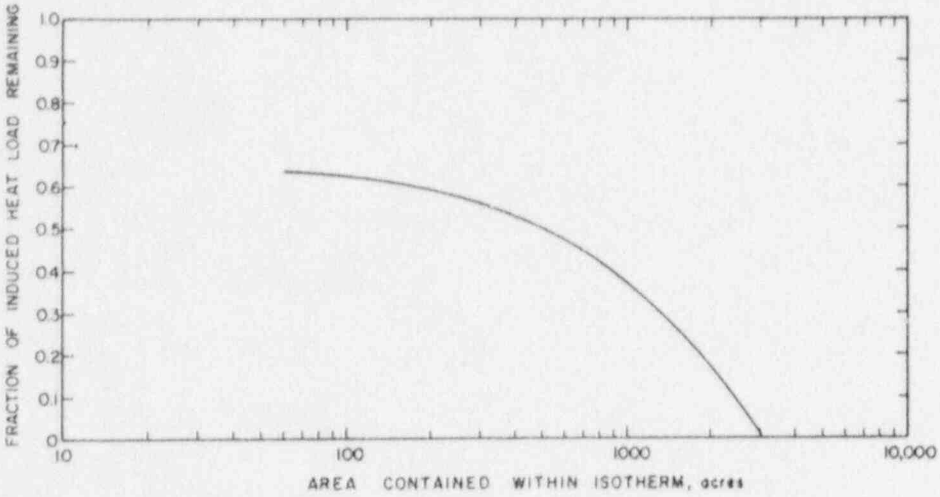

Fig. 5.3.7. Staff estimate of relation of residual heat load to surface area of Squaw Creek Reservoir.

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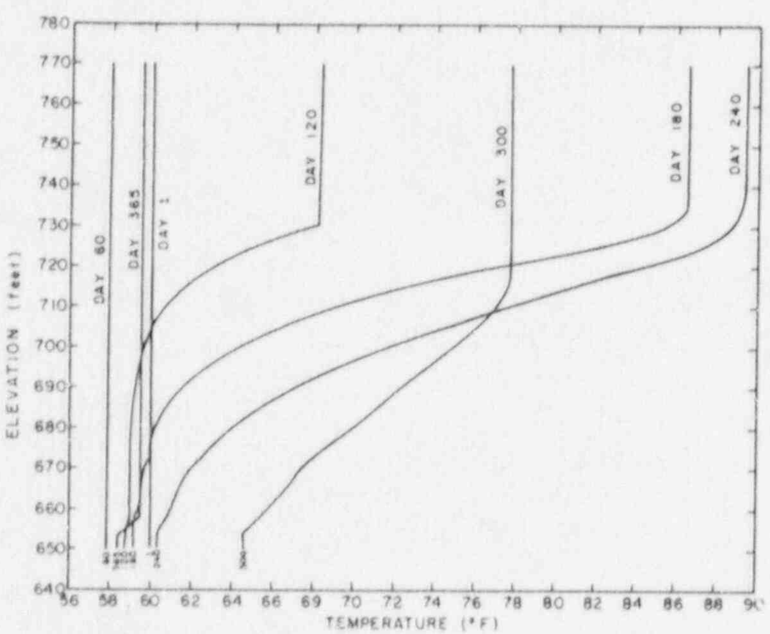

Fig. 5.3.6. Staff estimates of the vertical temperature profiles in Squaw Creek Reservoir for the average year.

Table 5.3.6. Staff evaluation of reservoir surface temperatures on day 340 of the average year

Area (acres)	Temperature at edge of area (°F)
0	102.1
61	97.5
213	96.9
335	96.3
639	95.3
943	94.3
1208	93.4
1552	92.6
1856	91.9
2130	91.2
2434	90.5
2739	90.0
3043	89.4

Table 5.3.7. Staff evaluation of increase in Squaw Creek Reservoir surface temperature following an increase in the plant load factor in an average year

Temperature at the edge of 1550-acre surface area

Case A: Predicted plant factors prior to April 30; full rated plant operation for the rest of the year from April 30 on

Case B: Predicted plant factors prior to May 30; full ultimate plant operation for the rest of the year from May 30 on. Ultimate plant operation was assumed to mean that the temperature rise of the circulating water passing through the steam plant is 15.0°F instead of the rated value of 14.2°F

Date	Temperature (°F)		
	Anticipated plant operation	Case A[a]	Case B
June 29	90.0	89.4	90.3
July 29	92.4	91.8	92.8
August 28	92.6	92.7	93.2
September 27	88.3	88.2	88.7
October 27	80.4	82.5	83.3
November 26	66.6	72.2	72.7
December 31	62.[illegible]	68.4	69.1

[a]Slightly lower values for Case A compared to those for anticipated operation of the station are due to minute errors associated with the finite difference routine in the staff's thermal model.

Gross water evaporation rates from Squaw Creek Reservoir shown in Table 5.3.8 were calculated by the staff using Ryan and Harleman's model[14] for the drought and average years.

Table 5.3.8. Staff evaluation of water makeup requirements for Squaw Creek Reservoir

In acre-feet per year

	1954	1955	1956	1971
Gross evaporation	44,472	41,867	46,034	40,058
Direct rainfall[a,b]	4,958	6,380	4,704	10,650
Water runoff[c]	2,100	10,180	4,670	8,040
Miscellaneous uses[c]	2,400	2,400	2,400	2,400
Required makeup	39,814	27,707	39,060	23,768

[a]D. J. Glanz, G. K. Young, and R. P. Shubinski, *An Ecologic Simulation of the Proposed Squaw Creek Reservoir and Its Impact on Lake Granbury, Texas*, report prepared by Water Resources Engineers, Inc., for Dames and Moore, and Texas Utilities Services Inc., May 14, 1973.

[b]U.S. Department of Commerce, National Climatic Center, Environmental Data Services, "Local Climatological Data – Annual Summary with Comparative Data – Fort Worth, Texas," 1971.

[c]Freese, Nichols and Endress, Consulting Engineers, *Engineering Report on Squaw Creek Reservoir*, report prepared for Texas Utilities Services, Inc., 1972.

The staff's predictions in Table 5.3.8 agree with the applicant's predictions in Table 5.3.3.

The staff made independent calculations of the densimetric Froude numbers of the reservoir water discharging into Lake Granbury, and then determined the submerged discharge jet behavior using the charts of Shirazi and Davis.[15] These results are shown in Table 5.3.9 and indicate that the staff concurs with the results of the applicant.[6] For Lake Granbury at its maximum drawdown level of 675 ft above mean sea level, the staff checked the applicant's analysis,[6] and found it to be reasonable and conservative.

Table 5.3.9. Staff evaluation of the return line discharge characteristics (submerged jet)

Date	Initial temperature difference (°F)	Froude number: Based on densities calculated by applicant[a]	Froude number: Based on densities calculated by staff	Downstream conditions: Temperature difference (°F)	Downstream conditions: Horizontal distance (ft)	Downstream conditions: Vertical distance (ft)
January 30, 1971	13.8	37	20	0.7	120	9
June 29, 1971	−16.3	9.7	9.6	0.8	60	−24
October 27, 1971	2.5	31	34	1.3	24	0
October 27, 1971	2.5	31	34	0.6	60	0

[a]A. E. Johnson and J. H. Duke, Jr., *An Analysis of the Effects of the Squaw Creek Reservoir Blowdown Plumes on Lake Granbury*, report prepared by Water Resources Engineers, Inc., for Texas Utilities Services, Inc., Nov. 30, 1973.

5.3.3 Staff conclusions

The staff concludes that results of its and of the applicant's thermal analyses are essentially in agreement. The staff further concludes that the assumptions used by the applicant are both reasonable and conservative. The staff reviewed the analysis of the thermal effects of the De Cordova Bend Steam Electric Station on Lake Granbury. Based on this review, the staff concluded that this analysis is conservative and concurs with the applicant that the interaction between this power station and CPSES on Lake Granbury would be negligible.

The staff estimates that returning of Squaw Creek Reservoir water to Lake Granbury will result in, on the average, a 2.5% increase in the total dissolved solids concentration in the water flowing through De Cordova Bend Dam. Further, the staff estimates that this increase will be 2.3% in the Brazos River just downstream of the Paluxy River–Brazos River confluence.

5.4 RADIOLOGICAL IMPACTS

5.4.1 Impact on biota other than man

5.4.1.1 Exposure pathways

The pathways by which biota other than man may receive radiation doses in the vicinity of a nuclear power station are shown in Fig. 5.4.1. Two recent comprehensive reports[1,2] have been concerned with radioactivity in the environment and these pathways. They can be read for a more detailed explanation of the subjects that will be discussed below. Depending on the pathway being considered, terrestrial and aquatic organisms will receive either approximately the same radiation doses as man or somewhat greater doses. Although no guidelines have been established for desirable limits for radiation exposure to species other than man, it is generally agreed that the limits established for humans are also conservative for these species.[3] An estimate of the occupational radiation exposure received in operating the station has been made. This estimate is based on experience at comparable operating reactors.

5.4.1.2 Radioactivity in the environment

The quantities and species of radionuclides expected to be discharged annually by the Comanche Peak Station in liquid and gaseous effluents have been estimated by the staff and are given in Tables 3.5.2 and 3.5.3, respectively. The basis for these values is discussed in Section 3.5. For the determination of doses to biota other than man, specific calculations are done primarily for the liquid effluents. The liquid effluent quantities, when diluted in the Comanche Peak Station discharge, would produce an average gross activity concentration, excluding tritium, of 4.6×10^{-4} pCi/ml in the plant discharge area. Under the same conditions, the tritium concentration would be 11 pCi/ml. Additional discussion concerning liquid dilution is presented in Section 5.4.2.

Doses to terrestrial animals such as rabbits or deer due to the gaseous effluents are quite similar to those calculated for man (Section 5.4.2). For this reason, both the gaseous effluent concentrations at locations of interest and the dose calculations for gaseous effluents are discussed in detail in Section 5.4.2.

5.4.1.3 Dose rate estimates

The annual radiation doses to both aquatic and terrestrial biota including man were estimated on the assumption of constant concentrations of radionuclides at a given point in both the water and

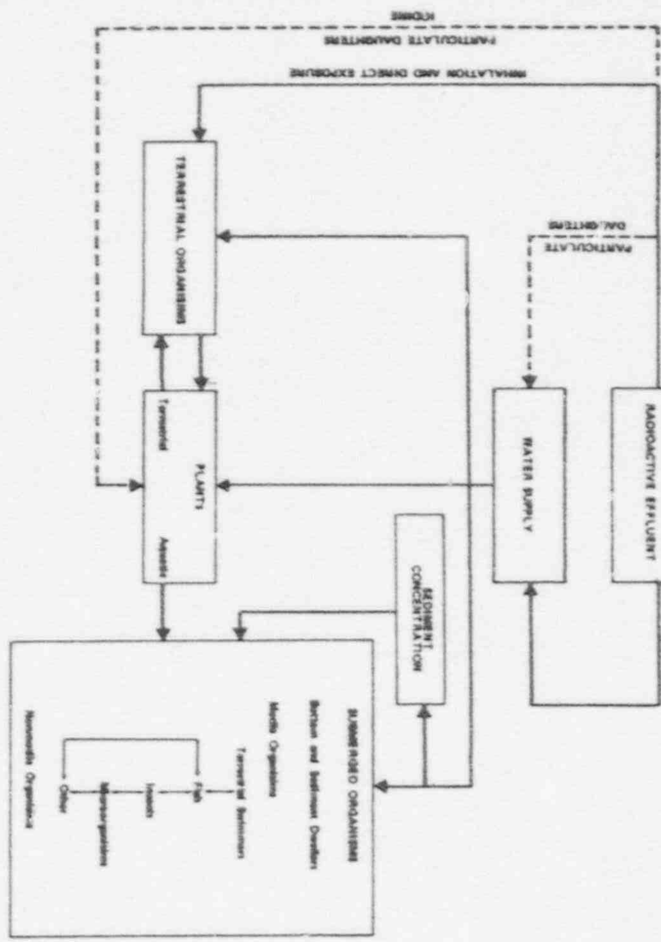

Fig. 5.4.1. Generalized exposure pathways for organisms other than man.

air. Referring to Figure 5.4.1, radiation dose has both internal and external components. External components originate from immersion in radioactive air and water and from exposure to radioactive sources on surfaces, in distant volumes of air and water, in equipment, etc. Internal exposures are a result of ingesting and breathing radioactivity.

Doses will be delivered to aquatic organisms living in the water containing radionuclides discharged from the power station. This is principally a consequence of physiological mechanisms that concentrate a number of elements that can be present in the aqueous environment. The extent to which elements are concentrated in fish, invertebrates, and aquatic plants upon uptake or ingestion has been estimated. Values of relative biological accumulation factors (ratio of concentration of nuclide in organisms to that in the aqueous environment) of a number of water-borne elements for several organisms are provided in Table 5.4.1.

Doses to aquatic plants and fish living in the discharge region due to water uptake and ingestion (internal exposure) were calculated to be 14 and 5.6×10^{-2} millirads/year, respectively, for the Comanche Peak Station operation. The discharge region concentrations were those given above and it was assumed that these organisms spent all of the year in water of maximum concentrations. All calculated doses are based on standard models.[4] The doses are quite conservative since it is highly unlikely that any of the mobile life forms will spend a significant portion of their life span in the maximum activity concentration of the discharge region. Both radioactive decay and additional dilution would reduce the dose at other points in the SCR.

External doses to terrestrial animals other than man are determined on the basis of gaseous effluent concentrations and direct radiation contributions at the locations where such animals may actually be present. Terrestrial animals in the environs of the station will receive approximately the same external radiation doses as those calculated for man. Table 5.4.2 lists the doses due to the gaseous effluents.

An estimate can be made for the ingestion dose to a terrestrial animal, such as a duck, which is assumed to consume only aquatic vegetation growing in the water in the discharge region. The duck ingestion dose was calculated to be about 34 millirads/year, which represents an upper limit estimate since equilibrium was assumed to exist between the aquatic organisms and all radionuclides in water. A nonequilibrium condition for a radionuclide in an actual exposure situation would result in a smaller bioaccumulation and therefore in a smaller dose from internal exposure.

TABLE 5.4.1. FRESHWATER BIOACCUMULATION FACTORS[5]

Element	Fish	Invertebrates	Plants
	(pCi/Kg of organism per pCi/liter of water)		
C	4550	9100	4550
Na	100	200	500
P	100000	20000	500000
Sc	2	1000	10000
Cr	200	2000	4000
Mn	400	90000	10000
Fe	100	3200	1000
Co	50	200	200
Ni	100	100	50
Zn	2000	10000	20000
Rb	2000	1000	1000
Sr	30	100	500
Y	25	1000	5000
Zr	3	7	1000
Nb	30000	100	800
Mo	10	10	1000
Tc	15	5	40
Ru	10	300	2000
Rh	10	300	200
Ag	2	770	200
Sn	3000	1000	100
Sb	1	10	1500
Te	400	150	100
I	15	5	40
Cs	2000	100	500
Ba	4	200	500
La	25	1000	5000
Ce	1	1000	4000
Pr	25	1000	5000
Nd	25	1000	5000
Pm	25	1000	5000
Sm	25	1000	5000
Eu	25	1000	5000
Gd	25	1000	5000
W	1200	10	1200
Np	10	400	300
Pu	4	100	350
Am	25	1000	5000
Cm	25	1000	5000

TABLE 5.4.2. ANNUAL INDIVIDUAL DOSES DUE TO THE GASEOUS EFFLUENTS

Location	$\chi/Q(Sec/m^3)$[a]	Dose (millirem/year) Total body	Skin	Thyroid
Site boundary[b] (1460 m WSW)	8.3×10^{-7}	2.4×10^{-2}	1.2×10^{-1}	3.8×10^{-2}[c]
Nearest farm (1460 m WSW)	8.3×10^{-7}	2.4×10^{-2}	1.2×10^{-1}	3.1[d]
Nearest residence (2900 m W)	4.2×10^{-7}	1.1×10^{-2}	5.6×10^{-2}	1.5×10^{-1}[e]
Visitor's Center[f] (275 m SE)	2.3×10^{-5}	1.8×10^{-1}	8×10^{-1}	2.5×10^{-1}[c]
Nearest park	9.5×10^{-8}	2.2×10^{-3}	1.2×10^{-2}	3.4×10^{-2}[c]

[a]Atmospheric dispersion factors based on 12 months onsite meteorological data, May 15, 1972 to May 15, 1973 (Sect. 2.6).

[b]At the site boundary, the beta and gamma air doses are 0.14 mrad/yr and 0.026 mrad/yr, respectively.

[c]Dose to adult thyroid from inhalation.

[d]Dose to infant thyroid via cow-milk pathway.

[e]Dose to adult thyroid from eating leafy vegetables.

[f]Doses based upon assumed occupancy of 2,000 hours per year.

The literature relating to radiation effects on organisms is extensive, but very few studies have been conducted on the effects of continuous low-level exposure to radiation from ingested radionuclides on natural aquatic or terrestrial populations. The most recent and pertinent studies point out that, while the existence of extremely radiosensitive biota is possible and while increased radiosensitivity in organisms may result from environmental interactions, no biota have yet been discovered that show a sensitivity to radiation exposures as low as those anticipated in the area surrounding the Comanche Peak Station. In the "BEIR" report,[6] it is stated in summary that evidence to date indicates that no other living organisms are very much more radiosensitive than man. Therefore, no detectable radiological impact is expected in the aquatic biota or terrestrial mammals as a result of the quantity of radionuclides to be released into Squaw Creek Reservoir and into the air by the Comanche Peak Station.

5.4.2 Impact on man

Routine power generation by the Comanche Peak Station will result in the release of small quantities of fission and activation products to the environment. This evaluation will provide the resulting radiation dose estimates which can serve as a basis for a determination that releases of radioactive materials to unrestricted areas are as low as practicable in accordance with 10 CFR 50 and within the limits specified in 10 CFR 20. The staff has estimated the probable nuclide releases from the Comanche Peak Station based upon experience with comparable operating reactors and an evaluation of the radwaste system. These releases have been discussed in Section 3.5.

Estimations were made of radiation doses to man at and beyond the site boundary via the most significant pathways among those diagrammed in Figure 5.4.2. The calculations are based on conservative assumptions regarding the dilutions of effluent gases and radionuclides in the liquid discharge, and the use by man of the plant surroundings.

Based upon experience at comparable operating nuclear power reactors, an estimate has been made of the occupational radiation exposures expected to result from operation of the Comanche Peak Station.

5.4.2.1 Radioactive materials released in liquid effluents

Expected nuclide releases in the liquid effluent have been calculated for the Comanche Peak Station and are listed in Table 3.5.2. In the immediate vicinity of the Comanche Peak Station discharge, the gross activity concentration, exclusive of tritium, is estimated to be 4.6×10^{-4} pCi/ml. Under the same conditions, the tritium concentration would be 11 pCi/ml, as stated in Section 5.4.1.2.

During normal reactor operations, a fraction of the noble gases produced will be released in the liquid effluent and subsequently discharged into the Squaw Creek Reservoir. The AEC Directorate of Regulatory Operations has analyzed operating reactor radioactive liquid effluent for noble gas content and under conditions of highest annual average noble gas concentrations in the discharge water, no significant doses would be delivered to human beings.

Consumption of water represents a potentially significant exposure pathway to the population. However, there are no drinking water supplies within 100 miles of the plant that could be affected by the effluents. In addition, no potential exists for ground water contamination.

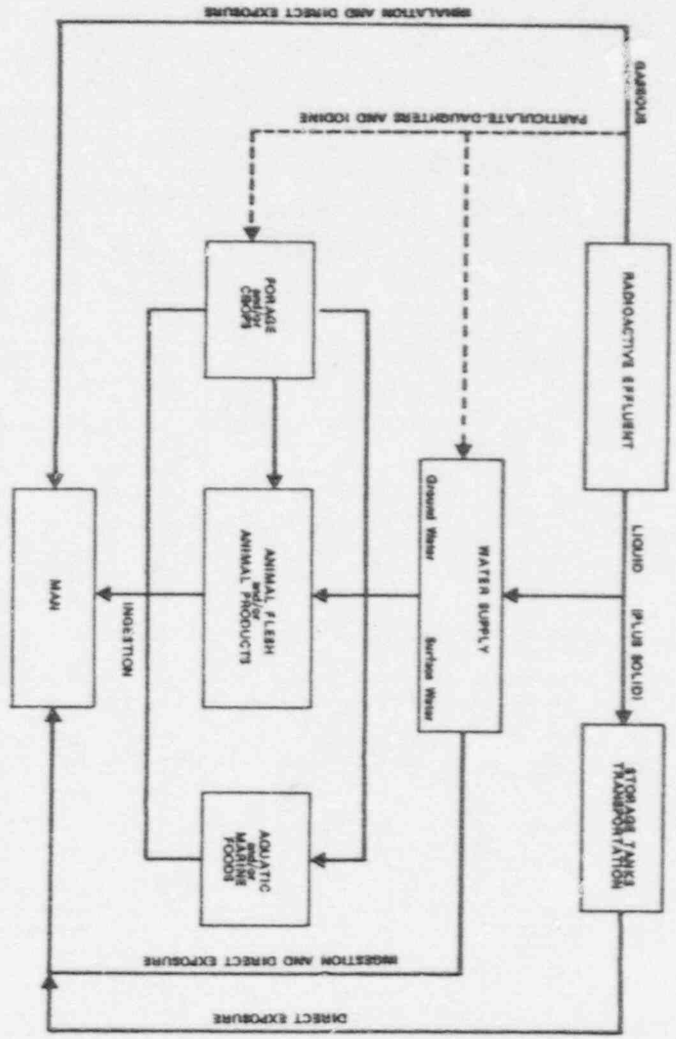

Fig. 5.4.2. Generalized exposure pathways to man.

Other pathways of relative importance involve recreational use of Squaw Creek Reservoir in the vicinity of the discharge zone. Individual doses from consuming fish caught in the immediate discharge area were evaluated using the biological accumulation factors listed in Table 5.4.1 and standard models.[4] Swimming, boating, and fishing in the discharge region were also included in the evaluation.

Radioactive materials deposited in the sediments of Squaw Creek Reservoir will not contribute significantly to the toal dose to individuals or to the population.

The presence of low concentrations of radionuclides in the water that might overflow into Squaw Creek (refer to 4.3.2.1) will not contribute significantly to the total dose to individuals or to the population.

Table 5.4.3 summarizes the potential individual doses from the liquid effluents.

TABLE 5.4.3
ANNUAL INDIVIDUAL DOSES FROM LIQUID EFFLUENTS

Location	Pathway	Dose (millirems/year)			
		Total body	GI tract	Thyroid	Bone
Coolant	Fish ingestion	1.2	$3.5x10^{-2}$	$1.2x10^{-1}$	$8.0x10^{-1}$
discharge	Swimming (100 hrs/yr)	$1.7x10^{-2}$			
region	Fishing, Boating (500 hrs/yr)	$4.2x10^{-2}$			

5.4.2.2 Radioactive materials released to the atmosphere

Radioactive effluents released to the atmosphere from the plant will result in the most significant radiation doses to the public. The staff estimates of the probable gaseous and particulate releases listed in Table 3.5.3 were used to evaluate potential doses. All dose calculations were performed using annual average site meteorological conditions and assuming that releases occur at a constant rate. Radioactive gases are released near ground level from the plant. Thus, doses result from immersion in the dispersed radioactive gases.

The primary food pathway to man involves the ingestion by dairy cows of radioiodine deposited onto grazing areas. Consumption of milk from these cows can result in exposure to the human thyroid. Doses to a child's thyroid which would result from consuming one liter of milk daily from a cow grazing eight months annually were calculated for the nearest farm using recognized models.[7,8] The staff has calculated that the release of radioactive materials in gaseous effluents from the operation of both reactors will result in a whole body dose of less than 5 millirems/year to individuals at or beyond the site boundary, and a dose of less than 15 millirems/year to a child's thyroid through the pasture-cow-milk cycle from the first real cow located at the nearest potential pasture, which is at the site boundary.

Another food pathway to man of secondary importance involves the consumption of leafy vegetables subject to deposition of the radionuclides released to the atmosphere. The thyroid dose resulting from an annual consumption of 72 kg of leafy vegetables produced at the nearest residence during the three month growing period was evaluated.

All doses due to gaseous effluents are summarized in Table 5.4.2.

5.4.2.3 Direct radiation

5.4.2.3.1 Radiation from the facility

The plant design includes specific shielding of the reactor, hold-up tanks, filters, demineralizers and other areas where radioactive materials may flow or be stored, primarily for the protection of plant personnel. Direct radiation from these sources is therefore not expected to be significant at the site boundary. Confirming measurements will be made as part of the applicant's environmental monitoring program after plant start-up. Low level radioactivity storage containers outside the plant are estimated to contribute less than 0.01 millirems/year at the site boundary.

5.4.2.3.2 Transportation of radioactive material

The transportation of cold fuel to a reactor, of irradiated fuel from the reactor to a fuel reprocessing plant, and of solid radioactive wastes from the reactor to burial grounds is within the scope of the AEC report entitled, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants." The environmental effects of such transportation are summarized in Table 5.4.4.

TABLE 5.4.4. ENVIRONMENTAL IMPACT OF TRANSPORTATION OF FUEL AND WASTE TO AND FROM ONE LIGHT-WATER-COOLED NUCLEAR POWER REACTOR[a]

Normal Conditions of Transport

	Environmental Impact
Heat, weight, and traffic density	Negligible

Exposed Population	Estimated Number of Persons Exposed	Range of Doses to Exposed Individuals[b] (per reactor year)	Cumulative Dose to Exposed Population[c] (per reactor year)
Transportation workers	200	0.01 to 300 millirem	4 man-rem
General public			
Onlookers	1,100	0.003 to 1.3 millirem)	
Along Route	600,000	0.0001 to 0.06 millirem)	3 man-rem

[a]Data supporting this table are given in the Commission's "Environmental Survey of Transportation of Radioactive Materials To and From Nuclear Power Plants," WASH-1238, December 1972.

[b]The Federal Radiation Council has recommended that the radiation doses from all sources of radiation other than natural background and medical exposures should be limited to 5,000 millirem per year for individuals as a result of occupational exposure and should be limited to 500 millirem per year for individuals in the general population. The dose to individuals due to average natural background radiation is about 130 millirem per year.

[c]Man-rem is an expression for the summation of whole body doses to individuals in a group. Thus, if each member of a population group of 1,000 people were to receive a dose of 0.001 rem (1 millirem), or if 2 people were to receive a dose of 0.5 rem (500 millirem) each, the total man-rem in each case would be 1 man-rem.

5.4.2.4 Occupational radiation exposure

Based on the review of the applicant's Safety Analysis Report the staff has determined that individual occupational doses can be maintained within the limits of 10 CFR 20. Radiation dose limits of 10 CFR 20 are based on a thorough consideration of the biological risk of exposure to ionizing radiation. Maintaining radiation doses of plant personnel within these limits insures that the risk associated with radiation exposure is no greater than those risks normally accepted by workers in other present-day industries.[11] Using information compiled by the Atomic Energy Commission[9,10] and others[12,13] of past experience from operating nuclear reactor plants it is estimated that the average collective dose to all onsite personnel at large operating nuclear reactor plants will be approximately 400 to 500 man-rems per year per unit. The total dose for Comanche Peak will be influenced by several factors for which definitive numerical values are not available but the aggregate of which are expected to lead to lower doses to onsite personnel than estimated above. Improvements to the radioactive waste effluent treatment system to achieve offsite population doses as low as practicable have the potential for causing a small increase to onsite personnel doses, all other factors remaining unchanged. However, the applicant's implementation of Regulatory Guides[14] and other guidance provided through the staff review process regarding reducing available exposures and maintaining onsite radiation doses as low as practicable is expected to result in an overall reduction of total doses from those currently experienced.

5.4.2.5 Population doses from all sources

Radiation doses calculated by the staff are intended to apply to an average adult. Specific persons will receive higher or lower doses, depending upon their age, living habits, food preferences, or recreational activities.

The average annual dose from gaseous effluents to all individuals living in unrestricted areas within a fifty mile radius of the plant was calculated using the projected 1980 population data furnished by the applicant.[15] Values for the man-rem dose at various distances from the plant are summarized in Table 5.4.5.

The cumulative dose resulting from the consumption of fish harvested from Squaw Creek Reservoir was estimated. It was conservatively assumed that 10% of the population within 50 miles of the plant consumed 5 grams of fish per day caught in the region of the reservoir where equilibrium conditions are assumed to exist.

TABLE 5.4.5. CUMULATIVE POPULATION, ANNUAL CUMULATIVE DOSE, AND AVERAGE ANNUAL TOTAL BODY DOSE DUE TO GASEOUS EFFLUENTS IN SELECTED ANNULI ABOUT THE PLANT

Cumulative Radius (Miles)	Cumulative Population (1980)	Annual Cumulative Dose (man-rem)	Average Annual Dose (millirem)
1	0	0.00	2.2×10^{-1}
2	50	0.00	1.4×10^{-2}
3	145	0.00	1.1×10^{-2}
4	325	0.00	7.0×10^{-3}
5	2780	C.00	3.4×10^{-3}
10	13070	0.02	2.0×10^{-3}
20	31000	0.04	1.2×10^{-3}
30	94200	0.04	1.6×10^{-4}
40	483500	0.08	1.6×10^{-4}
50	997100	0.10	1.0×10^{-4}

The exposed fishing and boating population was estimated to represent 25% of the total population within a fifty mile radius and each person was assumed to be exposed during 1 hour/yr of swimming and 5 hours/yr of boating in the mixing zone.

Lake Granbury is a secondary receptor of liquid effluents from the Comanche Peak Station; radionuclide concentrations in Lake Granbury will be less than one-twentieth of those in Squaw Creek Reservoir, and their radiological impact is considered to be negligible. Discussion of hydrological modelling is included in Section 2.5.

The population doses from all sources, including natural background, cloud immersion, consumption of fish, recreation, transportation, and occupational exposures, are summarized in Table 5.4.6.

5.4.2.6 Evaluation of radiological impact

Using conservative assumptions, the total man-rem dose in unrestricted areas from all effluent pathways, received by the estimated 1980 population of 997,000 persons who will live within a fifty mile radius of the Comanche Peak Station, would be about 15 man-rem per year. By comparison, an annual total of about 100,000 man-rem is delivered to the same population as a result of the average natural background dose rate of about 0.1 rem per year in the vicinity of the plant.[16] Effluents from the operation of the Comanche Peak Station will then be an extremely minor contributor to the radiation dose that persons living in the area normally receive from natural background radiation. The estimated radiation doses to individuals and to the population from normal operation of the Comanche Peak Station Units 1 and 2 support the staff's conclusion that the releases of radioactive materials in liquid and gaseous effluents are as low as practicable.

TABLE 5.4.6. SUMMARY OF ANNUAL TOTAL BODY DOSES TO THE POPULATION WITHIN 50 MILES

Category	Cumulative Dose (man-rem/yr)
Population (1980) dose from background	100,000
Restricted Area	
Occupational radiation exposure	1,000
Unrestricted Area	
Transportation of nuclear fuel and radioactive wastes	14.0
Gaseous cloud	<0.1
Fish ingestion	0.3

The 1000 man-rems received as occupational onsite exposure is a small percentage of the annual total of about 100,000 man-rems delivered to the 1980 population living within a 50-mile radius of the Comanche Peak Station.

5.5 NONRADIOLOGICAL EFFECTS ON ECOLOGICAL SYSTEMS

5.5.1 Terrestrial

5.5.1.1 The plant

Because of the nature of the cooling system, the direct ecological impacts of plant operation will occur on the aquatic environments of the area. The staff concludes that the actual operation of the CPSES should have no sustained nonradiological impacts on the terrestrial ecosystems of the local area.

5.5.1.2 Transmission lines

Except for limited areas on the CPSES site and in the vicinity of the Brazos River crossings, there appears to be no requirement for permanent access roads. When line maintenance is required, the applicant will restrict vehicle movement within the right-of-way so as to minimize disturbance to the vegetation. Areas continuing in use by the landowner for agriculture will need little attention. The basic method of vegetation control in other areas will be to mow the right-of-way and prune once every three years any trees that might endanger the lines. General chemical spraying will not be used. Where mowing is not possible and vegetation control is considered necessary, direct basal application of chemicals will be used. The applicant's overall objective in vegetation control of rights-of-way is to eliminate certain undesirable vegetation and to promote a stable ground cover of grasses, forbs, and native low-lying shrubs. In areas where the natural ground cover has been destroyed or seriously damaged, the applicant will plant grasses or low ground cover for vegetation restoration and erosion control, as is considered appropriate for the area. The staff concludes that these measures should minimize the adverse effects of transmission line maintenance on terrestrial ecosystems.

Ozone is recognized as a major component of the photochemical air pollution-oxidant complex. The National Primary Air Quality Standard for photochemical oxidants, as issued by the Environmental Protection Agency, is 80 ppb (by volume) maximum arithmetic mean for a 1-hr concentration, not to be exceeded more than once per year. The toxicity of ozone to vegetation is well documented; susceptible species show symptoms of damage from exposures to ozone in concentrations as low as 30 ppm.[1,2] One source of ozone production is believed to be associated with the coronal discharges of high-voltage transmission lines. However, recent studies[3,4] have shown that no measurable concentrations of ozone (less than 2 ppb) are formed due to the presence and operation of transmission lines that carry up to 765 kV. High-voltage lines for CPSES will carry a maximum of 345 kV. Any possible deleterious effects on plants directly beneath these lines and on those adjacent to the corridors which could be affected by chronic exposure to ozone drift have not been identified and are expected by the staff to be undetectable.

5.5.2 Aquatic

There are two aquatic systems which must be considered when evaluating potential operating effects of CPSES: (1) Squaw Creek Reservoir, the off-stream cooling pond for the station and (2) Lake Granbury, from which makeup water for Squaw Creek Reservoir will be drawn and into which blowdown from Squaw Creek Reservoir will be discharged. It is the conclusion of the staff that there will be no operational effects on Squaw Creek. The major effects have been discussed in Sect. 4.3.2 and are associated with the construction of the dam and the maintenance of flow in the creek.

5.5.2.1 Squaw Creek Reservoir

There are several factors associated with the operation of CPSES which may alter production patterns compared to those that might exist in the reservoir without plant operation. These include (1) impingement of fish on the intake screens, (2) entrainment of organisms, which will be exposed to rapid temperature and pressure changes, mechanical abrasion, and chlorination, (3) effects of discharge water, which will contain heat and residual chlorine, (4) increase in concentration of dissolved solids in the reservoir, and (5) stratification in the reservoir. The first three factors have been discussed in a recent report.[5] The relevancy of all the factors is detailed in the brief discussions below.

Impingement

It is possible that there will be impingement of Squaw Creek Reservoir fishes at three different structures during operation of CPSES: at the circulating water intake, the service water intake, and the return line intake to Lake Granbury. Estimates of intake velocities for conservative normal operation are given in Tables 3.4.1 and 3.4.3 and in Sect. 3.4.4. It appears that an impingement problem could arise because of the increase in velocity at the traveling screens of the circulating water intake. Decreasing the velocity to below 1 fps at the trashracks will reduce the likelihood of impingement. Velocity at the service water intake will be low enough to prevent a serious problem. The large mesh size of the screens on the return line intake (2-1/2 in.) will reduce the probability of impingement. Small fish not able to swim against the current will be drawn through the screens into the return pipeline. In the absence of data on fish distribution in Squaw Creek Reservoir, the staff concludes that impingement might be a problem only at the circulating water intake and that the velocity at the trashracks must be reduced to below 1 fps (refer to Sect. 11.6.2).

Entrainment

The staff adopts the applicant's assumption that there will be 100% mortality of the organisms entrained into the CPSES by the 2,200,000 gpm circulating water intake and the 32,000 gpm service water intake. Organisms will be subjected to a maximum 15 F° temperature increase across the condensers and rapid pressure changes in passage through the plant. These changes, including transit times, are tabulated in Table 3.4.2. In addition, shock chlorination will be used to control the growth of bacteria and algae in the cooling and service water systems (refer to Sect. 3.6.2). The combined effect of these factors supports the conservative assumption that most of the entrained organisms will be killed.

To illustrate the problem, staff calculations show that, with a total flow rate of 2,232,000 gpm and a reservoir volume of 135,360 acre-ft (at low water level of 770 ft above mean sea level), CPSES will circulate the entire volume of Squaw Creek Reservoir every 14 days (26 times per year). Many zooplankters have generation times greater than this (e.g., *Keratella*, 22 days).[6] Based on conservative estimates (100% mortality and no contribution of organisms entering the reservoir in the makeup water), the staff concludes that entrainment by CPSES may reduce the productivity of Squaw Creek Reservoir.

Discharge effects

The water discharged from CPSES will be a maximum of 15 F° above the intake temperature. The applicant will be required to reduce the residual chlorine at the discharge to 0.1 ppm or less (Sect. 3.6.2). This will reduce the probability of adverse effects on aquatic production in the reservoir (refer to Sect. 11.6.1).

Squaw Creek Reservoir will serve as a private cooling reservoir for CPSES and will not be subject to thermal regulations[7] (ER, Appendix B). Staff calculations for late summer conditions (day 240) of an average year (1971), with a discharge temperature

of 102°, show that the entire surface area of Squaw Creek Reservoir will have temperatures above 89.4°, 80% of the surface will be above 90.5°, and 20% will be above 95°. Temperature does not appear to be the limiting factor in the distribution of fish species in Texas. It is apparent from available information that during the summer, Texas reservoirs, in addition to natural streams and rivers thorughout the State, commonly exceed 90°F (surface temperature), are often above 95° and at times even up to 110°, and still support a diverse aquatic community.[8,9] All groups of game fish which would be expected in Squaw Creek Reservoir have been collected at temperatures above 102°F, the discharge temperature on day 240.[10] Fish have been found in Wilkes Reservoir at temperatures up to 107°F, but high mortalities occurred in fish caught in gill nets overnight.[11] This suggests that although fish frequent waters of such high temperatures, they cannot withstand long exposures to it.

Studies of the effects of heated effluents in Texas reservoirs generally have shown no significant differences in the distribution and growth of fishes between heated (temperatures up to 99 F°) and nonheated areas of reservors.[10,12,13]

Data from Texas reservoirs used for power production, such as Lakes Alcoa and Colorado City, have not experienced the game fish decline with age. In fact, for more than 20 years they have maintained higher productivity than any other reservoir surveyed by the Texas Parks and Wildlife Department.[9,14] The fish productivity of five "heated" reservoirs has been compared to that of ten "unheated" reservoirs, and results indicated that fish production in heated reservoirs was as good as, if not better than, in nonheated ones.[10] The study assumed, however, that the discharge of heat was the only variable in the 15 reservoirs, whereas many parameters that affect fishery production differ from one reservoir to another,[15,16] and no preoperational data were provided in the study for comparison.

Conflicting data are available on the use of discharge areas by fish during the winter,[11,17] but no mortality or adverse effects were observed in largemouth bass experimentally exposed to cold shock in a plant discharge.[14] The staff considers the problem of cold shock in Squaw Creek Reservoir to be minimal.

It is possible that high temperatures might make fishes more susceptible to parasitism. In Wilkes Reservoir, 59% of the game fish and 83% of the rough fish were found to be parasitized,[11] but Parks and Wildlife Department studies have shown no increase in disease or parasitism in 30 reservoirs used for cooling.[14]

Fewer studies have been done on the effects of thermal discharges on planktonic and benthic organisms than on fishes. Results have generally shown that annual benthic diversity and production are less in the immediate area of a discharge but are higher during the winter than in nonheated areas.[18,19] Interpretation of plankton studies is difficult because of the effects of current on distribution, but data indicate that higher densities, particularly of copepods and diatoms, may occur near a discharge and increases may take place during the winter.[11,20]

Several species of blue-green algae have been found to occur at high densities in Southwestern reservoirs (refer to Sect. 2.7.2), and the Parks and Wildlife Department has reported no problems with algae.[14,21,22] The occurrence of blue-green algae has often been associated with high temperatures, usually above 95°F,[23,24] and high nutrient content of water, especially nitrates and phosphates.[25,26] It has been predicted that nutrient levels in Squaw Creek Reservoir will be approximately the same as those in Lake Granbury.[27] The latest available data show that nutrient levels (especially nitrates) have dropped considerably since the data presented in the ER were collected.[28,29] Critical values for algal blooms are 0.045 ppm phosphates and 1.3 ppm nitrates.[30] Although Lake Granbury phosphate levels are within the critical range, nitrate levels are below it. The tendency for algal blooms to occur in Squaw Creek Reservoir will be increased by the high temperatures and also by the initial leaching of nutrients from the lake bed. Based on data with other reservoirs in the State, the staff concludes that this will not be a problem.

The staff concludes that the increase in the temperature of Squaw Creek Reservoir caused by CPSES operation will not have a detrimental effect on the productivity of the reservoir.

Increased total dissolved solids concentration

Heat dissipation from Squaw Creek Reservoir will increase the total dissolved solids concentration to approximately 2500 ppm. Salinity effects on some aquatic organisms have been discussed previously in Sect. 4.3.2. Additional species that might occur in Squaw Creek Reservoir, such as carp and threadfin shad, have been found to be tolerant of high salinities.[31-33] The lower Big Wichita River in Texas has a total dissolved solids concentration approximating that which will occur in Squaw Creek Reservoir, and it supports a diverse fishery.[34-35] Species of fish were found in Lake Diversion, a 3480-acre impoundment on the river, with total dissolved solids levels ranging from 1420 to 3500 ppm during the year of study. A large invertebrate fauna was also found. Of the 33 species in Lake Granbury, 24 (72%) have been found in the upper Brazos, where the creeks feeding the river have chloride concentrations averaging 10,000-60,000 ppm. Waters of 2,000-5,000 ppm total dissolved solids are considered as fresh in this area.[36] Species in the Brazos River system are adapted to concentrations that will result in Squaw Creek Reservoir due to the wide fluctuations in flow and salinity that naturally occur. From the available data, the staff finds that the increased total dissolved solids levels will not affect the productivity of Squaw Creek Reservoir.

Stratification

Squaw Creek Reservoir is predicted to stratify during the summer months, with low oxygen concentrations, possible formation of hydrogen sulfide, and colder temperatures occurring at depth below approximately 55 ft. It is expected that Squaw Creek Reservoir will contain no oxygen below this depth during August and September (ER, Amendment 1, Sect. 5.1.3), and thus 58% of the reservoir volume will virtually be eliminated from production. For three other months, dissolved oxygen levels will be higher but still below 5 ppm. Summer stratification occurs normally in many Texas reservoirs. It was found that benthic populations were severely reduced in Lake Granbury during periods of stratification in July[28] (Table B-7).

Return water to Lake Granbury will be withdrawn from the hypolimnion of Squaw Creek Reservoir. During periods of stratification, this procedure will aggravate the loss of nutrients from the reservoir because the withdrawals will be made from layers in which the most nutrients have accumulated.

The staff concludes that the operation of CPSES will exaggerate any stratification that might naturally occur in Squaw Creek Reservoir and will reduce the possible production in the reservoir.

5.5.2.2 Lake Granbury

The operational effects of CPSES on Lake Granbury can be classified into two types: (1) the effects of the withdrawal (entrainment and impingement) of diversion water into Squaw Creek Reservoir and (2) the effects of the discharge of blowdown water from Squaw Creek Reservoir.

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Withdrawal of Makeup Water

The facility for withdrawing makeup water from Lake Granbury has been discussed in Sect. 3.4.4. In the absence of information on the density of fish species in the area of the intake, standing crops and relative densities for Lake Granbury were estimated by extrapolating from data on Possum Kingdom, Lake Whitney, and two other Texas reservoir (ER, Sect. 5.1.3.1). These estimates were used by the applicant to calculate the number of fishes subject to impingement (34 to 44 lb of sport and commercial fish and 29 to 38 lb of other fish annually).

The shelter provided by the pump station support structure and the lights on the structure will attract fish to the intake area, but the low approach velocity at the screens will greatly reduce impingement losses. Table 5.5.1 lists the swimming speeds of a few species found in Lake Granbury and shows that most of the speeds are greater than 0.5 fps, which will be the approximate approach velocity to the screens (0.49 fps). The large mesh size of the screens (1-3/4 in.) will allow the smaller fish that cannot avoid the current to be pulled into the makeup line. The depth of the intake (30 ft below the surface) will also serve to reduce the possibility of impingement during periods of stratification in late summer. Although data on fish density in the area of the intake are lacking, the staff concludes losses from Lake Granbury due to impingement will not be significant.

In the absence of actual data on standing crops in Squaw Creek Reservoir, the staff must make the conservative assumption that none of the organisms withdrawn from Lake Granbury are replaced by the return water. Thus the withdrawal of makeup water will annually remove the plankton biomass contained in a maximum of 64,660 acre-ft. Using the maximum plankton populations of 9,900,000 phytoplankters/liter in July and 42 zooplankters/liter in May,[28] an annual total of 7.90×10^{17} phytoplankters and 3.35×10^{12} zooplankters will be withdrawn. An estimate of the biomass entrained, made in the same manner as in Sect. 4.3.2, results in 12,300,000 lb of phytoplankton and 460,000 lb of zooplankton being withdrawn annually. Based on the average plankton populations of the entire lake (refer to Sect. 2.7.2), these quantities are equal to 5.8% of the total phytoplankton standing crop per month and 1.6% of the total zooplankton standing crop per month. Most zooplankton organisms have generation times of one week to one month (*Keratella*, 22 days; *Brachionus*, 6 days),[6] and phytoplankters reproduce much more quickly. Thus the staff concludes that the plankton population will be able to compensate for the withdrawal.

Table 5.5.1. Swimming speeds of fish found in Lake Granbury

Name		Water temperature (°F)	Fish length (mm)	Fish observed (number)	Swimming speed (fps)	Source reference
Common	Scientific					
Channel catfish	*Ictalurus punctatus*	75	54	5	0.74	1
		80	57	1	1.74	2
		81	55	10	1.25	3
Bluegill	*Lepomis macrochirus*	65	43	1	1.23	2
		79	45	5	0.49	1
		86	49	5	0.41	1
White crappie	*Pomoxis annularis*	79	74	5	0.63	1
		84	60	5	0.38[a]	
Largemouth bass	*Micropterus salmoides*	85	50	2	1.28	2

[a]Results given in source reference 2 are very close to these values.

Source:

1. L. R. King, Swimming Speed of the Channel Catfish, White Crappie and Other Warm Water Fishes from Conowingo Reservoir, Susquehanna River, Pa., Ichthyological Associates Bulletin No. 4, 1969, pp. 1–74.
2. C. H. Hocutt, Swimming Speed of the Channel Catfish and Other Warm Water Fishes of Conowingo Reservoir as Determined in the Beamish Respirometer, pp. 289–303 in *Conowingo Reservoir–Muddy Run Fish Studies*, Progress Report No. 2, 1969.
3. L. R. King, Supplementary Results of Swimming Speed and Endurance Studies on White Perch as Determined by the Beamish Respirometer, Ichthyological Associates, 1970.

It is likely that the diversion intake will also entrain juvenile fishes. As discussed above, the large mesh size of the intake screens will allow many young fish that cannot avoid the intake velocity to be pulled through the screens. The pump support structure will attract fish to the intake and make the small juveniles vulnerable to entrainment.

After entrainment with the intake water, fishes will travel to the outfall in Squaw Creek Reservoir. Injury or mortality might be caused by the sudden reduction in pressure at the pumps, the return to 1 atm at the outfall, and the reaeration procedure, in which the water, discharged at an average velocity of 7 fps, will run over 50 ft of coarse riprap before entering Squaw Creek Reservoir.[37] It is possible that small fish and plankters that are entrained from Lake Granbury will be injured or will become lodged among the rocks.

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Larval fishes could also be an important component of the entrainable planktonic population. Since the muddy bottom at the intake is not conducive to the spawning of the most common fish in Lake Granbury (refer to Table B-4 and Sect. 2.7.2), it does not appear that the entrainment of fish eggs or larvae will be a problem.

The periods of low water level (late summer) are the times of stratification in Lake Granbury, when reduced populations will be in the hypolimnion. The deep intake will thus reduce the probability of entrainment during these periods. *Chaoborus*, however, has been found to be periodically abundant in the area of the intake (Table B-7). This species migrates to the surface at night while remaining on or near the bottom during the day and thus could be subject to entrainment.

It is the staff's conclusion that an adverse impact could result from the withdrawal of young fishes from Lake Granbury and their subsequent discharge from the makeup line but that, in the absence of real data on fish density and size distribution, the impact cannot be fully assessed. If the monitoring procedures required in Sect. 6.1.3.2 and 6.2.3.2 indicate a high mortality at the outfall, an alternate method of discharge will be required.

Discharge of blowdown water

The facility for discharge of blowdown water to Lake Granbury and the characteristics of the plume have been discussed in Sects. 3.4.4, 5.3.2, and 5.3.3. Maximum temperature differences will occur in January, when the discharge will be 13.3 F° warmer than the discharge location in Lake Granbury, and in July, when the discharge will be 18.2 F° cooler (Table 5.3.4). From June through October, the discharge will have a low dissolved oxygen level, with the concentration being 0.0 ppm from June through September. In other months, the dissolved oxygen levels of the discharge and ambient waters will be similar. The total dissolved solids concentration of the return will always be greater than that of Lake Granbury with a difference of +1155 ppm in January, which will make the disc... twice as concentrated as the receiving waters, and a minimum difference of +496 ppm in September.[38]

Of the 12 monthly simulations, those of primary ecological interest are September, when the plume is predicted to plunge to the bottom of the lake, and April through August, when the plume will break

the stratification in the receiving waters and move water from the hypolimnion to the surface.[38] The September plume is predicted to descend to the bottom at approximately 100 ft from the discharge. At this point, the temperature concentration will be near ambient conditions, and by the time the plume reaches bottom, the total dissolved solids will also be approaching ambient. The staff does not expect any effect on benthic organisms which might come into contact with this plume.

During the months of April through August, the plume is expected to destroy the thermocline in the receiving waters and bring to the surface (at approximately 75 ft from the discharge) waters that are low in dissolved oxygen (approximately 2 ppm) and 5° to 10° cooler. Fish will be able to move out of the affected area, but the total areas involved could not be predicted. It is possible that the plume will move planktonic organisms up from the deeper waters, thus increasing the populations in the affected area. If hydrogen sulfide develops in the hypolimnion during late summer, the plumes might circulate some of it to the surface. The effects of hydrogen sulfide on aquatic organisms have been discussed in Sect. 4.3.2.

The maximum temperature of the discharge water is predicted to be 74.6°F (in October), and therefore it is expected that no thermal exclusion zones will be formed. The minimum temperature will be 61.4° in December, and the discharge will remain warmer than the receiving waters from October through March, with a maximum difference of 13.3 F° in January. Fish will probably be attracted to the area of the discharge during the winter months.

The high total dissolved solids level of the discharge is not expected to have any significant effect on Lake Granbury. The 1400-ppm contour is usually reached within 75 ft of the point of discharge, and the annual average volume within this contour (excluding September) is 3865 cu ft. In September, the volume within the 1600-ppm contour is 12000 cu ft.

The staff concludes that there will be no significant effects on Lake Granbury associated with the discharge of blowdown water from Squaw Creek Reservoir.

5.6 IMPACTS ON PEOPLE

5.6.1 Physical impacts

The site is sufficiently remote that the noise of operating machinery should not be audible to local residents. The air pollution resulting from occasional operation of the diesel engines on emergency equipment will not be significant.

There is not expected to be any pollution of groundwater resources. Surface water pollution will be controlled and maintained within State standards. Provisions will be made for sanitary treatment and disposal of sewage in an evaporation pond to preclude any pollution of water resources.

Transportation of the operating personnel is expected to have only a minor impact on traffic. The upgrading of roads for construction will be more than adequate for continued use during operation. The infrequent use of the railroad spur will have only minor effect on traffic on FM Road 51 where they cross. There will be some continuing aesthetic impacts where the CPSES transmission lines are visible from roads and residential areas.

5.6.2 Population growth and operating personnel income

The applicant estimates a minimum operating work force of 67. The staff estimates that the average could be 80. The applicant has estimated the distribution of the residences of the operating personnel (ER, Sect. 8.1.3.2). About one-half of the workers are expected to live in Somervell and Hood counties. The staff estimates that there may be as many as 16 new families in Somervell County and 24 in Hood County. Using the Texas statewide average of 3.17 persons per household, the increase in population would be about 51 in Somervell County and about 76 in Hood County. The estimated increase in school-age children would be about 12 in Somervell County and about 16 in Hood County.

The estimated annual operating payroll within the six-county area in 1980 is about $1 million (ER, Table 8.1-8).

5.6.3 Impact on community services

The availability of housing in Hood and Somervell counties and the surrounding four counties (see Fig. 2.1.1) was discussed in Sect. 4.4.3. There is expected to be sufficient housing available for the operating force as the construction phase ends.

The availability of domestic water and sewage disposal in Hood and Somervell counties was discussed in Sect. 4.4.3. The increase in these services required during the construction phase should be adequate for the incremental increase required for CPSES workers.

The CPSES operator residences should not add significantly to the police and fire protection facility requirements in Hood and Somervell counties.

5.6.4 Impact on local institutions

The taxes which will be paid by the applicant were discussed in Sect. 4.4.4. Hood and Somervell counties and the Independent School Districts will be able to tax the project. The estimated tax revenues are considered adequate by the staff to cover the cost of increased county and school services resulting from CPSES operation. There is, however, no present way that the cities of Glen Rose and Granbury can tax CPSES. The applicant states in the ER that an approach that should be thoroughly investigated is to take advantage of the State law that permits a county government to provide a wide range of services, including water and sewer systems, within boundaries of incorporated cities. This approach would thus permit some of the CPSES-generated tax revenues to Somervell County to be used directly in meeting increased community service requirements in Glen Rose generated by CPSES workers (ER, p. 8.1-27).

5.6.5 Impact on recreational capacity of area

Squaw Creek Reservoir could have facilities available after it is filled for daily recreational visitor use, but the applicant states in the ER (ER, p. 8.1-28) that the area surrounding the reservoir would not be available to development of water-oriented housing as in the case of Lake Granbury.

There will be an aesthetic impact where the CPSES-related transmission lines cross Lake Granbury.

5.6.6 Conclusions

The staff concludes that the impacts on the community as a result of operation of CPSES are acceptable.

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6. ENVIRONMENTAL MEASURES AND MONITORING PROGRAMS

6.1 PREOPERATIONAL PROGRAMS

6.1.1 Hydrological

The applicant has developed a preoperational program (ER, Sect. 6.1) which the staff has reviewed and found to be adequate to establish base-line hydrological conditions if the program is expanded to include the following:

1. Concentrations of those characteristics or constituents listed in Table II-1 of *Water Quality Criteria* (Federal Pollution Control Administration, U.S. Department of the Interior, 1968) which can reasonably be expected to be affected by station operation shall be determined every two months at the point of discharge of the return line from Squaw Creek Reservoir. Measurements shall shall start at least two years before CPSES operation.

2. The water quality measurements at the Squaw Creek Station below the Squaw Creek Dam (U.S. Geological Survey stream gaging station at the intersection of Squaw Creek and State Highway 144) shall start at least six months before construction is initiated.

3. The Group III measurements in Table 6.1-1 of the ER shall be made at least every six months. Measurements shall start at least two years before CPSES operation.

4. Extensive well testing to adequately document that the capability of the Twin Mountains formation is sufficient to yield the required groundwater supplies for CPSES operation without adverse effects. The results of the test(s) will identify the zone of influence of the well field and its potential for adversely affecting neighboring wells and will aid in establishing the safe yield of the aquifer (refer to Sect. 11.6.7).

6.1.2 Meteorological

The pre-operational meteorological program, initiated May 15, 1972, consists of a 60 m tower, situated about 1500-ft east of the proposed reactor structures. After the Squaw Creek Reservoir is filled, the tower will be on a peninsula with the reactor structures.

Instrumentation on the meteorology tower consists of wind speed and direction sensors at 9 m and 60 m, vertical temperature gradient measured between 9 m and 30 m and between 9 m and 60 m, and dewpoint temperature sensors at 9 m and 60 m. Other parameters measured are ambient temperature, precipitation, and solar radiation. The

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primary data collection system is magnetic tape, with strip charts forming the secondary system. The magnetic tape data are compared with the strip charts to check the reliability of the system. Personnel visit the site at least once per week to check the recorders and perform any emergency maintenance that may be required. A log is kept at the site and observations are made concerning the status of the system and maintenance performed during each visit. Routine calibration is performed every six months and the findings recorded.

6.1.3 Ecological

6.1.3.1 Terrestrial

Base-line studies

The initial terrestrial ecology study was begun in the fall of 1972. This study and subsequent preconstruction studies will be used as the basis to assess the effects of site preparation and construction. The base-line study was designed to establish species composition of the terrestrial ecosystems of the site. Table 6.1.1 contains a summary of the preconstruction terrestrial monitoring program.

Construction effects monitoring

The construction effects preoperational terrestrial monitoring program is designed to give guidance during site preparation and construction so that (1) ecosystem degradation, as measured by either the reduction or increase in important flora and fauna, will be minimized, (2) the quantity and quality of important flora and fauna may be maintained or increased, and (3) future problem areas may be detected. Preconstruction studies focus on identifying loss in terms of important species, habitat types, and productivity. These studies will be suspended in the direct impact zones at the onset of major construction activity in the area. Where new habitats are created as a result of construction activities, studies will be initiated to observe the development of certain components of the newly created community. The indirect impact zones include all areas in which the biota may be indirectly affected by construction. These studies will observe changes in the presence and abundance of important species and habitat types as a result of potential changes in physical, chemical, and biological features of the direct impact zones.

The terrestrial sampling program will concentrate on four primary groups of organisms: vegetation, invertebrates, birds, and mammals. The majority of the sites described in the base-line study are direct impact locations in the reservoir area.

Table 6.1.1. Terrestrial monitoring program

Parameter	Items sampled	Methodology	Sampling location		Annual sampling schedule	Current status
			Direct	Indirect		
Species diversity	Vegetation	Identify species from plots in each location with Daubenmire frame, line transects, and point-centered quarter analysis techniques	Cross Timbers, Savanna, Slopes, Benches, Riparian		Fall Summer – every two years	Completed In progress
	Birds	Observation and strip census designed for density estimates	Slopes, Benches, Riparian	Cross Timbers, Slopes, Savanna, Benches, Riparian, Ashe Juniper	Update with new observations	Completed
	Mammals Small	Small mammals kill-trapped and live-trapped in single lines or grids	Fencerow, Slope, Bench, Riparian	Savanna, Fencerow	Fall and spring	In progress
	Bats	Document for current base line, collect with shotgun loaded with dust shot	Riparian	Uplands	Collect when encountered in spring, summer, and fall	Proposed
	Medium	Kill traps at 350-m intervals in single lines; dens, scats, tracks, and other signs recorded	Uplands, lowlands	Uplands	Update with new observations	Completed
	Invertebrates	Describe current base-line community structure	Slopes, Benches, Riparian	Cross Timbers, Slopes, Savanna, Benches, Riparian	Summer	Proposed
Species frequency	Vegetation	Describe community heterogeneity with Daubenmire frame, line transects	Slopes, Benches, Riparian	Cross Timbers, Savanna	Fall	Completed
	Birds	Comparative analysis of species diversity within and between habitats with strip census and observations	Savanna, Slopes, Benches, Riparian	Cross Timbers, Savanna Slopes, Benches, Riparian	Spring, summer	In progress
	Mammals Small	Comparative analysis between habitat communities with live traps and snap traps in single lines or grids	Fencerow, Slope, Bench, Riparian	Savanna, Fencerow	Fall	Completed
		Live-trap grid; 4 lines with 25 traps; 10-m trap interval; in each designated community		Cross Timbers, Savanna, Slopes, Benches, Riparian	Fall	In progress

Source: Table 6-13, ER.

In addition to the measures of species diversity of the vegetation previously discussed, spermatophyte standing crop will be determined by subsampling within larger plots judged to be representative of each of the vegetation communities located in the indirect impact zones; perennial-plant age structure will be determined by counting growth rings of samples taken with an increment borer from trees and shrubs; and net primary production will be assessed by the clip-plot technique.

The goals of the invertebrate sampling program are (1) to identify those species whose individuals comprise 95%, both by biomass and by number, of the populations of each major taxon and (2) to discriminate any trends in populations exposed to potential impacts which differ from trends observed in control populations. The significance of indicator species will be examined.

The avian studies conducted in the fall of 1972 will be continued during the preoperational monitoring program with the following exception: avian densities and species frequency between habitats will be determined seasonally in the six vegetative communities located in indirect, as well as direct, impact zones. Census routes will be conducted among vegetation communities and along contour lines where homogeneous communities occur. The species diversity of birds will be seasonally updated with the data obtained by the strip census. The census of birds in the direct impact locations will cease when construction begins in the respective zones. The parameters will assist in describing the natural variation common among avian populations before construction begins. Avian species which may occur in the Squaw Creek Reservoir area and which will receive special attention are listed in Table 6.1.2.

Several changes will be made in the mammal monitoring program. Live trapping will be used to estimate small mammal densities, species diversity, and frequency among and between habitats in each of the six permanently marked vegetation communities during the fall season. A spring season snap trapping program is proposed to describe the breeding status and number of young per female. Trapping should proceed for a minimum of one day during the spring only. The density of medium-sized mammals as well as their frequency and diversity among different habitats will be measured in the uplands and lowlands. A new lowland site will be chosen southeast of the proposed site where construction activities will not occur. Live trapping will be conducted for a minimum duration of two weeks during the fall of each year.

As part of the preoperation monitoring program, the amount of selected pesticides, herbicides, and heavy metals in soil on the site will be determined. The sampling will be correlated with

Table 6.1.2. Important avian species in Squaw Creek Reservoir area

Scientific name	Common name	Seasonal status[a]	Trophic position[b]	Habitats[c]	Population status[d]
Ardea herodias	Great blue heron	SP, SU, F, W	TC	R, U*	
Butorides virescens	Green heron	SU	TC	R*, U*	
Cathartes aura	Turkey vulture	SP, SU, F, W	D	R*, U*	
Coragyps atratus	Black vulture	SP, SU, F, W	D	R*, U*	
Accipiter cooperii	Cooper's hawk	F, W	TC	R, U	
Accipiter striatus	Sharp-shinned hawk	F, W	TC	R, U	
Buteo jamaicensis	Red-tailed hawk	SP, SU, F, W	TC	U*, R*	
Buteo swainsoni	Swainson's hawk	SP, SU	TC	U	
Buteo lagopus	Rough-legged hawk	F, W	TC	U*	
Aquila chrysaetos	Golden eagle	SP, SU, F, W	TC	U	
Haliaeetus leucocephalus	Bald eagle	F, W	TC	R, U	Endangered
Circus cyaneus	Marsh hawk	SP, F, W	TC	U*, R	
Pandion haliaetus	Osprey	SP, SU, F, W	TC	R*	Undetermined
Ictinia mississippiensis	Mississippi kite	SU	TC	R	
Falco columbarius	Pigeon hawk	SP, F	TC	U	Undetermined
Falco mexicanus	Prairie falcon	SP, W	TC	U	Threatened
Falco peregrinus	Peregrine falcon	SP, F, W	TC	R, U	Endangered
Falco sparverius	Sparrow hawk	SP, SU, F, W	TC	U*	
Geococcyx californianus	Roadrunner	SP, SU, F, W	TC	U	
Tyto alba	Barn owl	SP, SU, F, W	TC	U, R	
Bubo virginianus	Great horned owl	SP, SU, F, W	TC	R*, U	
Otus asio	Screech owl	SP, SU, F, W	TC	R*, U	
Strix varia	Barred owl	SP, SU, F, W	TC	R, U	
Megaceryle alcyon	Belted kingfisher	SP, SU, F, W	TC	R*, U*	
Lanius ludovicianus	Loggerhead shrike	SP, SU, F, W	TC	U	
Dendroica chrysoparia	Golden-cheeked warbler	SP, SU	I	U, R	Threatened
Colinus virginianus	Bobwhite quail	SP, SU, F, W	G	R, U	
Zenaidura macroura	Mourning dove	SP, SU, F, W	G	R, U	

[a]SP, spring; SU, summer; F, fall; W, winter. Because of the rarity of many of these species, seasonal status is largely drawn from the literature.

[b]G, granivore; I, insectivore; TC, top carnivore; D, detritivore.

[c]R, riparian; U, upland. Asterisk designates habitats where observed.

[d]From Office of Endangered Species and International Activities, 1973; referenced in ER.

Source: ER, Table 6.1-14, modified by the staff.

times of pesticide application and meteorological conditions. Soil cores will be taken at 300-ft intervals in bottomlands along Squaw Creek. Standard gas chromatographic methods will be used for analysis of residues.

Staff Evaluation

The staff finds the base-line studies to be complete, except for those items noted below.

1. The lack of data on amphibians and reptiles.
2. The use of steel traps in sampling the medium-sized mammals.
3. The lack of data on certain mammals such as fox squirrels, jackrabbits, and armadillo.

The staff concludes that problems 2 and 3 (above) will be corrected in the implementation of the construction effects monitoring program. The invertebrate sampling program may identify indicator species that will be extremely useful in assessing impacts on amphibians and reptiles. The proposed measures and estimates of certain functional ecosystem attributes represent positive steps forward in ecosystem analysis.

6.1.3.2 Aquatic

The staff finds that the preoperational monitoring program as discussed in the ER (ER, Sect. 6.1) will provide adequate background data to characterize the areas which might be adversely affected by the construction and operation of CPSES, with the following exceptions.

One or two sampling stations should be added between site 6 (ER, Fig. 6.1-1) and the point of release of water from Lake Granbury into Squaw Creek to characterize the populations which will be most affected. This should include a site immediately below the release point. A program for sampling fish larvae near the area diversion intake on Lake Granbury should be instituted to determine whether the area provides spawning or nursery habitat for fishes. Diurnal zooplankton sampling should be done in the intake area to characterize the vertical migration of species such as *Chaoborus*.

6.1.4 Radiological

The applicant has proposed an offsite radiological monitoring program to provide surveillance and backup support to detailed effluent

monitoring (Regulatory Guide 1.21). This program is needed in order to evaluate individual and population exposure and the ecological significance, if any, of the contributions to the existing environmental radioactivity levels that result from station operation at design levels. The monitoring program is to provide assurance that the contribution of radioactivity to the environment, and hence population dose, is indeed negligible. The applicant proposes to monitor aquatic organisms, terrestrial vegetation and crops, river water, groundwater, airborne particulates, radiation dose and dose rate, river bottom sediment, and milk. The preoperational phase should be implemented for two years before operation of Unit 1. The program is detailed in the applicant's Environmental Report and includes discussion of criteria for selection of sampling location and collection frequency, as well as type of sample or measurement.

6.2 OPERATIONAL PROGRAMS

The applicant discussed the operational monitoring program in the ER (ER, Sect. 6.2) and this has been reviewed by the staff. Since the action proposed pertains to issuance of construction permits, detailed staff evaluation of this program will be done at the time of application for an operating license.

7. ENVIRONMENTAL EFFECTS OF ACCIDENTS

7.1 PLANT ACCIDENTS INVOLVING RADIOACTIVE MATERIALS

A high degree of protection against the occurrence of postulated accidents in the Comanche Peak Steam Electric Station is provided through correct design, manufacture, and operation, and the quality assurance program used to establish the necessary high integrity of the reactor system, as will be considered in the Commission's Safety Evaluation. Deviations that may occur are handled by protective systems to place and hold the plant in a safe condition. Notwithstanding this, the conservative postulate is made that serious accidents might occur, even though they may be extremely unlikely; and engineered safety features are installed to mitigate the consequences of those postulated events which are judged credible.

The probability of occurrence of accidents and the spectrum of their consequences to be considered from an environmental effects standpoint have been analyzed using best estimates of probabilities and realistic fission product release and transport assumptions. For site evaluation in the Commission's safety review, extremely conservative assumptions are used for the purpose of comparing calculated doses resulting from a hypothetical release of fission products from the fuel against the 10 CFR Part 100 siting guidelines. Realistically computed doses that would be received by the population and environment from the accidents which are postulated would be significantly less than those to be presented in the Safety Evaluation.

The Commission issued guidance to applicants on September 1, 1971, requiring the consideration of a spectrum of accidents with assumptions as realistic as the state of knowledge permits. The applicant's response was contained in the "Comanche Peak Steam Electric Station Environmental Report" dated July 18, 1973.

The applicant's report has been evaluated, using the standard accident assumptions and guidance issued as a proposed amendment to Appendix D of 10 CFR Part 50 by the Commission on December 1, 1971. Nine classes of postulated accidents and occurrences ranging in severity from trivial to very serious were identified by the Commission. In general, accidents in the high potential consequence end of the spectrum have a low occurrence rate and those on the low potential consequence end have a higher occurrence rate. The examples selected by the applicant for these cases are shown in Table 7.1. The examples selected are reasonably homogeneous in terms of probability within each class.

Table 7.1 Classification of Postulated Accidents and Occurrences

Class	AEC Description	Applicant's Examples
1.	Trivial incidents	Small spills or leaks.
2.	Small releases outside containment	Leakage from valve stems, pipe flanges, or pump seals. Releases from relief valves.
3.	Radioactive waste system Failure	Equipment leakage or malfunction. Release of waste gas storage tank contents. Release of liquid waste storage tank contents.
4.	Fission products to primary system (BWR)	Not applicable.
5.	Fission products to primary and secondary systems (PWR)	Fuel cladding defects and steam generator leakage. Off-design transients that induce fuel failures above those expected in conjunction with steam generator leakage. Steam generator tube rupture.
6.	Refueling accident	Fuel bundle drop. Heavy object drop onto fuel in core.
7.	Spent fuel handling accident	Fuel assembly drop in fuel storage pool. Heavy object drop onto fuel rack. Fuel cask drop.
8.	Accident initiation events considered in design-basis evaluation in the Safety Analysis Report	Loss-of-coolant accidents, rod ejection accident, steam line breaks outside containment.
9.	Hypothetical sequence of failures more severe than Class 8	Not considered.

Commission estimates of the dose which might be received by an assumed individual standing at the site boundary in the downwind direction, using the assumptions in the proposed Annex to Appendix D, are presented in Table 7.2. Estimates of the integrated exposure that might be delivered to the population within 50 miles of the site are also presented in Table 7.2. The man-rem estimate was based on the projected population within 50 miles of the site for the year 2020.

To rigorously establish a realistic annual risk, the calculated doses in Table 7.2 would have to be multiplied by estimated probabilities. The events in Classes 1 and 2 represent occurrences which are anticipated during plant operations; and their consequences, which are very small, are considered within the framework of routine effluents from the plant. Except for a limited amount of fuel failures and some steam generator leakage, the events in Classes 3 through 5 are not anticipated during plant operation; but events of this type could occur sometime during the 40 year plant lifetime. Accidents in Classes 6 and 7 and small accidents in Class 8 are of similar or lower probability than accidents in Classes 3 through 5 but are still possible. The probability of occurrence of large Class 8 accidents is very small. Therefore, when the consequences indicated in Table 7.2 are weighted by probabilities, the environmental risk is very low. The postulated occurrences in Class 9 involve sequences of successive failures more severe than those required to be considered in the design bases of protection systems and engineered safety features. Their consequences could be severe. However, the probability of their occurrence is judged so small that their environmental risk is extremely low. Defense in depth (multiple physical barriers), quality assurance for design, manufacture and operation, continued surveillance and testing, and conservative design are all applied to provide and maintain a high degree of assurance that potential accidents in this class are, and will remain, sufficiently small in probability that the environmental risk is extremely low.

The AEC is currently performing a study to assess more quantitatively these risks. The initial results of these efforts are expected to be available in 1974. This study is called the Reactor Safety Study and is an effort to develop realistic data on the probabilities and sequences of accidents in water cooled power reactors, in order to improve the quantification of available knowledge related to nuclear reactor accidents probabilities. The Commission has organized a special group of about 50 specialists under the direction of Professor Norman Rasmussen of MIT to conduct the study. The scope of the study has been discussed with EPA and described in correspondence with EPA which has been placed in the AEC Public Document Room (letter, Doub to Dominick, dated June 5, 1973).

TABLE 7.2 SUMMARY OF RADIOLOGICAL CONSEQUENCES OF POSTULATED ACCIDENTS[a]

Class	Event	Estimated Fraction of 10 CFR Part 20 limit at site boundary[b]	Estimated Dose to Population in 50-mile radius, man-rem
1.0	Trivial Incidents	c	c
2.0	Small releases outside containment	c	c
3.0	Radwaste System Failures		
3.1	Equipment leakage or mal-function	0.018	3.1
3.2	Release of waste gas storage tank contents	0.072	12.
3.3	Release of liquid waste storage contents	0.002	0.34
4.0	Fission products to primary system (BWR)	N.A.[d]	N.A.[d]
5.0	Fission products to primary and secondary systems (PWR)		
5.1	Fuel cladding defects and steam generator leaks	c	c
5.2	Off-design transients that induce fuel failure above those expected and steam generator leak	<0.001	<0.1
5.3	Steam generator tube rupture	0.024	4.1
6.0	Refueling accidents		
6.1	Fuel bundle drop	0.004	0.65
6.2	Heavy object drop onto fuel in core	0.066	11.
7.0	Spent fuel handling accident		
7.1	Fuel assembly drop in fuel rack	0.002	0.41
7.2	Heavy object drop onto fuel rack	0.01	1.6
7.3	Fuel cask drop	0.056	10

TABLE 7.2 (Cont'd)

Class	Event	Estimated Fraction of 10 CFR Part 20 limit at site boundary[b]	Estimated Dose to population in 50-mile radius, man-rem
8.0	Accident initiation events considered in design basis evaluation in the SAR		
8.1	Loss-of-Coolant Accidents		
	Small Break	0.04	12.
	Large Break	0.36	410.
8.1(a)	Break in instrument line from primary system that penetrates the containment	N.A.	N.A.
8.2(a)	Rod ejection accident (PWR)	0.036	41.
8.2(b)	Rod drop accident (BWR)	N.A.	N.A.
8.3(a)	Steamline breaks (PWR's outside containment)		
	Small Break	<0.001	<0.1
	Large Break	<0.001	<0.1
8.3(b)	Steamline break (BWR)	N.A.	N.A.

[a]The doses calculated as consequences of the postulated accidents are based on airborne transport of radioactive materials resulting in both a direct and an inhalation dose. Our evaluation of the accident doses assumes that the applicant's environmental monitoring program and appropriate additional monitoring (which could be initiated subsequent to a liquid release incident detected by in-plant monitoring) would detect the presence of radioactivity in the environment in a timely manner such that remedial action could be taken if necessary to limit exposure from other potential pathways to man.

[b]Represents the calculated fraction of a whole body dose of 500 mrem, or the equivalent dose to an organ.

[c]These releases are expected to be in accord with proposed Appendix I for routine effluents.

[d]N.A. means "not applicable."

As with all new information developed which might have an effect on the health and safety of the public, the results of these studies will be made public and would be assessed on a timely basis within the regulatory process on generic or specific cases as may be warranted.

Table 7.2 indicates that the realistically estimated radiological consequences of the postulated accidents would result in exposures of an assumed individual at the site boundary to concentrations of radioactive materials that are within the Maximum Permissible Concentrations (MPC) of 10 CFR Part 20. The table also shows the estimated integrated exposure of the population within 50 miles of the plant from each postulated accident. Any of these integrated exposures would be much smaller than that from naturally occurring radioactivity. When considered with the probability of occurrence, the annual potential radiation exposure of the population from all the postulated accidents is an even smaller fraction of the exposure from natural background radiation and, in fact, is well within naturally occurring variations in the natural background. It is concluded from the results of the realistic analysis that the environmental risks due to postulated radiological accidents are exceedingly small and need not be considered further.

7.2 TRANSPORTATION ACCIDENTS INVOLVING RADIOACTIVE MATERIALS

As discussed in Section 5.4.2.4, the Commission's staff has recently completed an analysis of the potential impact on the environment of transporting fuel and solid radioactive wastes for nuclear power plants under existing regulations. The results of this analysis were published in a report entitled "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," dated December 1972. The report contains an analysis of the probabilities of occurrences of accidents and the expected consequences of such accidents, as well as the potential exposures to transport workers and the general public under normal conditions of transport.

For the Comanche Peak Steam Electric Station (CPSES), the characteristics of the reactor fuel and wastes and the conditions of transport for the fuel and waste fall within the scope of the Environmental Survey of Transportation.

The initial fuel supply for each of the CPSES units will be supplied by Westinghouse Electric Company. At present the Westinghouse fabrication facilities are located in Columbia, South Carolina. The new fuel elements will be shipped approximately 1100 miles from the fabrication plant to the site by truck.

Spent fuel elements removed from the reactors will be unchanged in appearance and will contain some of the original U-235 (which is recoverable). As a result of the irradiation and fissioning of the uranium, the fuel elements will contain large amounts of fission products and some plutonium. As the radioactivity decays, it produces radiation and heat. The amount of radioactivity remaining in the fuel varies with the length of time after discharge from the reactor. After removal from the reactors, the fuel elements are placed under water in a storage pool to radioactively decay before being loaded into a cask for transport. The irradiated fuel elements will be shipped, after an appropriate decay period, in AEC-DOT approved casks designed for transport. [The maximum shipping distance would be approximately 1500 miles.]

Solid radioactive wastes will be shipped by truck to a licensed burial site in accordance with AEC and DOT regulations. Two AEC licensed burial sites (Morehead, Kentucky, or Sheffield, Illinois) are approximately 1000 miles from the plant site. Approximately 60 shipments per year for both units will be needed.

In accordance with the proposed amendment (Sect. F) to Appendix D of 10 CFR Part 50, published on February 5, 1973, and the subsequent rule-making hearings, Table 7.3 summarizes the environmental impact of accidents during transportation of fuel and waste to and from the plant. (Normal conditions of transport were summarized in Table 5.4.4.)

TABLE 7.3. ENVIRONMENTAL IMPACT OF ACCIDENTS DURING TRANSPORTATION OF FUEL AND WASTE TO AND FROM THE COMANCHE PEAK STEAM ELECTRIC STATION

Aspect	Environmental risk
Radiological effects	Small
Common (nonradiological) causes	1 fatal injury in 100 years; 1 nonfatal injury in 10 years; $475 property damage per year

8. THE NEED FOR POWER GENERATING CAPACITY

This section sets forth the staff's assessment of need for additional generating capacity in the time frame proposed. Considerations are given to the applicant's service area, regional relationships, the system power requirements, power supply, and requirement for reserve.

8.1 DESCRIPTION OF THE POWER SYSTEM

8.1.1 Applicant's service area

The applicant, Texas Utilities Generating Company, will operate CPSES for three joint owners; these are: Dallas Power and Light Company (DPL), Texas Electric Service Company (TES), and Texas Power and Light Company (TPL). The above companies are all subsidiaries of Texas Utilities Company (TUC) and along with other TUC subsidiaries comprise the Texas Utilities Company System (TUCS).

The TUCS service area is shown in Fig. 8.1.1. Examination of this figure indicates that this system supplies electrical energy to approximately one-third of the State of Texas geographically. This system contains slightly more than one-third of the State's generating capacity. This capacity is about equally divided between the three joint owners of CPSES. The most heavily populated area, the most industrialized segment of the service area, and the predominant load centers are all in the fast-growing region in the Dallas-Fort Worth area including the TPL Central Division. In 1972 this area accounted for 61% of total system load (ER, Table 1.1-1a).

8.1.2 Regional relationships

The joint owners of CPSES (DPL, TES, and TPL) are all members of the Texas Interconnected System (TIS), which is a group of nine interconnected utilities serving the bulk of the State of Texas. Six of these systems are privately owned, and the remainder are publicly owned. This affiliation was established some 30 years ago for reliability purposes but imposes no obligation on members. Each member is expected, however, on the average, to maintain a minimum capacity reserve of 15% above expected peak load (ER, p. ii).

The TIS members are also members of the Electric Reliability Council of Texas (ERCOT), which is one of nine regional councils of the National Electric Reliability Council (NERC). Membership of ERCOT

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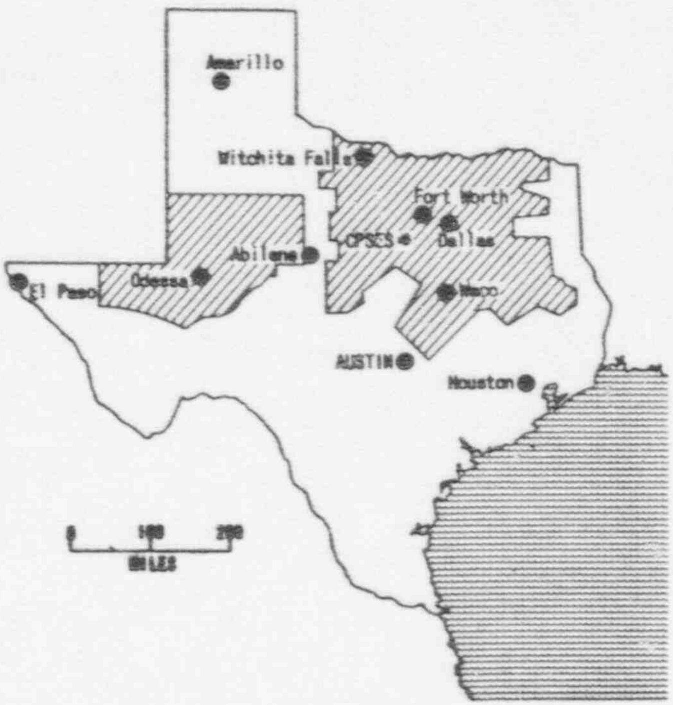

Fig. 8.1.1. Applicant's service area.
Source: ER, Fig. 1.1-4.

is composed of 28 municipalities, 47 cooperatives, 8 investor-owned companies, and 1 State agency. As one of the nine regional NERC councils, ERCOT[1] participates in review of national planning to solve power problems, considers design and operating criteria to enhance the reliability of service by each member to its customers, and annually reports to the FPC current and projected data concerning the electric power supply in its region. However, the principal expectation placed upon ERCOT members (ER, p. iii) is that, on the average, reserve margins will be maintained above 15% of expected peak load.

A basic operating philosophy among ERCOT members[2] is that each member will supply the requirements of its customers without heavy reliance upon interchange except under abnormal circumstances. Under normal circumstances, interties are operated lightly loaded, which allows the spinning reserves of each entity to be available for contingencies elsewhere within the system. Interties are not maintained with neighboring power pools.[3] The ERCOT members have a good record of serving their firm load obligations over the years,[2] and this policy serves to insulate the system from problems of neighboring systems.

The position of joint owners of CPSES within the State (December 1970) from the standpoint of capacity is shown in Fig. 8.1.2. At that time DPL, TES, and TPL owned 36% of the State generating resources and, as ERCOT members, were intertied with other utilities supplying collectively about 85%[2] of the electric power needs of Texas. The 345-kV intertie system linking major entities of TIS and ERCOT is shown in Fig. 8.1.3.

8.2 POWER REQUIREMENTS

8.2.1 Energy consumption

A recent report[2] issued by the Office of the Governor, Division of Planning Coordination, State of Texas, indicates history of statewide energy growth of 10% per year. This is somewhat similar to the applicant's experience (ER, Table 1.1-10), with a 1963-72 growth in electrical energy sales of 10.5% per year. The applicant predicts future growth to be at an average annual rate of 9.7% to 1980 and 7.6% between 1980 and 1984 (ER, Table 1.1-10). Sales by customer class for 1972 were as follows:

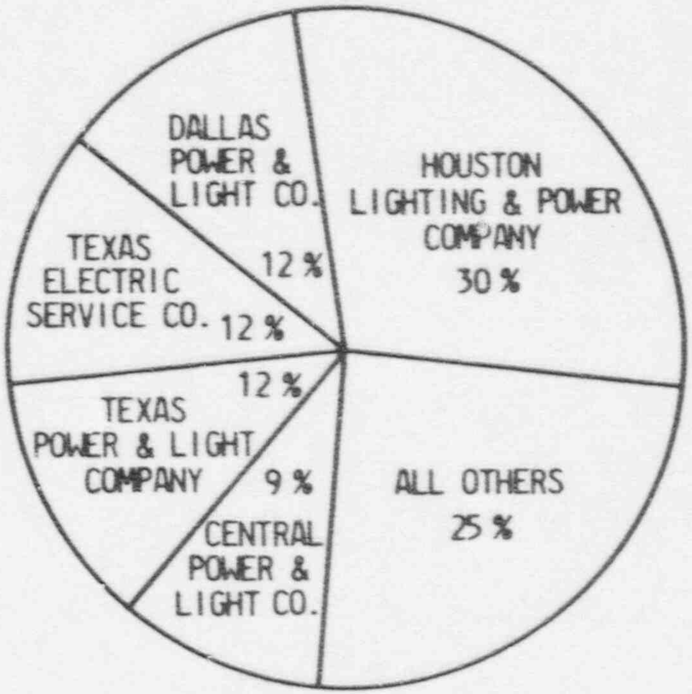

Fig. 8.1.2. Distribution of electrical generating capacity in Texas as of December 31, 1970.
Source. Lyndon B. Johnson School of Public Affairs, Policy Research Projects: State Planning for Nuclear (and Electric) Power, Report Phase 1, "Electric Demand, Power Facilities, and Energy Resources of Texas," University of Texas at Austin, December 1972, p. 62.

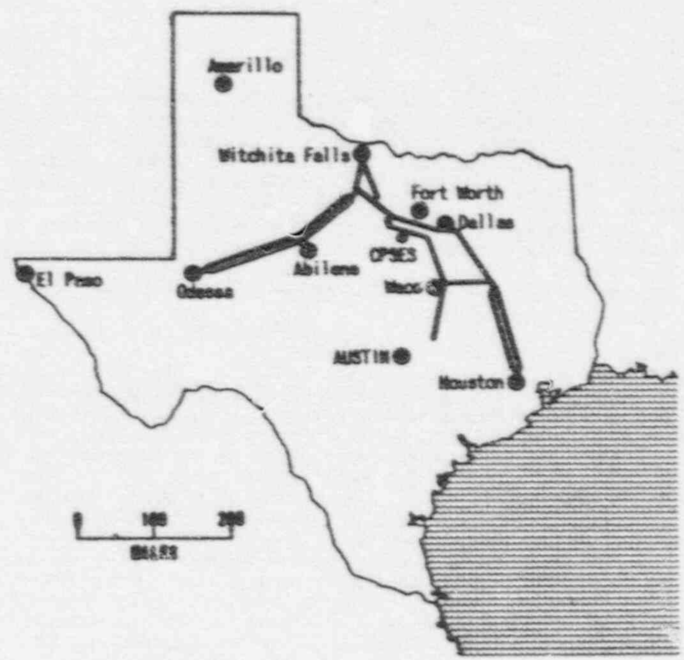

Fig. 8.1.3. ERCOT 345-kV load transfer system.
Source: Office of the Governor, Division of Planning Coordination, "Electric Power in Texas," November 1972.

	Sales (MWhr)	Percent
Residential	12,748,036	34
Commercial	9,471,615	26
Industrial	11,535,114	31
Government and municipal	1,227,335	3
Other utilities	2,379,287	6
Total	37,361,387	100

(Source: ER, Table 1.1-10)

8.2.2 Peak load demand

The history of the applicant's load and resource growth experience through 1972 and the projection to 1984 are given in Table 8.2.1. Also shown is the percent of annual increase in peak load. Historically the average annual increase between 1963 and 1972 was 9.2% per year.

Table 8.2.1. TUCS loads and resources, 1963–1984

Interruptible loads not included

Year	Resources[a] (MW)	Peak hour loads[a] (MW)	Percent increase in peak hour load	Percent reserve (% of peak hour load)
1963	4,272.6	3,770.6		13.3
1964	4,660.4	4,181.9	10.9	11.4
1965	5,000.4	4,330.7	3.6	15.5
1966	5,658.6	4,891.1	12.9	15.7
1967	6,493.4	5,410	10.6	20.0
1968	7,027.8	5,699	5.3	23.3
1969	7,402.8	6,828	19.8	8.4
1970	8,314.8	7,188	5.3	15.7
1971	9,062.5	7,679	6.8	18.0
1972	10,354.5	8,285	7.9	25.0
1973	10,929.5	8,670[b]	4.6	26.1
1974	12,007.0	10,286	18.6	16.7
1975	13,357.0	11,218	9.1	19.1
1976	14,237.7	12,224	9.0	16.5
1977	15,472.7	13,310	8.9	16.2
1978	16,972.7	14,489	8.9	17.1
1979	18,472.7	15,752	8.7	17.3
1980[c]	20,223.2	17,100	8.6	18.8
1981[c]	21,635.7	18,536	8.4	16.7
1982[c]	23,348.2	20,074	8.3	16.3
1983[c]	25,563.7	21,722	8.2	17.7
1984[c]	27,463.7	23,484	8.1	16.9

[a]Applicant's ER, Amendment 1, Table 1.1-8, except 1973 figures, which are now historical.
[b]Actual instead of predicted.
[c]Including Comanche Peak.

The increase in 1973 was only 4.6%. (The staff attributes this largely to unusually cool weather conditions.) In projecting peak-hour requirements the applicant has estimated an 18.6% increase for 1974 but from 1975 through 1984 has projected a declining annual increase from 9.1% to 8.1%. The average annual rate of increase over the 1973 to 1984 period is 9.1%. This suggests a declining rate of growth (1963-72 vs 1973-84). Projections of several others summarized in a recent report by Ebasco Services Inc.[4] suggest that the growth rate might increase between 1973 and 1984.

8.2.3 The Impact of Energy Conservation and Substitution on Need for Power

Recent energy shortages have focused the Nation's attention on the importance of energy conservation as well as measures to increase the supply of alternative energy sources. The need to conserve energy and to promote substitution of other energy sources for oil and gas have been recommended by the Report to the President on the Nation's Energy Future as major efforts in regaining national energy self-sufficiency by 1980.[5] In the following sections, the staff considers conservation of energy as related to the need for the electricity to be produced by the CPSES.

8.2.3.1 Promotional Advertisement

In the past, electric utilities have attempted, through advertising, to accelerate the demand for electricity in their service areas. Generally, the major thrust of advertising was to promote demand during off-peak periods, thereby covering expensive peaking capacity with expanded lower cost baseload capacity. Notably electric space and water heating has been promoted to offset increasing air conditioning and, hence, summer peaking demands.

The applicant terminated promotional advertising in the past year.[6] Accordingly, elimination of promotional advertising is no longer an available measure for the applicant to dampen demand. On the other hand, promotional advertising by manufacturers of electrical appliances and equipment has not been eliminated. These manufacturers spent an estimated $450 million in promotional advertising in 1972.[7] Thus, it is doubtful that the applicant's reduced promotional advertising will have much, if any, significant impact on projected demand.

8.2.3.2 Change in Utility Rate Structure

The Federal Power Commission regulates the transmission and sale of energy in interstate commerce.[8] There is no Public Utilities Commission in the State of Texas; regulation of rates is done by the local communities in the applicant's service area.[9]

Historically, utility rate structures were designed to encourage consumption of electricity primarily by using the declining block rate, which reflected the declining average cost of furnishing additional kilowatt hours of electrical energy to each customer. In the past the economic logic for declining block rates was never seriously disputed. Today, however, under conditions of increasingly scarce fuel resources, declining block rates, by lowering the price of each additional kilowatt hour, may tend to encourage unnecessary use of electricity by individual customers and also encourage individual consumers to use more and more electricity at the expense of other energy sources.

The most commonly mentioned alternatives to declining block rates to dampen demand for electricity are increasing block rates, peak load pricing and flat rates.

Table 8.2.2 presents some statistics on the average cost of electricity to consumers and the average energy (Kilowatt-hours) used per customer from 1964 through 1971. Statistics such as these indicate that across the United States even though the price of electricity has increased during the last few years the demand is still increasing. The question that statistics such as these do not answer is, at what point will the costs of residential and commercial electricity cause the consumer to significantly decrease his demand. However, with sufficient economic incentive, total demand could be reduced, or at least its rate of growth reduced.

Table 8.2.2

STATISTICS ON COST AND CONSUMPTION OF ELECTRICITY[10]
(1964-1971)

	Average Cost to Consumers - Cents Per Kilowatt - Hour			Average Kilowatt - Hours Per Customer (Billions)		
	Residential	Commercial	Industrial	Residential	Commercial	Industrial
1971	2.32	2.20	1.10	7.639	42.598	1,735.482
1970	2.22	2.08	1.02	6.700	40.480	1,695.087
1969	2.21	2.06	.98	6.246	37.607	1,666.015
1968	2.25	2.07	.97	5.706	35.009	1,578.366
1967	2.31	2.11	.98	5.220	32.234	1,481.496
1966	2.34	2.13	.98	4.931	30.238	1,445.802
1965	2.39	2.18	1.00	4.618	28.093	1,289.949
1964	2.45	2.26	1.02	4.377	25.450	1,217.878

Since the demand for electricity is also sensitive to such other factors as Gross National Product, the local economy, the substitution of electricity for more scarce fuels, population growth, and local temperature variations there are questions of how long it would take a rate change to have a detectable effect considering these other variables.

8.2.3.3 Load-shedding, Load Staggering and Interruptible Load Contracts to Reduce Peak Demand

Load shedding is an emergency measure to prevent system collapse when peak demand placed upon the system is greater than the system is capable of providing. This measure is usually not taken until all other measures are exhausted.

The Federal Power Commission's report on the major load shedding that occurred during the Northeast Power Failure of November 9 and 10, 1965, indicates that reliability of service of the electrical distribution systems should be given more emphasis, even at the expense of additional costs.[11] This report identified several areas that are highly impacted by loss of power, such as elevators, traffic lights, subway lighting, prison and communication facilities. It's the serious impact on areas such as these that result in load shedding as only a temporary method to overcome a shortage of generating capacity during an emergency. It cannot be considered as a viable alternative for required additional capacity.

Load staggering has also been considered by the staff as a possible conservation measure. Basically this alternative involves shifting the work hours of industrial or commercial firms to avoid diurnal or weekday peaks. However, the staff considers the interference with customer and worker preferences as well as productivity to be of significant impact to make such proposals of questionable feasibility. As in the case of load shedding, load staggering cannot be considered as viable alternative for required additional capacity.

For interruptible load contracts to be effective in system planning, the load reduction must be large enough to be effective in system stability planning. Thus, this type contract is primarily related to industrial customers. The acceptability of interruptible load contracts to industrial customer depends upon balancing the potential economic loss resulting from unannounced interruptions against the saving resulting from the reduced price of electricity. If the frequency or duration of interruptions increase as a result of insufficient installed capacity, the customer will convert to a normal industrial load contract. Even if the applicant had 1200 MWe of interruptible load, it is speculative to project that customers would continue this contractual relationship if faced with frequent and long periods with no electrical service.

8.2.3.4 Factors Effecting the Efficient Utilization of Electrical Energy

Promoting the efficient utilization of electrical energy by developing new standards for insulation, new lighting requirements for buildings and energy efficient labeling will result in reductions in long term growth of energy requirements in the Applicant's service area.

In general, municipalities adopt and enforce local building codes which govern the standards for buildings and structures. Apart from these requirements, the owner of a house or commercial building would increase the installed insulation only up to the point that the extra cost would be paid for by his future savings in fuel consumption. An increase in the price of energy used for space heating or cooling would increase the economically optimum quantity of insulation. As local building codes are changed and insulation in existing structures increased, the change in both summer and winter demand in the applicants' service area will be reflected in their historical loads. However, it is speculative at this time to predict which codes will be changed and which homeowners will add insulation so that the projected peak demand could be reduced.

With respect to new lighting requirements, electrical energy savings do, to some extent, appear possible for both new and existing residential and commercial buildings. For example, encouraging residential customers in existing houses to use lower wattage electric bulbs and reduced usage

is important in the next decade as an emergency conservation measure and will compliment savings brought about by institution of new standards and requirements in new house construction. Fluorescent lighting is about four times more efficient than incandescent lighting and is presently in widespread use in industry and commerce. Most residential houses have incandescent lighting. One study indicated that if all households in 1970 had changed to fluorescent from incandescent lighting, the residential use of electricity would have been reduced approximately 7.5% and total electrical sales would be reduced approximately 2.5%.[12] However, since the majority of residential lighting occurs in off peak hours, the reduction on peak demand would be less than one percent. Thus the electrical savings resulting from new lighting changes on peak demand is minimal.

The importance of energy efficiency labeling of appliances is that it will allow the consumer to select the most energy efficient appliance. Table 8.2.3 projects the average annual use of electricity by household appliances based on historical trends. As indicated, space heating, water heating, air conditioning, freezers, cooking and clothes drying are among the large uses of electricity in residential appliances. Of these appliances, improvement in the efficiency of air conditioners has been a major area of consideration since air conditioners contribute substantially to the peak summer demand.

For instance, making air conditioners function with lower energy demand typically requires a combination of increased heat exchanger size and higher efficiency compressors. This results in higher initial cost. Estimates of the cost differential for a typical room air conditioner to double the efficiency from 5.5 Btu per watt to 11 Btu per watt is approximately $100.[12] For this conservation of energy method to be effective, the consumer must be convinced that it is profitable for him in the long-term to purchase the more expensive machine. This will require a public educational program and effective energy efficiency labeling. In addition, selection of central air conditioners by subdivision developers has historically been based on minimizing front end costs consistent with meeting local building codes. This approach continues to favor the lower cost units. Thus the reduction in peak demand due to energy efficient labeling is undeterminable at this time.

In addition the staff is aware that the National Institute of Occupational Safety and Health has recommended heat stress standards to the Occupational Safety and Health Administration which, if adopted, would require a significant number of employers to air condition thier plants.[13] This possible requirement, coupled with future substitution of electrical energy for fuels in short supply, namely oil and natural gas, will tend to increase the demand for electrical power and thus make any reduction in the future peak demand for electricity due to this conservation of energy measure speculative.

8.2.3.5 Consumer Substitution of Electricity for Scarce Fuels

While conservation measures are rather quickly adopted in a "crisis" situation, the consumer's substitution of electrical energy for fuels such as oil or gas takes several years to result in a substantial upward impact on the need for power. The staff expects that substitution of electricity for scarce energy sources will likely accelerate in the applicant's service area because of the uncertainty of oil and gas supplies and the outlook for higher prices relative to the price of electricity produced from coal-fired or nuclear plants. Nationally, for instance, electric space hearing is projected to grow from 7.6 percent for all homes in 1970 to 16 percent in 1980 and to 27 percent in 1990.[12] Other increases are forecasted in the growth of electric water heater, and ranges. The advent of electric automobiles or other new uses of electricity cannot be discounted but are not now quantified in projecting need for power since the use of such items is speculative. It is the staff's evaluation that substitution effects will to some degree offset any savings from other conservation of energy techniques.

A second kind of substitution which is relatively important in considering the applicant's need to add the proposed nuclear plant to his system is the desirability of adding nuclear capacity as soon as possible in order to reduce fuel consumed by gas- or oil-fired units now forming a significant part of the applicant's system. This, in turn, will increase the availability of these material resources for other uses for which there is no available substitute.

8.3 POWER SUPPLY

8.3.1 Applicant's system capability

Table 8.2.1 also shows the applicant's net generating capability at the peak load period, 1963-72 actual, 1973-84 predicted. Planned generation additions, retirements, reratings, and transactions with

Table 8.2.3

Projections of Average Annual Electricity Use[12]

	Average annual electricity use in households having the appliance (kWh/household)		
	1970	1980	1990
Refrigerators	1,300	1,600	1,800
Air conditioning			
Room	1,946	2,000	2,000
Central	3,560	3,600	3,600
Lighting	750	850	900
Space heating	14,588	15,000	15,000
Water heating	4,500	4,800	4,800
Clothes drying	993	1,000	1,000
Cooking	1,175	1,200	1,200
Television	417	440	470
Food freezers	1,384	1,500	1,600

other utilities contributing to this summary are shown in Table 1.1-4 of Amendment 1 to the applicant's Environmental Report. Table 8.2.1 also gives the percent reserve over peak hour load.

8.3.2 Regional capability

As discussed previously, ERCOT philosophy has been to provide reliability reserves internally; thus no interties are maintained with other power pools. Within ERCOT the lack of seasonal diversity (ER, Amendment 1, Table 1.1-8, and ER, p. 1.1-2) precludes the possibility of diversity exchange. Further, if interties with neighboring utilities were being utilized for supply of purchased power at a time of emergency, the needed reserves outside the affected system might not be available. Therefore, it does not appear practical for the applicant to obtain any large blocks of energy, even if available, through purchase or interchange arrangements as means of replacing or deferring the CPSES requirement.

8.4 RESERVE REQUIREMENT

Figure 8.4.1 is a plot of the TUCS loads and resources. This figure presumes that CPSES is in commercial service as planned. Also, the FPC accepted[14] limits of 15% to 25% margin over peak are shown. It is apparent that the planned margins of reserve over projected peak hour loads are well within FPC criteria and only slightly over the 15% criteria of TIS and ERCOT. It is also readily apparent, as indicated by shaded areas on Fig. 8.4.1, that delay of CPSES will present an unsatisfactory level of reserves. Without the station, margins for 1980 through 1984 would fall to 12.1%, 10.5%, 4.9%, 7.1%, and 7.2%.

8.5 CONCLUSION

As shown in Fig. 8.4.1, it is apparent that although sufficient reserve will be provided if CPSES is on schedule, delay will reduce reserve margins below those required by TIS and ERCOT and well out of the range of FPC recommended reserves. In view of these projections and the unavailability of purchased power, the staff concludes that the need for additional generating capacity will almost certainly be needed in the 1980 to 1982 time frame. Although each of the conservation of energy measures evaluated has a potential for reducing the future demand for electricity, there is no reliable way at this time to quantify the anticipated reduction in power demand resulting from conservation of electricity methods which could be implemented by either federal, state, or local regulating bodies or voluntary actions of the public. Our ability to predict is speculative due to the uncertain nature of the effectiveness of the measures that may be taken, by substitutional effects and by possible regulations that may require increased electrical demand.

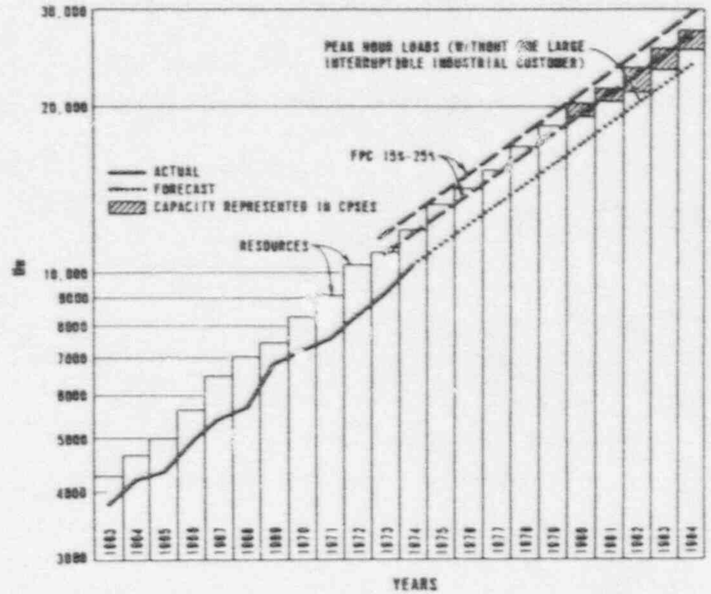

Fig. 8.4.1. Applicant's resources and peak hour loads, 1963-1984.

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9. BENEFIT-COST ANALYSIS OF ALTERNATIVES

9.1 ALTERNATIVE ENERGY SOURCES AND SITES

9.1.1 Alternates not requiring creation of new generating capacity

9.1.1.1 Purchased power or diversity exchange

The staff explored in Sect. 8 the applicant's general obligations to the interconnected systems of Texas, basically ERCOT, and the operating and reserve policies practiced by the utilities of the state. Neighboring utilities must add capacity to maintain their own reserves, and are all summer peaking systems. The staff concludes that the purchase or exchange of power is not a viable alternative.

9.1.1.2 Reactivating or upgrading an older plant

The applicant does not have deactivated units of sufficient size to achieve 2300 MWe. Upgrading of existing units is not considered by the staff to be practical. This would require higher pressure or higher capacity boilers, additional or redesigned turbines and condensers, and added capacity to dissipate waste heat. The staff concludes that this is not a viable alternative.

9.1.1.3 Operating peaking units as base load

The applicant does not have sufficient generating capacity to maintain the 15% system reserve criterion beyond 1980. Therefore new capacity must be installed. The staff concludes that conversion of existing peaking units is not a viable alternative.

9.1.2 Alternatives requiring creation of new generating capacity

9.1.2.1 Power network considerations

The applicant's service area is shown in Fig. 8.1.1. The load center in 1980 will be in the Dallas-Fort Worth area, as indicated in the ER (ER, Table 1.1-1a). The center of the transmission system network in 1980 will be on the south side of the above area (ER, Fig. 1.1-4).

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9.1.2.2 Environmental considerations

The regions within 20 miles of Dallas and Fort Worth are the most heavily populated. The land west of Fort Worth is less productive from an agricultural point of view and receives less rainfall than that north, south, or east of Fort Worth.

9.1.2.3 Energy type and source considerations

Fossil fuel is rather abundant in Texas (ER, Fig. 9.2-3). Lignite is abundant in an area extending from 80 miles east to 200 miles south of Dallas. The applicant already is mining or has plans to mine much of the lignite east of Dallas for existing or proposed fossil-fueled plants. Oil and gas are being used for more than 90% of the applicant's present generating capacity. The applicant's plans indicate a 25% increase in the use of oil and gas by 1980.

The possible fuels are discussed in more detail below.

Natural gas

Natural gas has been used by the applicant in the past to the fullest extent practical. This resulted from the low cost of surplus gas. Proven reserves, however, have declined, and instead of a surplus, it is estimated that at the current rate of discovery only two-thirds of the national demand will be met by domestic production in 1985.[1] The staff concludes that natural gas will not be available in 1980 in the quantities required. This is underscored by a recent report[2] by the Railroad Commission of Texas, the agency empowered to regulate the petroleum industry in Texas.

Crude oil and other liquid petroleum products

Crude oil and other liquid petroleum products, in general, are subject to the same constraints as natural gas. The Railway Commission of Texas reported[3] on the growth of imports of foreign petroleum to supplment domestic production and also stated that at no point during the period 1950-1960 did annual addition to reserves exceed production. Further, it is shown that during the period 1960-1973 the additions to reserves have been due largely to improved techniques of extraction rather than new discoveries. The Texas State Governor's Division of Planning Coordination confirms[1] this situation. The recent reduction in the import of oil

from the Middle East indicates that dependence on foreign oil is unwise. Oil production from shale is not expected to be available for economical production of electricity in 1980. The staff concludes that oil will not be available for CPSES use in the quantities required in 1980.

Coal and lignite

Subbituminous coal exists in Texas but unfortunately the deposits are not large enough to economically supply a major generating facility.[4] Lignite is relatively abundant and plays a large part in the applicant's plans (ER, Amendment 1, Table 1.1-12). But this resource is not without limit.[5] Discussions with State officials in August 1973[6] indicate that the applicant's last station utilizing lignite for its 30-year life will probably go into operation around 1985. These facts make it clear that, although lignite is an available and useful fuel, the reserve available is already factored into the applicant's generation planning. Lignite is, however, a viable alternative which could be used for CPSES.

Low-sulfur coal could be brought in by rail from eastern Wyoming. The applicant has considered this alternative in some detail (ER, pp. 9.2-8 and -9). To utilize this resource, the cost burden of a 1400-mile rail haul must be considered. The applicant expects costs, based on current experience of an adjacent utility, to be $9.65 per ton ($2.15 per ton for coal, $7.50 per ton freight).

Coal and lignite will be compared with other alternative fuels later.

Nuclear

The applicant proposes to fuel CPSES with uranium. There is sufficient uranium for the life of this station. This fuel will be compared with other alternatives later.

Municipal solid wastes

A utility[7] in New Jersey considered the 35,000 tons/day of solid wastes (domestic, commercial, and industrial) produced in New Jersey as an alternative fuel source for electric power generation. Using an average heat content of 5,000 Btu/lb and the assumption that 50% of the wastes produced are combustible, this utility calculated that the power that could be generated would be 700 MWe. There

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would be even less solid waste available within practical transport distance of any of the alternative sites for CPSES. Even if sufficient solid waste from other sources were available, it is very doubtful that the administrative, legal, and technical problems could be resolved in time to create a facility of 2300 MWe capacity in the time frame required. The staff does not believe that the burning of municipal solid waste is a viable alternative.

Hydroelectric power

There are no sites available in the applicant's service area where hydroelectric power in any significant amounts of base-load capacity can be generated.

Geothermal energy

Geothermal energy is currently being developed as a power source in Europe and to a limited extent in the western part of this country. According to the Department of the Interior's Final Environmental Statement (1973) for Geothermal Leasing Program, there are no known geothermal resource areas in the State of Texas. Therefore, geothermal energy is not a viable alternative.

Solar power

Solar power is also being studied at this time with increasing emphasis. Until a low-cost method of power storage can be coupled with solar units, this supply of energy will remain unsuitable as a source of base-load power.

Wind power

Power from the wind has been demonstrated on a 1-MW scale in Vermont. Because wind power is intermittent, it is unsuitable as a source of base-load power.

Fusion

The present status of this source of energy is such that a demonstration plant is not expected to be built before 1990. Therefore the staff does not consider this to be a viable alternative at this time.

Conclusions

The staff concludes that coal, lignite, and uranium are viable fuels for CPSES.

9.1.2.4 Candidate regions

The applicant considered sites on all of the major river basins in the applicant's serv. e area, as shown in the ER (ER, Fig. 9.2-4). These rivers and their direction from the Dallas-Fort Worth area are: Red River, 80 miles north on the border with Oklahoma; Sabine River, 60 to 160 miles east; Trinity River, through Dallas-Fort Worth; Brazos River, 40 miles southwest; Colorado River, 150 miles southwest. All of the rivers run in a southeasterly direction toward the Gulf of Mexico. Water from the Red River is not available to the applicant for CPSES use at this time. The relatively high rainfall in eastern Texas creates interest in the Sabine River. The proximity of the lignite to this river results in viable sites along this river for this alternative fuel. The length of transmission lines to the load center and other environmental considerations given in Sect. 9.1.2.2 make this river less desirable than others for a nuclear station. Further, the potential seismic activity in this area would increase the station construction costs. The Trinity River basin contains some of the best agricultural land in north central Texas, and the basin is more heavily populated than the others. The Brazos River contains a high dissolved solids concentration, but otherwise this basin is attractive in features such as its short distance from the load center. The Colorado River is about 150 miles from the load center, and therefore long transmission lines would be required to a site on this river. The availability of water in this basin is dependent on development of future impoundments.

Based on the above considerations, the staff concludes that sites within the Brazos River basin offer the best potential for minimum environmental costs.

9.1.2.5 Candidate site alternatives

The staff has considered nine sites in the Brazos River basin (shown in Fig. 9.1.1) in the alternative evaluation. The applicant considered eight of these sites (all except Lake Granbury) and has given a detailed description of the eight sites in the ER (ER, pp. 9.2-42 to 9.2-91). A comparison of impacts with the Squaw Creek site impacts is given below.

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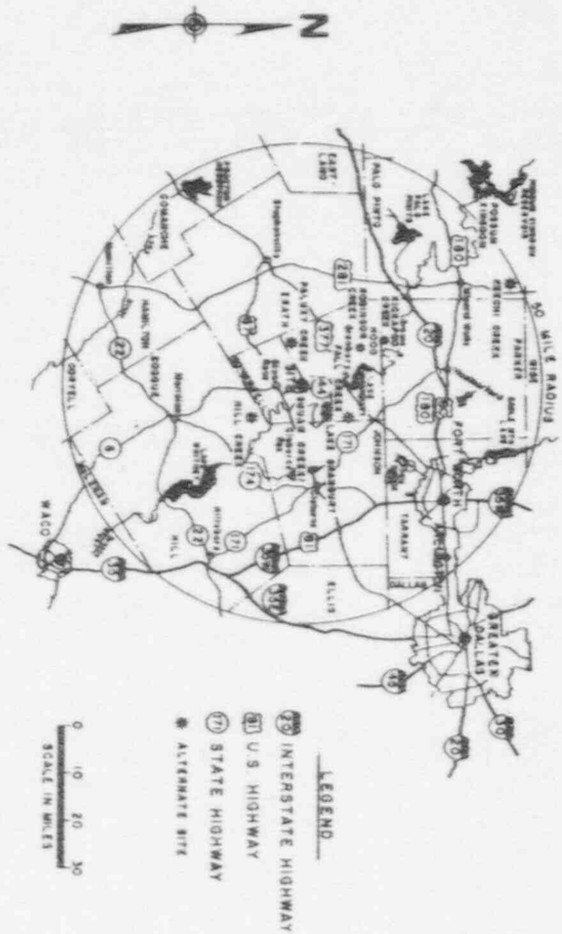

Fig. 9.1.1. Alternative sites considered for CPSES.

Squaw Creek site

This is the proposed site 5 miles north of Glen Rose described in Sect. 2.

Paluxy River site

This site is about 9 miles west-northwest of Glen Rose. A reservoir at this site would require relocation of a cemetery and more than 1 mile of farm road FM 204. The makeup and return water lines to Lake Granbury and the transmission lines would be about 7 miles longer than those for Squaw Creek. About 6 miles of the Paluxy River and the adjacent farmland would be inundated by the reservoir.

The staff concludes that use of this site would result in more environmental costs.

Hill Creek site

This site is in Bosque County 7 miles south-southeast of Glen Rose. The additional length of lines required would be about the same as those for the Paluxy River site. Transportation of construction material would result in a greater community impact. The impacts would create about the same community costs in Somervell County without the increase in taxable property as in the case of Squaw Creek. The staff concludes that the use of this site would result in more environmental costs.

Fall Creek

This site is 25 miles southwest of Fort Worth, or about 10 miles closer than Squaw Creek. A reservoir at Fall Creek would be closer to Lake Granbury. About 1500 acres of cultivated land would be inundated. A residential and recreational development is within the reservoir area. This site is considered to have more potential for residential development as the Fort Worth area expands. Farm road FM 1192 would require relocation. The terrestrial impact of shorter lines is offset by the inundation of more cropland. The staff concludes that this site offers no overall environmental advantages.

Robinson Creek

This site is 8 miles northwest of Granbury in Hood County. A reservoir would inundate a cemetery. Much more residential development area is near this site. Farm road FM 4 would be inundated. The makeup line to Lake Granbury would be shorter, but the transmission lines could cause greater aesthetic impact. Impacts of cooling towers (if used) could affect a larger number of residents. The staff believes that the environmental costs would be greater at this site.

Kickapoo Creek

This site is in Parker County 13 miles northwest of Granbury. The population in the vicinity of the site is greater. About twice as many residents would be displaced. Farm road FM 1543 would require relocation. The rail spur would be longer and would require crossing the Brazos River. The staff does not believe that the use of this site would result in less environmental impact.

Possum Kingdom site

This site would be on the Possum Kingdom Reservoir, impounded on the Brazos River in 1941. The site is about 60 miles west of Fort Worth. The existing lake is attracting considerable recreation and residential development. The use of lake water for condenser cooling and discharge of heated water into this public lake would cause a significant impact on the aquatic biota. A large area would be affected. The discharge temperature might be as high as 95°F. A 23-mile-long rail spur would be required. The required additional transmission lines would be longer. The potential impact on this recreational area is considered by the staff to be of greater environmental cost than that of inundation of land at the Squaw Creek site.

Keechi Creek

This site is 11 miles north-northwest of the city of Mineral Wells and about 55 miles west-northwest of Fort Worth. A reservoir would inundate 5000 acres. Makeup water would be obtained from Possum Kingdom Reservoir 8 miles to the west. Two cemeteries would be inundated. A transmission line, two pipelines, and a farm road would require relocation. There are several oil fields near the site. The staff concludes that this site, if used, offers no less environmental costs than the Squaw Creek site.

Lake Granbury

This site would be near the De Cordova Bend Dam about 7 miles southeast of Granbury. The applicant is currently constructing a fossil-fueled station near this area which uses the lake for cooling. The additional impacts on this public lake that would be caused, if once-through cooling were used for CPSES, are considered by the staff to be unacceptable. A station with cooling towers is considered a viable alternative by the staff. The impact on the recreation and residential areas of Lake Granbury would be significant. The construction of a rail spur would affect more residential areas and cross more highways. The staff concludes that the impacts associated with a similar station at Squaw Creek even with the longer water and transmission lines would be more acceptable than those of such a station on Lake Granbury.

Conclusions

The staff concludes that the use of the proposed site at Squaw Creek will not cause any greater environmental costs than the use of the other sites in the Brazos River Basin. In the judgment of the staff, alternative station systems such as the use of a fossil-fueled boiler or cooling towers would not change the balance of total environmental costs between the sites considered and those at Squaw Creek.

9.1.2.6 Candidate site plant alternatives

Squaw Creek site

Generating systems which are considered viable at this site for production of 2300 MWe are (1) nuclear, (2) coal (Wyoming) fired, and (3) lignite fired.

Sabine River Basin

This basin is judged by the staff to be less desirable than Squaw Creek for possible nuclear station sites for environmental reasons, as discussed previously. However, this basin is considered to have viable sites for lignite-fired stations because of the proximity of the lignite. A 2300-MWe station fired with lignite at a mine-mouth site about 200 miles from the load center is considered for comparison.

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9.1.2.7 Comparison of alternative generation systems

Economic

The applicant estimated the 1980 costs of nuclear and fossil-fueled stations and reported the results in the ER (ER, Table 9.2-2). The staff estimates of such station capital costs at the time of commercial operation are given in Appendix C. Although the staff estimates are higher, the nuclear station in both studies was estimated to cost 20% more than a coal-fired station, as shown below:

	Estimated capital cost (millions of dollars)	
Alternative	Staff (1982)	Applicant (1980)
Nuclear	909	762.48
Lignite-fired (mine mouth)	-	702.87
Coal-fired	762	636.93

Most of the difference between the staff's and the applicant's estimates can be accounted for by the additional two years at 7% per year interest on construction loans and the 5 to 7% per year increase in value assumed between 1980 and 1982.

Based on the ratio of the applicant's lignite- and coal-fired estimates, the staff estimates that a lignite station built for commercial operation in 1982 would cost $819 million. The mine-mouth lignite station would require the equivalent of three additional 345-kV transmission lines to the Dallas-Fort Worth area 200 miles from the station. The staff estimates that this would cost $75 million in 1982, assuming a 5% per year increase. This would increase the 1982 cost of the mine-mouth lignite station to $894 million.

Operating costs in mills per kilowatt-hour in 1980 were estimated by the applicant and reported in the ER (ER, Table 9.2-2). These costs were based on 1973 costs increased by 5% per year. For instance, nuclear fuel costing 2.00 mills/kWhr in 1973 is estimated to cost 2.81 mills/kWhr in 1980. The staff thinks that the applicant's estimates are reasonable and has used the same approach to estimate the 1982 operating costs given below:

	1982 estimated operating costs (mills/kWhr)		
Alternative	Fuel	Operating and maintenance	Total
Nuclear	3.10	0.68	3.78
Lignite fired (mine mouth)	2.33	1.40	3.73
Lignite fired (Squaw Creek)	4.50	1.40	5.90
Coal (Wyoming) fired	9.15	1.54	10.69

If the station operated 100% of the time at 2,300,000 kW, the total output would be 20,148 × 10^6 kWhr. Actually, the station should generate between 60 and 80% of this with the following results:

Capacity factor	Millions of kilowatt-hours generated annually
60%	12,089
70%	14,104
80%	16,118

The 1982 annual operating costs, exclusive of capital cost and transmission loss considerations, are given below:

	Annual operating, maintenance, and fuel costs (millions of 1982 dollars)		
Alternative	60%	70%	80%
Nuclear	45.7	53.3	60.9
Lignite fired (mine mouth)	45.1	52.6	60.1
Lignite fired (Squaw Creek)	71.3	83.2	95.1
Coal (Wyoming) fired	110.6	150.8	172.3

Using an operating period of 30 years, a discount rate of 8.75%, no increase beyond 1982 costs (and in parentheses an increase of 5% per year beyond 1982 in operating, maintenance, and fuel costs), and the staff-estimated capital costs, the generating costs are:

Alternative	Generating costs (millions of dollars) for average capacity factor of — 60%	70%	80%
1982 Present worth			
Nuclear	1389	1469	1549
	(1702)*	(1834)	(1966)
Lignite fired (mine mouth)	1368	1447	1525
	(1676)	(1807)	(1937)
Lignite fired (Squaw Creek)	1568	1693	1818
	(2057)	(2263)	(2470)
Coal (Wyoming) fired	1904	2326	2552
	(2662)	(3360)	(3733)
Annualized 1982 dollars			
Nuclear	132.2	139.8	147.4
Lignite fired (mine mouth)	130.2	137.7	145.2
Lignite fired (Squaw Creek)	149.3	161.1	173.1
Coal (Wyoming) fired	181.2	221.4	242.9

*Numbers in parentheses include 5% per year increase in operating, maintenance, and fuel costs beyond 1982.

The staff concludes that the nuclear station has an economic advantage over the other systems at the Squaw Creek Site. The mine-mouth lignite-fired station costs are somewhat less than those for the nuclear station.

Environmental

From an environmental viewpoint, the major effects of the alternative generating systems result from the heat dissipation system and the radioactive and nonradioactive particulate and gaseous

effluents. A fossil station would have essentially the same type of heat dissipation system as a nuclear station. Because of the higher efficiency of a fossil station and the discharge of some of the waste heat through the smokestack, both consumptive water use and heat discharge to the reservoir would be about 2/3 of that for a nuclear station.

The combustion products leaving the 400- to 800-ft-high smokestack of a coal or lignite plant are an aesthetic and air pollution nuisance. Over 200 tons of SO_2, 100 tons of NO_x, and 18 tons of particulates would be discharged per day from a coal-fired station assuming the use of low sulfur coal and reasonable ash reduction in the stack. Although the radioactive effluents from the nuclear station are of concern, the controls imposed on the nuclear station would result in such effluents being equivalent to only a fraction of the natural background radioactivity.

The mine-mouth lignite station would require the equivalent of three additonal 345-kV transmission lines to the load center some 200 miles from the station. Assuming a 250-ft right-of-way, 6000 acres of land would be impacted.

The creation and shipment of radioactive wastes from the nuclear station is an adverse effect, but is considered of lesser impact than the transportation and onsite storage of a trainload every two or three days of coal required for a fossil station. Storage facilities capable of handling 1 million metric tons of coal would have to be constructed, assuming a minimum 60-day supply for the station. The storage and disposal of millions of tons of ash from coal or lignite would result in a significant impact. The staff concludes that the nuclear station results in less environmental impact than a coal-fired or lignite-fired station.

Conclusion

The staff concludes that the significantly lower generating costs and lower environmental impacts of a nuclear station, compared with a coal-fired or lignite-fired station at Squaw Creek, favor the selection of a nuclear plant. When transmission line losses are considered, the staff further concludes that the mine-mouth lignite-fired station offers only slight economic advantage and would result in an additional 5500 acres of land being impacted for transmission lines.

9.2 STATION DESIGN ALTERNATIVES

9.2.1 Alternative cooling systems

The staff considered the use of other methods of dissipating waste heat. Squaw Creek Reservoir is so isolated from other water resources that importation of sufficient water from sources such as sewage effluent is considered impracticable. A review of potential water supplies by the staff indicates that the only water available in sufficient quantity for condenser cooling purposes is from Lake Granbury.

Five potential options to the proposed reservoir cooling system were considered:

- dry cooling towers
- once-through condenser cooling
- mechanical-draft wet cooling towers
- natural-draft wet cooling towers
- a spray canal

9.2.1.1 Dry cooling towers

The use of dry (fin-and-tube heat exchanger) cooling towers was considered for the Squaw Creek site. The staff estimates that from 15 to 20 towers would be required. The capital cost of these towers is estimated to be several times the cost of the reservoir system.

Dry cooling towers have been used in Europe for fossil-fueled plants and chemical processing plants but have not gained widespread acceptance in the United States for large installations. In Europe or the United States, no dry cooling tower has ever been operated on a power plant of more than 250 MWe.[1] The principal manufacturers of large-capacity dry cooling towers are located in Europe.

The great advantage of dry cooling towers is that there is no consumptive use of water. It follows, since there are no liquid or vapor effluents, that there are no fogging, icing, or chemical deposition problems. A serious limitation of dry-type towers is that all of the thermal energy is transferred to the moving air stream as sensible heat. Since heat transfer to air is so much

poorer than to water, the dry tower designs are generally based on barometric condensers in order to eliminate the temperature differences of the conventional tube-and-shell designs. Rather than the 1 to 3.5 in. Hg absolute back pressures of water-cooled plants, the dry towers will give a turbine back pressure of 5 to 10 in. Hg absolute. An increase of back pressure from 2 in. Hg absolute to 10 in. Hg absolute will decrease electrical output by almost 10% for fossil-fueled plants and even more for nuclear plants. Therefore, the use of dry towers will result in an increased capital cost of the plant, with a reduction in plant efficiency due to the higher back pressure and high auxiliary power requirements. About 5 to 10% more fuel would be required for the station.

This higher capital cost, along with the higher fuel cost, led the staff to conclude that dry cooling towers are not a viable alternative to the reservoir proposed by the applicant.

9.2.1.2 Once-through condenser cooling

The flow in the Brazos River is not sufficient to provide the 2,200,000 gpm (4900 cfs) of water required continuously for such cooling.

As mentioned in Sect. 9.1, the use of Lake Granbury for once-through cooling of CPSES would result in additional impacts on Lake Granbury considered unacceptable by the staff. The staff concludes that this alternative is not viable.

9.2.1.3 Mechanical-draft wet cooling towers

One viable alternative for dissipating heat from the warmed circulating water is mechanical induced-draft wet cooling towers. This heat dissipation system would be a closed system, like the reservoir, but has the potential of using less water and land. The applicant (ER, Table 9.2-4) estimated that each of the required eight mechanical-draft cooling towers would occupy a 360 by 75 ft land area. This is equivalent to about 5 acres for the eight towers, and auxiliary equipment for the towers could double this area.

The staff estimated the consumptive water use by such a system for an average year (1971), using the following assumptions: (1) ratio of the water to dry air mass flow is 1.5, (2) 14°F approach temperature, and (3) 0.03% drift losses. These estimates along with the staff's estimates of Squaw Creek Reservoir consumptive water use,

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are shown in Table 9.2.1. The staff does not concur with the applicant (ER, p. 9.2-28) that cooling towers would require more water. Although there is less induced evaporation from the reservoir than from cooling towers, the sum of natural and evaporative losses from the reservoir is greater than the losses from the cooling towers. Makeup water for the cooling towers could be obtained from Lake Granbury (refer to Sect. 11.6.3).

Table 9.2.1. Staff's estimates of water consumption in Squaw Creek Reservoir and wet forced-draft cooling towers during the year 1971

Month	Water use (acre-ft)					
	Squaw Creek Reservoir			Cooling towers		
	Net total evaporation	Net natural evaporation[a]	Net induced evaporation	Induced evaporation	Drift	Total
January	2,350	640	1,710	1,950	70	2,020
February	2,060	360	1,700	1,840	70	1,910
March	2,650	1280	1,370	1,580	50	1,630
April	1,880	760	1,120	1,600	40	1,640
May	1,870	490	1,380	2,350	70	2,420
June	4,020	1860	2,160	3,170	90	3,260
July	3,680	1030	2,650	3,340	90	3,430
August	3,340	910	2,430	3,110	90	3,200
September	4,010	1220	2,790	3,000	90	3,090
October	1,310	−1000[b]	2,310	2,260	70	2,330
November	1,600	340	1,260	1,460	40	1,500
December	640	−790[b]	1,430	1,400	50	1,450
Total	29,410	7100	22,310	27,060	820	27,880

[a]Freese, Nichols and Endress, Consulting Engineers, *Engineering Report on Squaw Creek Reservoir*, report prepared for Texas Utilities Services, Inc., 1972.

[b]Negative values are where the rainfall exceeds depth evaporation.

Because of the concentrating effect of water evaporation, water blowdown from the cooling towers is necessary to limit the total dissolved solids concentration in the circulating water. Also, chemicals will be added to the circulating water to control the algae and bacterial slime growth and scale. Algae and bacterial slime growth can be controlled by chlorine addition, and the amount necessary to do this is discussed in Sect. 3.6.2. Scale growth is often controlled by reducing the alkalinity of the water by the addition of sulfuric acid.

If the cooling tower blowdown is sent to Lake Granbury, the staff concurs with the applicant (ER, p. 9.2-23) that the concentration factor for the total dissolved solids should be limited to about 2. For higher concentration factors, other means of disposal should be used, such as blowing down to evaporation ponds.

If the blowdown is discharged into Lake Granbury, the staff estimated that the amount of blowdown would be about equal to the water evaporation rate. This could be as high as about 55 cfs for an average year, as shown in Table 9.2.1. In comparison, the anticipated blowdown rate from Squaw Creek Reservoir is anticipated to be 37 cfs, and therefore a larger pipe may be required for the cooling tower blowdown. For the average year case considered by the staff, the blowdown water temperature would be within 3°F of Lake Granbury water temperature at the discharge elevation for most of the year, as shown in Table 9.2.2. (The 3°F value is the limit outside of the mixing zone allowed by the Texas water quality standards discussed in Sect. 5.2.3.) When the temperature difference exceeds 3°F, the staff (using the information of Shirazi and Davis[2]) estimates that this difference can be reduced to acceptable values within 100 ft of the point of blowdown discharge into Lake Granbury.

Table 9.2.2. Staff's estimates of wet cooling tower blowdown water temperatures and Lake Granbury water temperatures at the discharge elevation during the year 1971

Month	Temperature (°F)	
	Blowdown water	Lake Granbury water[a]
January	53.9	51.1
February	56.7	56.5
March	60.4	58.4
April	69.8	62.9
May	78.3	69.4
June	86.0	82.4
July	86.5	86.6
August	86.4	88.9
September	83.6	79.4
October	78.0	72.1
November	64.5	58.6
December	62.7	54.6

[a]A. E. Johnson and J. A. Duke, Jr., *An Analysis of the Effects of Squaw Creek Reservior Blowdown Plumes on Lake Granbury*, report prepared by Water Resources Engineers, Inc., for Texas Utilities Services, Inc., Nov 30, 1973.

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Since the concentration factor of the tower water is 2, a mixing zone will be required to dilute the blowdown in Lake Granbury to the State standards discussed in Sect. 5.2. Addition of sulfuric acid to the cooling tower water for pH control would increase the blowdown sulfate concentration about 5% according to the staff's estimates. The staff (using the information of Shirazi and Davis[2]) also estimates that the mixing zone would be limited to about 200 ft of the blowdown discharge, which is within the Texas water quality standards.

If the concentration factor for the tower water is allowed to be higher, the staff concurs with the applicant (ER, p. 9.2-24) that the blowdown should be discharged to an evaporation pond. The applicant calculated that a 2700-acre evaporation pond would be required for cooling towers using water having 4800 ppm total dissolved solids (concentration factor of 4). Cooling towers using salt water (seawater) that contains about 30,000 ppm total dissolved solids are available. The staff calculated that towers operating with this quality water would have a concentration factor of 25 and would require a 450-acre evaporation pond to handle the blowdown. Both of these options are considered by the staff to be less desirable than blowdown to Lake Granbury or using the applicant's proposed reservoir cooling system.

The total dissolved solids concentration in the cooling tower water can be limited by using flash evaporation or ion exhcange techniques. The staff concludes that neither of these alternatives is viable for CPSES. Flash evaporation requires large amounts of energy, and the equipment is expensive. For ion exchange units, the amount of water and chemicals that ultimately must be disposed of is about as large as the amount of water being treated by the ion exchange units. Also, the capital and operating costs of these units add to the cost of operating the station.

Since cooling towers add water to the air, there is concern about additional fogging and drift deposition associated with these towers. Calculations were made by the staff of additional fogging and drift deposition due to these tower using the Oak Ridge Fog and Drift Program.

The staff calculations show that there would be less than 12 hr per year of additional fog at Texas State Highway 144, located about 2.5 miles northeast of the station. There would be no significant increase in fog at Farm-to-Market Road 201, located 2 miles west of the station.

Drift deposition is based on a 0.03% drift fraction. A fall of 39.7 g per square meter per year is found 1 mile north of the station. (The maximum fall was found to be 89.4 g per square meter per year at 0.7 mile north of the station.)

The capital cost of the cooling tower installation for CPSES has been estimated by the staff to be about the same as that for the reservoir heat dissipation system (refer to Sect. 11.6.4). However, the operating costs of a station with a wet cooling tower system are greater than those with a cooling reservoir. The staff estimates that about 0.4% of the electrical output of the station would be used to pump the circulating water through the towers, and about 0.3% of the electrical output would be used to operate the cooling tower air fans.[3] This results in about a 1% increase in fuel consumption for a station producing the same net electrical power.

In consideration of the factors summarized in Table 9.2.3, the staff concludes that either a reservoir or mechanical-draft wet cooling towers would be acceptable for the CPSES heat dissipation system. In addition, a reservoir system offers the inherent advantage of providing additional operating flexibility in that the system would be less sensitive to the natural fluctuations of flow and water quality that are experienced in Lake Granbury. The staff estimates that the station with the reservoir could operate for at least one to three months without makeup from Lake Granbury (reservoir elevation would vary from 775 feet to 770 feet).

9.2.1.4 Natural-draft wet cooling towers

The volume of air flow and the cooling efficiency of natural-draft towers depend on the temperature difference between the air in the shell and the ambient air. Natural-draft towers are not generally considered suitable for hot climates, in which the difference obtainable between inside and outside air temperatures would at times be too small to achieve the minimum required air flow and rate of evaporative cooling of the circulating water. Inherently, these conditions tend to reduce the cooling efficiency of a natural-draft cooling tower during the hotter, drier months of the year. For example, meteorological data for the Fort Worth region indicate that, on the average, a wet-bulb temperature of 76°F would be exceeded at least 10% of the time (ER, p. 9.2-18). Because of these atmospheric conditions, the natural-draft wet cooling tower system is not considered a viable alternative by the staff.

Table 9.2.3. Staff's comparison of alternative CPSES heat dissipation systems

Item	Squaw Creek Reservoir	Mechanical-draft wet cooling towers
Required land, acres	4300	400[a]
Capital cost, dollars	~20,000,000	~20,950,000
Operating cost		Additional 0.7% of station electrical power
Water consumption, acre-ft/year	29,400	27,900
Circulating water holdup time	Large	Small
Thermal inertia	Large	Small
Maintenance requirements	Little	Moderate
Blowdown to Lake Granbury, cfs	37	Up to 55
Blowdown temperature	Acceptable	Acceptable
Added chemicals	Chlorine	Chlorine and sulfuric acid
Cropland removal, acres	940	None
Effect on lower Squaw Creek	*a*) Average flow rate will be reduced from 11 cfs to 1.5 cfs *b*) Average total dissolved solids concentration will increase from 275 mg/liter to 1200 mg/liter	None
Recreation potential	Good	None
Increased fogging	Localized	Some
Drift	None	Significant

[a]Includes safe shutdown impoundment.

9.2.1.5 Spray canal

Use of a spray canal is another possibility for dissipating the station waste heat. The applicant (ER, p. 9.2-20) stated that about 528 spray units would have to be installed in a canal about 300 ft wide and about 22,000 ft long (152 acres). Such a canal would be excavated to about 17 ft depth, and the depth of the water in this canal during plant operation would be about 10 ft. Based on design of other power plants using this type of a heat dissipation system,[4] the staff concurs that these are reasonable numbers and dimensions. The canal probably would be a V or U shape and probably would contain additional spray modules to be used when other modules are out for maintenance.

These floating modules pump water from just below the canal water surface through nozzles to produce a coarse spray rising to a height of about 20 ft. Heat is dissipated from the water as the spray rises and falls back into the canal, primarily by evaporation. There will be some fine spray and mist that will invade the immediate area surrounding the spray canal. Most of this drift will fall back to the ground within 200 ft of the spray module,[5] and the staff believes that it would be desirable to put a 150-ft collection apron on each side of the canal (an additional 150 acres) to collect this drift. Drift beyond 600 ft distance from the spray module is very very small.[5] Fogging from a spray canal system would be less than that from mechanical-draft cooling towers, discussed in Sect. 9.2.1.3.

A typical spray module would be powered by a 75-hp motor.[4] The staff estimates that about 1.3% of the electrical power of the station would be used to drive 528 units. This is greater than the power required to operate the mechanical-draft wet cooling towers. Therefore the staff concludes that a spray canal is a less desirable alternative than either mechanical-draft wet cooling towers or a reservoir.

9.2.2 Intake system

As now proposed by the applicant (Sect. 3.4.2), the water velocities through the trashracks and the velocities approaching the traveling screens in the circulating water intake structure and the service water intake structure are considered too high by the staff. These velocities should be less than 1.0 ft/sec for all normal operating conditions, including times when a traveling screen is out for maintenance. The applicant will be required to redesign these structures to meet this requirement (refer to Sect. 11.6.2).

The applicant evaluated a deep intake alternative to the proposed system and reported the results (ER, p. 10.2-2 to p. 10.2-4). The return of oxygenated water to Lake Granbury in the summer with the deep intake system is considered by the staff to be an improvement over the proposed system. Squaw Creek Reservoir would be more productive with the deep intake. However, the staff estimates that the annualized generating costs would be increased by as much as 1/2 million dollars in 1982 with the deep intake. The staff concludes that the deep intake is not justified over an intake near the surface.

9.2.3 Discharge structure

The staff evaluated the alternative discharge structures discussed by the applicant (ER, p. 10.3-1). The staff concludes that the alternative structures offer no significant improvement in the overall impact on the environment.

9.2.4 Chemical and sewage systems

The alternative of discharging the chemical waste to Squaw Creek above or below the dam is considered less desirable to the staff than discharge to the evaporation pond.

The discharge of treated sewage effluent to Squaw Creek Reservoir has been approved by the Texas Water Quality Board. Accordingly, consideration of alternatives is not warranted.

9.2.5 Biocide system

The staff has recommended changes in the design of the biocide system (Sect. 3.6.2). An alternative for controlling organic growth is the use of a mechanical condenser tube cleaning system. "On-load" cleaning systems, such as the Amertap and MAN systems, have been used successfully at other power stations. The use of a mechanical tube cleaning system would not eliminate the need for biocide treatment in the plant, as such treatment would still be required in the station service and cooling water systems. Accordingly, this is more a technique for reducing the use of biocides in the plant than for replacing their use. The staff concludes that any biocide system which limits the total residual chlorine in the plant discharge to 0.1 ppm would be acceptable (refer to Sect. 11.6.1).

9.2.6 Transmission lines

The staff has examined the proposed transmission line rights-of-way and has concluded that the applicant is taking reasonable precautions in limiting the impact of transmission lines on ecological systems. The proposed routing of transmission lines appears environmentally acceptable when compared to any other feasible routing patterns. The impact on the community is considered acceptable with the residential area bypass route as discussed in Sect. 3.8.

9.2.7 Railroad spur

The applicant is proposing a reasonable route to the closest existing railroad. The staff concludes that this route results in the least impact and that the benefits of railroad transportation outweigh the environmental costs.

9.2.8 Makeup and return lines to Lake Granbury

The staff believes that the only reliable source of water is Lake Granbury and that since the Squaw Creek site is more desirable than a station located on Lake Granbury, the makeup connection is necessary. The location and use of underground pipes are considered by the staff to result in the least overall impact on the environment of the alternatives considered. The alternative of allowing dissolved solids concentrations to continue to increase in Squaw Creek Reservoir and therefore not require a return line is considered unacceptable by the staff. The return line to Lake Granbury is therefore considered by the staff to be acceptable. The discharge of the blowdown to Squaw Creek is unacceptable to the staff.

The applicant is proposing to use water from Lake Granbury to maintain the flow in Squaw Creek below the dam at 1.5 cfs. This is considered acceptable to the staff.

9.2.9 Alternative radioactive waste treatment systems

The applicant plans to provide the state-of-the-art technology for radioactive waste treatment. Accordingly, consideration of alternatives is not warranted.

9.3 ALTERNATIVES TO NORMAL TRANSPORTATION PROCEDURES

Alternatives such as special routing of shipments, providing escorts in separate vehicles, adding shielding to the container, and constructing a fuel recovery and fabrication plant on the site rather than shipping fuel to and from the station have been examined by the staff for the general case. It was concluded that the environmental impact of transportation under normal or postulated accident conditions is not considered sufficient to justify the additional effort required to implement any of these alternatives.

REFERENCES FOR SECTION 9.1

1. Office of the Governor, Division of Planning Coordination, Electrical Power in Texas, Nov. 1972, p. 11.

2. Jim C. Langdon, Chairman, A Report to the Members of the Committee on Natural Resources from the Railroad Commission of Texas, as Required by H. S. R. No. 26.

3. Ibid. p. 2.

4. Office of the Governor, Division of Planning Coordination, Electrical Power in Texas, Nov. 1972, pp. 11 and 21.

5. Ibid. p. 21.

6. "Trip Report on Site Visit to Comanche Peak Steam Electric Station, Glen Rose, Texas," F. J. Miraglia, Project Manager, Environmental Projects Branch 3, Directorate of Licensing, USAEC, Docket Nos. 50-445 and 50-446, Sept. 26, 1973.

7. Public Service Electric and Gas Company, Hope Creek Generating Station Units 1 and 2, Environmental Report, Docket Nos. 50-354 and 50-355.

REFERENCES FOR SECTION 9.2

1. Final Environmental Statement, Hope Creek Generating Station, Numbers 1 and 2 Units, Docket Nos. 50-354 and 50-355, Directorate of Licensing, U.S. Atomic Energy Commission, February 1974.

2. M. A. Shirazi and L. R. Davis, *Workbook of Thermal Plume Prediction*, vol. 1, *Submerged Discharge*, Office of Research and Monitoring Report No. EPA-R2-72-005a, Environmental Protection Agency, August 1972.

3. D. R. F. Harleman and G. Jirka, "The Effect of the Choice of a Power Generation and Remarks on the Utilization of Waste Heat," Position Paper No. 22, prepared by Massachusetts Institute of Technology for the Federal Power Commission, Technical Advisory Committee on Conservation of Energy, June 1973.

4. Virginia Electric and Power Company, *Surry Power Station Units 3 and 4, Environmental Report*, Docket Nos. 59-434 and 50-435.

5. Virginia Electric and Power Company, *Surry Power Station Units 3 and 4, Environmental Report*, Amendment 1, Docket Nos. 50-534 and 50-435.

10. CONCLUSIONS

The conclusions below are based on the station as modified to meet staff requirements.

10.1 UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

10.1.1 Abiotic effects

10.1.1.1 Land

The construction of any large power station causes considerable disturbance to and modification of the land. The station site will remove about 200 acres from potential productivity for the lifetime of the station. The railroad spur and access road will remove an additional 180 acres. Because of the extensive clearing, excavating, and leveling required for site preparation, subsoils and parent rock will be exposed over most of the site peninsula area. The use of 439 acres of land will be restricted within the rights-of-way of the transmission lines.

With the construction of Squaw Creek Reservoir for use as the cooling system, the most significant adverse environmental effect on the land will be the conversion of 3228 acres of land from a terrestrial environment into an aquatic environment.

10.1.1.2 Water

The construction of CPSES is not expected to cause any adverse effects on the use of water except the inundation by Squaw Creek Reservoir of approximately 8 linear miles of Squaw Creek and a change in the water flow and quality below the dam on this creek. Following construction, water from Lake Granbury will be used to provide water below Squaw Creek Reservoir and no adverse effects are expected.

A maximum of about 45,000 acre feet per year of water will evaporate from Squaw Creek Reservoir during CPSES operation. This will result in an increase in the average total dissolved solids concentration in the Brazos River below the station of 2.3 percent.

The use of ground water for CPSES is small but the applicant must show to the satisfaction of the staff that this will not cause any adverse impacts on other users.

10.1.1.3 Air

The construction of the station will cause some smoke and dust within a few miles of the construction areas. During station operation the staff believes that there will be no adverse impact on the air quality.

Some local fog may occur around Squaw Creek Reservoir. That resulting from CPSES operation is not expected to be significant at the closest state or county road.

10.1.2 Biotic effects

10.1.2.1 Thermal effects

The thermal alteration of Squaw Creek Reservoir is not expected to have an adverse effect on aquatic productivity. The loss of plankton in passage through the station condensers may, however, reduce the reservoir productivity. The thermal effect on Lake Granbury is not considered by the staff to be significant.

10.1.2.2 Chemical effects

There is not expected to be any significant adverse effect on aquatic organisms as a result of chemical additions. The increase in total dissolved solids in Squaw Creek reservoir will not significantly affect productivity. The alteration of the dissolved oxygen strata in Lake Granbury by the blowdown from Squaw Creek Reservoir will be limited to an area within a few hundred feet of the discharge.

10.1.2.3 Mechanical effects

Adverse effects from impingement will be minimized by the redesign of the intake system. Any entrained organism in the CPSES condenser cooling water is assumed to be destroyed.

Some small fish may be destroyed by pressure changes and injury at the outfall if they are entrained in the make-up pipe from Lake Granbury.

10.1.2.4 Radiological effects

The staff does not believe that any adverse effects will occur since the radioactive effluents are reduced to as low-as-practical. The 800-1000 man-rem/yr received as occupational on site exposure is 1.0 percent of the annual total to the 1980 population within a 50-mile radius and the risk associated with this exposure is no greater than those risks normally accepted by workers in other present day industries.

10.2 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

10.2.1 Summary

The purpose of this section is to set forth the relationship between the proposed use of man's environment implicit in the proposed construction and operation of the nuclear generating station (as permitted under the terms of the proposed construction permit) and the actions that could be taken to maintain and enhance the long-term productivity. One must attempt to foresee the uses of the environment of potential interest to succeeding generations and consider the extent to which this present use might limit, or on the contrary enhance, the range of beneficial uses in the long term.

In consideration of the impacts and alternatives discussed in detail in Sections 4, 5, and 9, the staff has found several effects of the proposed construction and operation which tend to be inimical to some of the objectives of the NEPA with respect to economic productivity. These are identified in this section. The staff believes, however, that the proposed use of the site and its environs will not significantly affect the long-term productivity of the environment.

10.2.2 Enhancement of productivity

The construction of CPSES will have potential good and adverse effects on the economy of this section of North Central Texas. The availability of additional electricity will tend to allow growth.

10.2.3 Uses adverse to productivity

The local effects of construction and operation of a nuclear power station might, in general, tend to oppose productivity through impacts on land, water, and air. Land areas on the site are converted to this particular use, and the presence of a station could, in some cases, alter the use of surrounding areas. Water resources and air are usually affected in some degree by materials and heat discharged from a station. These types of impacts are relevant to any type of power station, the effects differing mainly in degree. The staff has tried to consider all potential deterrents to productivity in this case, but summarizes below only those which are potentially adverse or need explanation.

Land usage

The conversion of 3228 acres of land from a terrestrial environment into an aquatic environment is considered permanent. The staff concludes that the beneficial uses of the reservoir outweigh the loss of the beneficial uses of the land.

All of the land adjoining Squaw Creek Reservoir is owned by the applicant. The staff concludes that the effects of the construction and operation of the station on the adjoining lands are acceptable.

The need for transmission rights-of-way will result in the removal of 439 acres of land for purposes other than those permitted by the applicant. In those sections where easements only are acquired, the land owner will still be able to use the land within the corridors for agricultural or other endeavors that are compatible with the transmission of electricity. The need to maintain clearance for the conductors will prevent certain types of activities within the corridors. Otherwise, the staff does not consider the use of the land within the rights-of-way to be detrimental to the contemporaneous land uses in the vicinity.

Water usage

There does not appear to be anything detrimental to the commercial use of the Brazos River that will result from construction or operation of CPSES. The loss of fish that can be anticipated from data currently available does not appear to be extensive or to be commercially important.

The discharge of liquid effluents to Lake Granbury and the Brazos River should not affect the short- or long-term productivity of aquatic life in the river and its tributaries. The consumptive use of water from Lake Granbury will be about 39,000 acre feet per year and the groundwater resources should not be depleted in the vicinity of the station.

10.2.4 Decommissioning and land use

In the long term, beyond the useful life of the proposed generating station, this site may continue to be used for generation of electrical energy. At the termination of such use, the land areas occupied by the nuclear facilities would be removed from productive use, unless decommissioning measures include removal of all structures. Although the details of decommissioning may not be worked out for several years, the various alternatives should not be diminished by the proposed action of permitting construction. The range of beneficial uses of the site by future generations will not be significantly curtailed.

Commission regulations prescribe procedures whereby a licensee may voluntarily surrender a license and obtain authority to dismantle a facility and dispose of its component parts.[1] Such authorization would normally be sought near the end of the nuclear plant's useful life. In any event, the Commission requires that a qualified licensee maintain valid licenses appropriate to the type of facility and materials involved. Under current regulations, the Commission generally requires that all quantities of source, special nuclear, and by-product materials not exempt from licensing under Parts 30, 40, and 70 of Title 10, Code of Federal Regulations, either be removed from the site or secured and kept under surveillance.

To date, experience has been gained with decommissioning of six nuclear electric generating stations which were operated as part of the Commission's power reactor development program: Hallem Nuclear Power Facility, Piqua Nuclear Power Facility, Boiling Nuclear Superheat Power Station, Elk River Reactor, Carolinas-Virginia Tube Reactor, and Pathfinder Atomic Power Plant. The last two facilities were licensed under 10 CFR Part 50; the others were Commission-owned and operated under the provisions of Part 115.

Several alternative modes of decommissioning have been experienced in those cases. They may be summarized generally as four alternative levels of restoration of the plant site, each with a distinct level of effort and cost.

In decommissioning at any level, economically salvageable equipment and all reactor fuel elements would be removed, some equipment would be decontaminated, and wastes of the type normally shipped during operation would be sent to waste repositories. In addition, the respective levels of restoration would involve the following measures:

Lowest level. There would be minimal dismantling and relocation of radioactive equipment. All radioactive material would be sealed in containment structures (primarily existing ones), which would require perpetual, continual surveillance for security and effectiveness.

Second level. Some radioactive equipment and materials would be moved into existing containment structures to reduce the extent of long-term containment. Surveillance as in the lowest level would be required.

Third level. Radioactive equipment and materials would be placed in a containment facility approaching a practically minimum volume. All unbound contamination would have been removed. The containment structure would be designed to need minimal perpetual maintenance, surveillance, and security.

Highest level. All radioactive equipment and materials would be removed from the site. Structures would be dismantled and disposed of onsite by burial or offsite to the extent desired by the tenant.

Estimated costs of decommissioning at the lowest level are about $1 million plus an annual maintenance charge in the order of $100,000.[2] Estimates vary from case to case, a large variation arising from differing assumptions as to level of restoration. For example, complete restoration, including regrading, has been estimated to cost $70 million.[3] At present land values, it is not likely that consideration of an economic balance alone would justify a high level of restoration. Planning required of the applicant at this stage will assure, however, that variety of choice for restoration is maintained until the end of useful station life.

As of now the following procedure is anticipated for decommissioning CPSES at the end of its useful life (ER, p. 5.9-1).

1. Deactivation of the reactors.
2. Decontamination of process systems and appropriate areas of the plant.
3. Removal of all nuclear fuel from the site for recovery of fuel materials and disposal of radioactive wastes in accordance with the existing procedures and requirements.
4. Sealing of buildings or portions of buildings containing activated process piping and components by means of welding, bolting plates over all openings.

5. Dismantling and sealing of all gaseous and liquid waste systems and effluent lines.
6. Maintaining necessary security and fire systems in an operable and operating state.
7. Complete dismantling after a number of years if required.

Whether the facility would be further dismantled would require an economic study involving the value of the land and scrap value versus the complete demolition and removal of the complex. However, no additional work would be done unless it is in accordance with rules and regulations in effect at the time.

In addition to personnel required to guard and secure the facility, concrete and steel would be used to prevent access to areas which contain significant quantities of induced radioactivity.

10.3 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

10.3.1 Introduction

Irreversible commitments generally concern changes set in motion by the proposed action which at some later time could not be altered so as to restore the present order of environmental resources. Irretrievable commitments are generally the use or consumption of resources that are neither renewable nor recoverable for subsequent utilization.

Commitments inherent in environmental impacts are identified in this section, while the main discussions of the impacts are in Sections 4 and 5. Also, commitments that involve local long-term effects on productivity are discussed in Subsection 10.2.

10.3.2 Commitments considered

The types of resources of concern in this case can be identified as: (1) material resources — materials of construction, renewable resource material consumed in operation, and depletable resources consumed — and (2) nonmaterial resources, including a range of beneficial uses of the environment.

Resources which, generally, may be irreversibly committed by the operation are: (1) biological species destroyed in the vicinity, (2) construction materials that cannot be recovered and recycled with present technology, (3) materials that are rendered radioactive but cannot be decontaminated, (4) materials consumed or reduced to unrecoverable forms of waste, including uranium-235 and -238 consumed, (5) the atmosphere and water bodies used for disposal of heat and certain waste effluents, to the extent that other beneficial uses are curtailed, and (6) land areas rendered unfit for other uses.

10.3.3 Biotic resources

10.3.3.1 Terrestrial

The construction of CPSES will result in the significant alteration of about 4400 acres of the terrestrial ecosystems of Hood and Somervell counties. Of this, some 3228 acres required for the Squaw Creek Reservoir and 200 acres for the station site will be permanently altered. Restoration might be possible, although considerable difficulties are expected. Therefore, the use of this land represents an irreversible and irretrievable commitment. The construction will result in the disturbance of five vegetation communities, the greatest impact being the virtual elimination of the riparian communities along Squaw Creek. I[illegible] of the reproductive capability and growth rate characterist[illegible] most of the species and the current successional status of the communities, a restoration of the upland vegetation communities is possible, assuming satisfactory soil conditions and sufficient time. However, restoration of the riparian communities is highly unlikely, and therefore the elimination of this vegetation must be considered an irreversible commitment of this resource.

Construction activities will have direct impacts on certain consumer populations; however, indirect impacts through loss of habitat will be more significant. The construction of the reservoir will result in the total displacement of terrestrial consumers from the areas involved. Such displacement increases competitive pressure and, subsequently, population regulation through elimination of individuals. The biotic potential of some species is such that loss of individuals has little long-term effect on population structure and stability. For certain other species, notably many avian and mammalian top carnivores, the loss of even a few individuals may have a long-term effect on the population of that area. Reduction of individuals of such species must also be considered as an irreversible and irretrievable commitment of that resource in the site environs.

10.3.3.2 Aquatic

The most significant aquatic impact resulting from construction of CPSES will be the elimination of approximately 2/3 of the steam habitat in Squaw Creek, which is equivalent to approximately 5% of the total stream length in the 2-county area. A number of species presently in Squaw Creek will not be able to survive in the reservoir, and the habitat available to them will thus be reduced. If the dam and reservoir were removed after the operation of CPSES, a stream habitat could possibly be restored. Because restoration of the riparian vegetation is unlikely, however, this portion of the creek could not be returned to its present character, and its elimination must thus be considered an irreversible commitment of this resource.

The quality of water below the dam will be changed due to the use of water from Lake Granbury to maintain flow in Squaw Creek. The flow will probably not be sufficient to retain the present character of the stream. If normal flow were restored, however, the creek would return to its present condition and the impact is thus not considered irreversible.

There will be an irretrievable loss of some fish and planktonic organisms from Lake Granbury due to the filling of Squaw Creek Reservoir and the withdrawal of makeup water for CPSES operation.

10.3.4 Material resources

10.3.4.1 Materials of construction

Materials of construction are almost entirely of the depletable category of resources. Concrete and steel constitute the bulk of these materials, but there are numerous other mineral resources incorporated in the physical station. No commitments have been made on whether these materials will be recycled when their present use terminates.

Some materials are of such value that economics clearly promotes recycling. Station operation will contaminate only a portion of the equipment to such a degree that radioactive decontamination would be needed in order to reclaim and recycle the constituents. Some parts of the station will become radioactive by neutron activation. Radiation shielding around each reactor and other components inside the dry-well portion of each containment structure constitute the major materials in this category, for which it is not feasible to separate the activation products from the base materials. Components that come in contact with reactor coolant or with radioactive wastes will sustain varying degrees of surface contamination, some of which could be removed if recycling is desired. The quantities of materials that could not be decontaminated for unlimited recycling probably represent very small fractions of the resources available in kind and in broad use in industry. Quantities of materials used in other nuclear plants of about the same power output as CPSES but not necessarily of the same typical design are shown in Table 10.3.1. Production, consumption, and reserves are also given.

Construction materials are generally expected to remain in use for the full life of the station, in contrast to fuel and other replaceable components discussed later. There will be a long period of time before terminal disposition must be decided. At that time, quantities of materials in the categories of precious metals, strategic and critical materials, or resources having small natural reserves must be considered individually, and plans to recover and recycle as much of these valuable depletable resources as is practicable will depend upon need.

10.3.4.2 Replaceable components and consumable materials

Uranium is the principal natural resource material irretrievably consumed in station operation. Other materials consumed, for practical purposes, are fuel cladding materials, reactor control elements, other replaceable reactor core components, chemicals used in processes such as water treatment and ion exchanger regeneration, ion exchange resins, and minor quantities of materials used in maintenance and operation. Except for the uranium isotopes 235 and 238, the consumed resource materials have widespread usage; therefore, their use in the proposed operation must be reasonable with respect to needs in other industries. The major use of the natural isotopes of uranium is for production of useful energy.[4]

The two reactors in the plant will be fueled with uranium enriched in the isotope 235. After use in the plant, the fuel elements will still contain uranium-235 slightly above the natural fraction. This slightly enriched uranium, upon separation from plutonium and other radioactive materials (separation takes place in a chemical reprocessing plant), is available for recycling through the gaseous diffusion plant. Scrap material containing valuable quantities of uranium is also recycled through appropriate steps in the fuel production process. Fissionable plutonium recovered in the chemical reprocessing of spent fuel is valuable for fuel in power reactors.

Table 10.3.1. Estimated quantities of materials of construction of water-cooled nuclear power plants

Material	Approximate quantity used in plant[a] (metric tons)	World production[b] (metric tons)	U.S. consumption[b] (metric tons)	U.S. reserves[b] (metric tons)	Strategic and critical material[c]
Aluminum	41	9,089,000	4,227,000	8,165,000	Yes
Asbestos	90	2,985,000	712,000	1,800,000	Yes
Beryllium	0.6	288	308	72,700	Yes
Cadmium	0.005	17,000	6,800	86,000	Yes
Chromium	954	1,590,000	39 000	2,000,000	Yes
Copper	1,670	6,616,000	1,905,000	77,564,000	Yes
Gold	0.001	1,444	221	9,238	No
Lead	108	3,329,000	1,261,000	32,024,000	Yes
Manganese	1,074	7,711,000	1,043,000	907,000	Yes
Mercury	0.03	9,837	2,727	703	Yes
Molybdenum	377	64,770	23,420	2,858,000	No
Nickel	1,110	480,000	129,000	181,000	Yes
Platinum	0.002	46.5	16.0	93.3	Yes
Silver	2	8,989	5,005	41,057	Yes
Steel	80,000	574,000,000	128,000,000	2,000,000,000	No
Tin	5	454,200	82,100	47	Yes
Tungsten	0.01	35,000	7,300	79,000	Yes
Zinc	5	5,001,000	1,630,000	30,600,000	Yes

[a]Quantities used are compiled from various sources for two-unit plants of about the same power rating as the Comanche Peak Steam Electric Station, Units 1 and 2.

[b]Production, consumption, and reserves were compiled, except as noted, from the U.S. Bureau of Mines publications *Mineral Facts and Problems* (1970 ed., Bur. Mines Bull. 650) and the *1969 Minerals Yearbook*. They are expressed in terms of contained element, regardless of the form. "Production" usually includes material recovered from both primary ores and secondary sources such as scrap recovery. Production and consumption figures are for 1969 unless otherwise noted. Estimates of reserves were published in 1969 but are based on data compiled over a number of years. The reserves stated are the quantities extractable at currently competitive prices; they include inferred as well as measured and indicated ores, when such information was available. Usually, resources recoverable with advanced methods or at greater cost are much greater than the reserves listed.

[c]Designated by G. A. Lincoln, "List of Strategic and Critical Materials," Office of Emergency Preparedness; *Fed. Regist.* 37(39): 4123 (Feb. 26, 1972).

If the two units of this plant operate at 80% of capacity, about 12,710 metric tons of contained natural uranium in the form of U_3O_8 must be produced to feed the plant for 40 years. The assured U.S. reserves of natural uranium recoverable at: (1) a cost of $8 or less per pound of U_3O_8 are 277,000 metric tons of uranium and (2) a cost of $10 or less per pound of U_3O_8 are 340,000 metric tons of uranium.[5] In addition to the assured reserves, the potential uranium resources in conventional deposits recoverable at: (1) $8 or less per pound of U_3O_8 are estimated to be 450,000 metric tons of uranium and (2) $10 or less per pound of U_3O_8 are estimated to be 700,000 metric tons of uranium, but this increment will require a major effort in exploration and development to bring it into production.[5] The long-term uranium resource situation in the U.S. will be dependent upon the larger expected reserves of ore recoverable at greater cost and upon utilization of breeder reactors. Plutonium produced in light water reactors, if recycled as fuel to these same reactors, will reduce the requirements for uranium by 15 to 20 percent.

The 12,710 metric tons of mined natural uranium required to feed the fuel cycle for this two-reactor plant consists of 90 metric tons of uranium-235, with the balance uranium-238. A total of 65 metric tons of Uranium-235 will be consumed during a 40-year period. Uranium consumption in the proposed operation is considered by the staff to be a reasonable productive use of this resource.

..ctor fuel and control rod materials consumed in a station similar to CPSES are listed in Table 10.3.2. In view of the quantities of materials in natural reserves, resources, and stockpile and the quantities produced yearly, the expenditure of such material is justified by the benefits of the electrical energy produced.

Table 10.3.2. Consumption of materials used in a 2300-MWe PWR (40 years)

Material	Quantity used in fuel and control rods (metric tons)
Cadmium	1.1
Indium	2.9
Silver	22
Tin	9.2
Uranium	
U-235	65
U-238	180
Zirconium	605

10.3.5 Water and air resources

The expected releases of chemicals and radioactive materials and their consequences are discussed in Sections 3 and 5. It is necessary, in station operation, to use both air and water resources to bear these discharges. There is, therefore, a commitment of these resources for this purpose. The more significant commitment of these resources is the consumptive use of 39,000 acre feet per year of water from Lake Granbury, since this could tend to curtail other beneficial consumptive uses. Such a commitment is, however, neither irreversible nor irretrievable. There are no irreversible or irretrievable commitments of air.

10.3.6 Land resources

About 4400 acres of land would be completely committed to the construction and operation of this power station for the 40 years that the plant would be licensed to operate. Some of the area could be restored for other purposes with a moderate decommissioning effort; however, 3228 acres inundated by Squaw Creek Reservoir are considered to be irreversibly committed.

10.4 COST-BENEFIT BALANCE

10.4.1 Benefit description of the proposed plant

The benefits are listed in Table 10.4.1 and discussed below.

Table 10.4.1. Benefits from the proposed facility

Direct benefits	
Expected average annual generation, kWh	14,104,000,000
Capacity, kW	2,300,000
Expected average annual amount of steam sold from the station, Btu (millions)	0
Expected average annual delivery of other beneficial products (appropriate physical units)	0
Indirect benefits (as appropriate)	
Taxes (annual local and State)	$3,400,000
Research	See text
Regional product	0
Employment (annual operating payroll)	$1,000,000
Education	0
Others (recreation, etc.)	See text

10.4.1.1 Expected average annual generation

Station operation at 2300 MWe with an average annual capacity factor of 70% is assumed. The result is the generation of 14,104 million kW-hr/yr. This represents about 10% of the applicant's planned 1982 installed capacity. This benefit will be available to customers in the applicant's 75,000 square mile service area. This will be provided at a cost equal to or below that of alternative generation sources and without the large release of air emission products of a fossil facility.

10.4.1.2 Proportional distribution of electrical energy expected

The applicant's projection (ER, p. 8.1-4) of distribution of demand for electricity by user classification for 1982 is:

Residential:	40%
Industrial:	32%
Commercial:	20%
Public:	3%
Other:	5%

10.4.1.3 Other products

The applicant does not plan to sell steam or other beneficial products from the facility except possibly certain radioactive products resulting from the fission in the fuel. Such products may be recovered for beneficial use at some future date.

10.4.1.4 Taxes

The station will provide tax revenues to Somervell and Hood counties and the school districts in these counties. The state will also receive tax revenues from the applicant. The applicant estimated the annual CPSES tax revenue to be about $3.4 million (ER, p. 8.1-22). Of this amount $1.2 million would be revenue to the counties, $1.85 million would be revenue to the school districts and $0.31 million would be state revenue.

10.4.1.5 Research

The preconstruction surveys are considered by the staff to be a benefit. The monitor program proposed by the applicant will also provide beneficial information other than that related to station operation.

10.4.1.6 Environmental enhancement

Squaw Creek Reservoir may be developed in part as a recreational facility. The surrounding area will not be available for water-oriented housing (ER, p. 11.1-5). The staff believes that the reservoir will be of some recreational benefit.

10.4.1.7 Employment

The construction work force during the peak year will average 1150. The total construction payroll for the project will be $124,191 million (ER, Table 8.1-6). The staff estimates that the operating force will be about 80 with an annual payroll of over $1 million.

10.4.1.8 Regional development

The electricity generated, the worker payroll, and the tax revenues are expected to be beneficial in regional development.

10.4.2 Cost description of the proposed facility

10.4.2.1 Power generation costs

The generating costs (taxes not included) of the proposed station are given in Section 9.1.2.7. The staff estimated cost of the station in 1982 is $909 million. The annual operating, maintenance and fuel costs in 1982 are estimated to be $53.3 million at an average capacity factor of 70%. Using a 30-year life and a discount factor of 8.75%, the present worth (1982 dollars) of the generating costs is $1.469 billion. The annualized generating costs in 1982 will be $139.8 million at an average capacity factor of 70%. The staff estimates that the cost of decomissioning would have a present worth in 1982 of $7.7 million or an annualized generating cost of $0.73 million which would increase the total annualized generating costs to $140.53 million. This is equivalent to a cost at the station of 10 mills per kWhr.

10.4.2.2 Social costs other than community service costs

The staff discussed social impacts in Sections 4.4 and 5.6. Somervell and Hood counties will experience the greatest impacts. Although some of these cannot be quantified, any dollar costs are judged by the staff to be small in comparison with the tax revenues that these counties will eventually recieve from CPSES.

10.4.2.3 Community service costs

The increased community service costs were discussed in Sections 4.4 and 5.6. The above counties will again be the most heavily impacted. These counties including the cities of Glen Rose and Granbury will have increased demands for public services. The

capital costs associate[illegible] e added facilities required and the increase in operatin[illegible] s will be less than the eventual tax revenues received from CPSE[illegible] in these two counties. At present the above cities cannot tax CPSES; however, there is a State of Texas law which permits a county to provide public services of the type required. The staff is confident that the applicant and the above counties can insure that such services as required are available as needed. The applicant has already provided such assistance to the Glen Rose Independent School District (ER, Supplemental Report).

10.4.2.4 Environmental costs

The environmental costs were discussed in Sections 4, 5, 7, and 9 and Subsections 10.1, 10.2, and 10.3 of this section. One of the most significant costs is the loss to other use of 4321 acres of land (Table 5.1-1). The 3228 acres under the reservoir is considered to be permanently altered. This represents about 5% of the riparian habitat in Somervell and Hood counties. About 8 linear miles of Squaw Creek will be inundated. Six to eight farm residences will be lost. The loss of historical and archeological resources is not considered of serious consequence.

A maximum of about 45,000 acre feet per year of water (Table 5.3.8) will evaporate from Squaw Creek Reservoir. As much as 39,000 acre feet of this will come from Lake Granbury. To limit total dissolved solids buildup some blowdown would be returned to Lake Granbury. This would result in an increase in total dissolved solids concentration in Lake Granbury and the Brazos River below this lake of about 2-1/2%. The environmental costs in terms of Lake Granbury aquatic organisms are expected to be of small significance. The dissolved oxygen concentration of a few surface acres of Lake Granbury will be reduced to near zero in the summer at the point of blowdown discharge from Squaw Creek Reservoir. This will result in fish displacement from this area.

Some smoke and dust will create a nuisance during construction within a mile of the construction area. The air quality during operation will not be reduced in the judgment of the staff.

10.4.3 Summary of cost-benefit balance

The staff concludes that the primary benefit of increased availability of electrical energy outweighs the environmental and economic costs of the station. The staff further concludes that the

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indirect benefits of increased employment and increased tax revenues outweigh the social costs resulting from construction and operation of CPSES.

As indicated in Section 9 the staff believes that there would be no reduction in overall costs by the use of an alternate site, the use of an alternate generating system, or any combination of these. The staff evaluation of alternate cooling systems indicated that the use of cooling towers would result in about the same impacts as the proposed system except in the use of land for Squaw Creek Reservoir and the impounding of a portion of Squaw Creek. The staff believes that the potential beneficial uses of Squaw Creek Reservoir are about equal to the environmental costs of the loss of the land and stream habitats inundated. The staff concludes that a nuclear station using Squaw Creek Reservoir for cooling is a system with a benefit to cost ratio at least as high as that of any alternative system including that of a nuclear station using mechanical draft wet cooling towers.

In the staff's opinion, the benefits of increased availability of electrical energy and improved system reliability in the applicant's service area outweighs the economic and environmental costs caused by the Station when it is operated in accordance with the conditions listed in the Summary and Conclusions.

REFERENCES FOR SECTION 10.3

1. Title 10, "Atomic Energy," *Code of Federal Regulations*, Part 50, "Licensing of Production and Utilization Facilities," Sect. 50.82, "Applications for Termination of Licenses."

2. *Atomic Energy Clearing House*, Congressional Information Bureau, Inc., Washington, D.C., vol. 17, No. 6, p. 42; vol. 17, No. 10, p. 4; vol. 17, No. 18, p. 7; vol. 16, No. 35, p. 12.

3. Pacific Gas and Electric Company, *Supplement No. 2 to the Environmental Report, Units 1 and 2, Diablo Canyon Site*, July 28, 1972.

4. U.S. Department of the Interior, Bureau of Mines, *Mineral Facts and Problems*, p. 230, 1970.

5. U.S. Atomic Energy Commission Press Release T-133, dated March 27, 1974.

11. DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

11.1 INTRODUCTION

Pursuant to Appendix D of 10 CFR Part 50, the Draft Environmental Statement (DES) was transmitted in February 1974 with a request for comment to the Federal, State and local agencies listed in the summary at the beginning of this final statement. In addition, the AEC requested comments on the Draft Environmental Statement from interested persons by a notice published in the Federal Register on February 21, 1974.

Letters in response to these requests were received from the following:

Advisory Council on Historic Preservation (ACHP)
Department of the Army, Corps of Engineer (CE)
Department of Transportation (DOT)
Department of Agriculture, Soil Conservation Service (SCS)
Department of Agriculture, Forest Service (FS)
Department of Health, Education, and Welfare (HEW)
Department of Interior (DOI)
Texas Utilities Generating Company (TUGCo)
Department of Commerce (DOC)
State of Texas (Tex)
Citizens Association for Sound Energy (CASE)
Federal Power Commission (FPC)
Environmental Protection Agency (EPA)

The letters are reproduced in Appendix D of this Statement. The staff's consideration of the issues raised in these letters is reflected in this Section and by changes in the text. The abbreviations and associated Appendix D page numbers refer to the specific comments received from the various agencies and sources.

11.2 Advisory Council on Historic Preservation

11.2.1 Historic and Natural Landmarks (ACHP, D-1)

The applicant met with the Texas Historical Commission and discussed plans for further archaeological field surveys. These plans include the applicant awarding a contract to Southern Methodist University (SMU) for additional salvage work at the only site in the project area which was felt by SMU to be of potential archaeological significance. In addition, SMU will conduct a survey of the water pipeline and transmission line rights-of-way to determine potential construction impacts upon any cultural, historical and/or archaeological resources.

A letter from the State Historic Preservation Officer has been received by the applicant and is reproduced as Appendix E of this statement.

11.3 United States Department of Agriculture

11.3.1 Soil Conservation Service

(1) Effects on Land Use-(SCS, D-3)
Certain modifications have been made in text regarding accessibility to farms and stockpiling of topsoil (Sects. 3.9.1 and 4.3.1.3).

The construction of Squaw Creek Reservoir will result in the loss of about 940 acres of improved cropland (Sect. 4.1.2).

(2) Use of Adaptive Grasses-(SCS, D-3)
Certain introduced grasses may be superior to native grasses in erosion control; however, introduced grasses may not be superior in other functional attributes and do not contribute to the restoration of a natural system. This distinction is considered in Sections 4.3.1.1 and 4.5.2.

(3) Changes to Soils Section of ER-(SCS, D-3)
The applicant has indicated that comments on Section 2.7.5 of the ER regarding soils in the project area will be incorporated in the next amendment to the ER.

11.3.2 Forest Service

(1) Land Use After Decommissioning-(FS, D-4)
Less than 100 acres of land, presently used for grazing, would be removed from longterm productivity after decommissioning of the station.

(2) Forestation of Squaw Creek Reservoir Shoreline-(FS, D-4)
The staff agrees with the recommendation of the U. S. Forest Service that the shoreline of Squaw Creek Reservoir and all adjacent sites with sufficient moisture for tree growth be reforested in an attempt to mitigate the loss of the Squaw Creek riparian community. The applicant has stated that it will cooperate with

the appropriate state agencies (such as the Parks & Wildlife Dept., Texas Forest Service, etc.) to develop such plans.

11.4 Department of Health, Education, and Welfare

11.4.1 Site Clearing-(HEW, D-4)

The potential adverse impacts on local air quality of brush and debris burning was considered in Section 4.3.1.2. While staff agrees with the comment that chipping and shredding of brush and cutting firewood from larger trees would reduce the volume of materials to be burned; vegetation suitable for mulch and firewood materials is sparsely distributed in the project area. The brush cleared will be burned in accordance with applicable State and local directives.

11.4.2 Air Pollution and Noise Abatement-(HEW, D-5)

The applicant indicates that construction equipment will be monitored for compliance with all applicable directives with regard to air pollution and noise abatement. The CPSES construction contract provides for compliance with the Occupational Health and Safety Act of 1970 (latest revision) as well as any additional Federal, State and local laws and regulations pertaining to health and safety.

11.4.3 Chemical Effluents-(HEW, D-5)

In the vicinity of the discharge of Squaw Creek Reservoir water into Lake Granbury, the concentrations of total dissolved solids (TDS) are given in Table 3.6.3. Directly downstream of the discharge, Lake Granbury flows through the De Cordova Bend Dam. As a result, the average concentration of TDS of water passing through the dam is expected to be completely mixed.

11.4.4 Evaporation Pond-(HEW, D-5)

The applicant has amended its ER which now indicates that the evaporation pond will be lined with an impervious liner (Sect. 3.6.1.2). The staff does not expect sludge removal from the pond will be necessary.

11.4.5 Effect of Transmission Lines-(HEW, D-5)

The staff does not expect any adverse effects due to electromagnetic radiation due to CPSES transmission lines upon area communications. The applicant has stated that its transmission lines will be designed and operated to minimize all radio interference and acoustical noise. (ER, Sect. 3.9.22)

The applicant states that there are no crop-dusting operations currently carried on in the vicinity of the transmission line right-of-way.

11.4.6 Road Maintenance-(HEW, D-5)

The staff and applicant's positions regarding increased traffic in the vicinity of the project are given in Section 4.1.1 and 4.5.1, respectively. With regard to the volume of vehicle traffic anticipated, the applicant has indicated that it will cooperate fully with the Texas Highway Department concerning maintenance and improvements to access roads in the project vicinity.

11.4.7 Solid Waste-(HEW, D-5)

The applicant has stated that solid radioactive waste will be packaged in containers suitable for long-term storage of such materials. These containers may not necessarily be 55 gallon steel drums, as the technology for such packaging is rapidly changing and improving. Therefore, the most suitable methods available at the time will be employed.

Disposal of this waste must comply with the Commission's Regulations.

11.4.8 Impact on Local Institutions-(HEW, D-5)

Chapter 8 of the Environmental Report discusses in detail the socio-economic impacts of the project upon the local communities. An extensive treatment of this subject is contained in a report entitled Supplemental Report on Questions Relating to Indirect Benefits and Costs of the Proposed CPSES, dated September 1973, which was prepared for the applicant by Westwood Research, Inc. The Applicant states that it is fully cognizant of the importance of maintaining an adequate level of community services, and will cooperate with the local officials in mitigating any adverse impacts resulting from a burden upon local resources.

11.5 Department of the Interior

11.5.1 Post-construction Monitoring-(DOI, D-6 and D-9)

With respect to construction activities, the staff will require as a condition of the construction permit (see Summary and Conclusions) that the applicant take necessary mitigating actions to avoid unnecessary adverse environmental impacts and to establish a program of control to assure that construction activities are not resulting in significant

adverse environmental impact. Inspection of construction activities and of the program of control by the AEC will ensure compliance with this permit condition. In addition, the staff has concluded that the construction permit be conditioned so that the applicant will notify the Commission of planned remedial action in the event unexpected significant environmental damage is experienced during construction.

With respect to adverse impacts on aquatic and terrestrial ecosystems that may occur as a result of the future operation of the facility, the environmental technical specifications accompanying any operating license will contain provisions to require notification to the AEC of significant effects and programs to alleviate the condition. The requirement to notify other State or Federal agencies is a matter between those agencies and the applicant and is not a part of construction permits or operating licenses issued by the AEC.

11.5.2 Regional Demography-(DOI, D-6)

The suggested additions have been made in the text (Sect. 2.2.1)

11.5.3 Historical and Archeological Resources-(DOI, D-6 and D-7)

See response to Advisory Council on Historic Preservation (Sect. 11.2.1).

11.5.4 Geology and Seismology-(DOI, D-6 and D-7)

The information on geology in the environmental statement is not intended to be sufficient for an independent assessment of the adequacy of the facility design with respect to the geologic environment. Such adequacy is determined by the AEC in its safety evaluation of the proposed station, which, as presumed in the comment, does include consideration of seismology. The primary purpose of including ecosystem descriptions in the environmental statement is to permit an evaluation of how the construction and operation of the proposed plant might have an adverse impact on some element of the ecosystem or its interactions. For this purpose, the staff believes the descriptions of geology and seismology in the statement are sufficient.

11.5.5 Effects on Lake Granbury Water Quality-(DOI, D-7)

The staff has evaluated the operational effects of Squaw Creek Reservoir releases to Lake Granbury (Sect. 5.2.3).

11.5.6 Terrestrial Ecology-(DOI, D-7)

The suggested changes have been made in the text (Sects. 2.7.1.3 and 4.3.1.1).

11.5.7 Evaporation Pond-(DOI, D-7)

Figure 2.1-3a of the Environmental Report shows the correct configuration of the evaporation pond. The design and the operational details associated with a pond of a 28,000 gallons/day capacity are discussed in Section 3.6.1.2. The environmental impacts associated with the construction of this pond were assessed by the staff in Section 4.1.1.

11.5.8 Solid Radioactive Wastes-(DOI, D-7)

Wet solid wastes will consist mainly of spent demineralizer resins, filter sludges and evaporator bottoms. The staff considers that all wet solid waste will be stored onsite for approximately 180 days prior to shipment which allows shortlived radionuclides time for decay. Dry solid wastes will consist of ventilation air filters, contaminated clothing, paper and miscellaneous items such as tools and laboratory glassware. Since these wastes normally contain less radioactivity than wet solid wastes, we assume that these wastes are shipped as soon as they are packaged and not held for decay.

Based on the staff's evaluation of similar type reactors and data from operating reactors, the staff estimates that approximately 9,500 Ci/yr of wet solid wastes will be shipped from the site in drums or shipping casks. The staff estimates that less than 5 Ci/yr of dry and compacted solid wastes will be shipped from the station. Greater than 90% of the radioactivity associated with the wastes will be long-lived fission and corrosion products, principally Cs-134, Cs-137, Co-58, Co-60, and Fe-55.

The concerns expressed in this comment are appropriately addressed in the AEC document "Environmental Survey of the Nuclear Fuel Cycle." As noted in that document, the environmental effects of the entire uranium fuel cycle with regard to an individual reactor are small. Further, the potential for any significant effect from the disposal of solid radioactive wastes from a reactor is extremely limited due to (1) the small quantity of radioactivity contained in the wastes, and (2) the care taken in establishing and monitoring commercial land burial facilities as noted below. Commercial land burial facilities must be located on land which is owned by a State or the Federal government, and after radioactive wastes are buried at a site, that site must not be used for any other purpose. Authorization to operate a commercial land burial facility is based on an analysis of the nature and location of potentially affected facilities and of the site topographic, geographic, meteorological, and hydrological characteristics; which must demonstrate that buried radioactive waste will not

migrate from the site. Environmental monitoring includes sampling of air, water and vegetation to determine migration, if any, of radioactive material from the actual location of burial. To date, there have been no reports of migration of radioactivity from commercial burial sites. In the event that migration were to occur, plans for arresting any detected migration have been developed. On the basis of the general environmental considerations of burial sites now developed, the wide range of wastes that can be buried, and the observation that an applicant is not restricted to a specific burial site, the staff believes that a more detailed discussion of solid radioactive waste disposal sites is inappropriate to an environmental statement for any one nuclear power plant facility.

11.5.9 Squaw Creek Reservoir Construction-(DOI, D-7)

Figure 2.7-2C of the Environmental Report illustrates the location of the borrow areas with respect to topography, soils, and vegetation. Summary descriptions of the soils, producers, and consumers occurring in these areas are found in section 2.7.1 and Appendix A of this statement.

11.5.10 Displaced Fauna-(DOI, D-8)

The formation of Squaw Creek Reservoir will result in the displacement of consumer species (Sect. 4.3.1.2). As the overall carrying capacity of these terrestrial ecosystems is expected to be at equilibrium, any displacements through loss of habitat will result in population regulation through elimination of individuals.

11.5.11 Brush Clearing of Juniper and Mesquite-(DOI, D-8)

The staff concurs that the recommended brush clearing of juniper and mesquite thickets (Section 4.3.1.2) should be consistent with the guidelines of the Texas Department of Parks and Wildlife.

11.5.12 Biomass and Productivty-(DOI, D-8)

The staff agrees that recreational quality cannot be measured by biomass. However, in the context used in Section 4.3.2.1 the implication was a reservoir would be more productive than an intermittent stream.

11.5.13 Squaw Creek Channel Relocation-(DOI, D-8)

The statement in Section 4.3.2.1 of the DES with regards to relocation of Squaw Creek during construction of the dam was misleading. The creek will not be routed around the construction site; rather, a portion of the stream channel will be shifted slightly within the reservoir site until closure of the dam. The text of this Statement has been clarified.

11.5.14 Siltation Effects on the Paluxy and Brazos Rivers-(DOI, D-8)

The staff concludes that the erosion and runoff controls to be implemented during construction will minimize the effects of siltation in Squaw Creek. As a result the staff concludes siltation due to the construction of Squaw Creek Reservoir will not affect the Paluxy or Brazos Rivers.

11.5.15 Releases to Lower Squaw Creek-(DOI, D-8)

The applicant has indicated that the Lake Granbury water discharged into lower Squaw Creek will be aerated. The shallow and wide nature of the stream will lend itself to such aeration. However, rip-rap will be placed at the discharge to enhance aeration. The applicant will be required to meet applicable Texas Water Quality Standards.

11.5.16 Recreational Impacts-(DOI, D-8 and D-9)

Plans for recreational development on Squaw Creek Reservoir have not yet been formulated. This activity is within the jurisdiction of the Texas Parks and Wildlife Department. While the recreational development is not the responsibility of the applicant, full cooperation will be given to the State agencies (Refer to Sect. 11.11.24).

Recreational use may be permitted within the exclusion zone as shown in Figure 3.4.1, although the exact configuration of land to be designated for recreational purposes is subject to revision as plans are developed.

A general picture of the recreational activity on Lake Granbury is contained in the Westwood Research, Inc. report referred to previously (Sect. 11.4.8). In addition, Section 2.2. of the Environmental Report discusses area demographic data, including recreational aspects.

The return line discharge point in Lake Granbury is in an area already excluded to recreational use as it is within an existing buoy line. This buoy line is shown in Figure 3.4-14 of the Environmental Report. The staff does not believe that impacts on Lake Granbury recreational activities due to either the construction or the operation of CPSCS will be significant.

11.5.17 Transmission Line River Crossing-(DOI, D-9)

The staff has examined the proposed transmission line rights-of-way and has concluded that the applicant has taken reasonable precautions to minimize adverse impacts. Alternative routes were considered less desireable than the proposed route from an overall environmental standpoint.

11.5.18 Thermal Analysis-(DOI, D-9)

Concerning the Applicant's thermal analysis, recirculation of water between the power plant intake and discharge was accounted for in the reservoir heat budget analysis. The Δt through the power plant is 14.2°F, and the Δt between the intake and discharge as shown in Fig. 5.3.4 is 12.7°F. This difference indicates heat storage in the lake, however, this heat storage should be expected to occur during the spring of the year. The reverse process will tend to occur in the fall. Similar processes will occur from day to day due to variations in air temperatures. The applicant's model was executed eight times per day to account for both diurnal and day-to-day variations (Table 3.3.1). The staff analysis supports the applicant's results.

11.5.19 Effects of Transmission Lines on Birds-(DOI, D-9)

Based on past experience with construction and operation of transmission line facilities of similar scope and in similar settings the applicant does not anticipate that transmission lines and towers will have an adverse effect on birds and waterfowl.

11.5.20 Entrainment in Squaw Creek Reservoir-(DOI, D-9)

The staff estimate of entrainment by CPSES is 686.4×10^6 lbs of zooplankton per year. The assumptions used in this estimate are:

1) plankton concentrations in the reservoir are equal to those in Lake Granbury in the area of the makeup water intake,

2) a combined cooling and service water intake of 2,232,000 gpm,

3) biomass values as used in Section 4.3.2.3.

As stated in Section 5.5.2.1 the staff concluded, based on conservative assumptions, that productivity of Squaw Creek Reservoir may be reduced due to entrainment of organisms by CPSES.

Short circuiting within the reservoir would not have an appreciable effect on the staff conclusions.

11.6 Texas Utilities Generating Company

The comments that follow are those in which the applicant's position differs in some way from the staff's assessment.

11.6.1 Operational Chlorination Practices (TUGC, D-11 to D-13)

Staff Position (DES)
The applicant shall design the station to control the addition of chlorine to the circulating water systems such that the concentration of total residual chlorine at the point of discharge to Squaw Creek Reservoir is 0.1 ppm or less at all times.

Applicant Position
Chlorination of the condensers of the CPSES to a maximum level of 0.5 ppm - 1.0 ppm free residual chlorine at the discharge to Squaw Creek Reservoir is necessary (Appendix D, D-11 to D-13).

Staff Position (FES)
The applicant has submitted a brief summary of the chlorination limits utilized at various stations in its system which indicates that the levels used approximate the 0.5 - 1.0 ppm chlorine residual at the condenser outlet claimed as necessary for CPSES (Appendix D-11 to D-13). In addition, the reports referenced by the applicant compared the general productivity of reservoirs and lakes in Texas that receive power plant effluents to similar water bodies that do not receive power plant effluents. Staff review of these reports indicated that the data (1) were not correlated to the operational schedule of the power plants; and (2) did not identify any detrimental effects in the reservoirs or lakes that could be directly attributed to power plant operation. However, on the bases of the information received from the applicant, the staff is unable to conclude that the applicant has adequately demonstrated the need for the desired free chlorine levels (i.e., 0.5 ppm).

The staff recognizes, however, that circumstances existing at the CPSES may require total residual chlorine levels higher than those recommended by the staff. Therefore, the staff will require that the applicant design the station to control the addition of chlorine to the circulating water system such that the concentration of total residual chlorine at the point of discharge to the Squaw Creek Reservoir is 0.1 ppm or the minimum practicable level demonstrated by the applicant to be necessary for efficient operation of the CPSES. The minimum practicable level of chlorination necessary shall be determined by the applicant prior to the initiation of power operation of CPSES through a study program.

This study shall include an evaluation of the effects the residual chlorine releases on Squaw Creek Reservoir; a demonstration of the minimum total residual chlorine level necessary for efficient operation of CPSES and and evaluation of the monitoring program to be used to determine total residual chlorine and its effects. Alternative methods of reducing chlorine residuals shall also be investigated and these shall include but not be limited to optimizing chlorine dosage, modifying condenser design to permit sequential treatment of sections of the condensers, and optimizing the chlorination schedule to coincide with periods of low flow in the condensers. (Refer to Sect. 11.11.8).

11.6.2 Intake Structure Design/Water Velocities-(TUGCo, D-14 to D-15)

Staff Position (DES):
The applicant shall redesign the circulating and service water intake to reduce the velocity at the trash racks and ahead of the screens to no more than 0.8 fps.

Applicant Position
Redesign of the circulating and service water intake structures to accomplish a reduction in intake velocity from approximately 1.34 fps to 0.8 fps max would impose an economic burden of between $850K to over $1400K and would not result in any definitive benefit over that of recent experience with intake velocities equal to or greater than 1.0 fps (Appendix D, D-14 to D-15) (Refer to Sect. 11.11.9).

Staff Position (FES):
The staff evaluation of the data submitted to date indicates that the predicted impingement impacts on Squaw Creek Reservoir (SCR) do not appear to warrant the expenditure of about one million dollars to modify the design of the intake structure. The staff will require the applicant to monitor the debris collected on the travelling screens of the SCR intake structures to determine the identity and number of fish caught thereon and take the necessary action to reduce the impact from this source if necessary. This monitoring program shall be submitted as part of the operational monitoring programs proposed by the applicant in his Operation License Stage Environmental Report.

In addition, the staff will require that, during the design stages of the plant, the applicant evaluate alternative actions which will mitigate the adverse effects of the high intake velocity. Such measures shall include but not be limited to fish diversion facilities and fish return mechanisms (screen lifts, fish pumps, etc.). It is the view of the staff that by designing the SCR intake structures with either these provisions fully incorporated or with means for adding them later, if necessary, is a practical method of assuring that means for reducing environmental impact due to impingement will be readily available (Refer to Sect. 11.11.9).

11.6.3 Cooling Tower Water Consumption-(TUGCo, D-15 to D-17)

Staff Position
Although there is less induced evaporation from the reservoir than from cooling towers, the sum of natural and evaporative losses from the reservoir is greater than the losses from the cooling towers (Section 9.2.1.3).

Applicant Position
Experience in the applicant's service area has shown cooling ponds to offer significant water conservation advantages when compared to alternative forms of cooling, such as mechanical-draft wet towers. The consumptive water use, as presented in the DES, for the proposed Squaw Creek Reservoir appears to be excessive, while cooling tower water requirements appear unrealistically low (Appendix D, D-15 to D-17).

Staff Position (FES)
As indicated below, the staff, after reviewing the information on water losses from cooling ponds and cooling towers, still concludes that the sum of natural and evaporative water losses is greater from the cooling pond than from the cooling towers.

The staff agrees with the applicant that water resource management should be one of the concerns in the selection of a power plant site and in the selection of a cooling system for a particular plant. Although the applicant stated that its experience shows that the AEC estimates of the cooling tower forced evaporation losses at the CPSES site would be unrealistically low, they did not present any experimental data supporting this comment.

The method used by the staff considered the fraction of the heat that is dissipated as sensible heat to the air and the fraction of the heat that is dissipated by evaporation. Monthly averages of the 1971 meteorological data for Amon Carter Field, Fort Worth, Texas were used by the staff in calculating the results shown in Table 9.2.1.

The staff has refined its method of estimating evaporative water losses from cooling towers and made additional estimates of the water evaporation rates for the hypothetical cooling towers at the CPSES. These calculations were done for the years 1956 and 1971 using the monthly averages

of the meteorological data for Amon Carter Field, Fort Worth, Texas. The towers are assumed to be designed to be capable of dissipating the entire waste heat load with a 14°F approach temperature in air having a wet bulb temperature of 76°F and a dry bulb temperature of 110°F (ER Amend 2, Table 9.2-4). A tower rating factor was calculated from these design conditions and the approach temperature for each month was found for this rating factor. Two cases were considered for each of these years.

a. The towers designed to handle the condenser heat load at 100% plant factor and 2.20×10^6 gpm circulating water flow rate and operated at the circulating water flow rates and temperature ranges given in Table 3.3.1.

b. The towers designed to handle the condenser heat load at 100% plant factor and 1.65×10^6 gpm circulating water flow rate and operated at a constant circulating water flow rate and the plant factors given in Table 3.3.1.

These additional estimates are shown in Table 11.6 3.1.

The results in this table for the year 1971 essentially are in agreement with the results shown in the Table 9.2.1. These results also indicate that there is little difference in the water evaporation since the tower is designed to operate at a constant circulating water flow rate or at variable circulating water flow rate as given in Table 3.3.1. There is some increase in the rate of water evaporation for 1956, which is representative of a dry year at the CPSES site, as compared to that for 1971, which approximates conditions of an average year at the CPSES site.

A comparison of the water consumed by the cooling towers and by Squaw Creek Reservoir as estimated by the staff is shown in Table 11.6.3-2. For the years considered, it can be seen that the water consumed by the cooling towers is less than that consumed by Squaw Creek Reservoir. This is particularly true for the dry year (1956), where about 40,000 acre-ft of water would be consumed in Squaw Creek Reservoir compared to about 29,000 acre-ft of water that would be consumed by the cooling towers.

Both the staff and the applicant considered the direct precipitation in estimating the amount of water that would have been consumed in Squaw Creek Reservoir. The staff did not, as the applicant stated, consider the runoff from Squaw Creek into Squaw Creek Reservoir in estimating the water consumption in the reservoir. The applicant has

Table 11.6.3-1

Supplementary Staff Estimates of Water Evaporation in Wet Forced-draft Cooling Towers

Month	Water Use (acre-ft)			
	Year 1956		Year 1971	
	Varying Water flow[a]	Constant Water Flow[b]	Varying Water Flow[a]	Constant Water Flow[b]
January	1939	1927	1958	1946
February	1819	1809	1828	1821
March	1578	1612	1539	1555
April	1599	1650	1571	1600
May	2481	2491	2334	2336
June	3217	3166	3165	3127
July	3538	3444	3322	3274
August	3526	3433	3101	3095
September	3286	3209	2975	2958
October	2401	2411	2267	2265
November	1451	1449	1472	1460
December	1451	1426	1457	1413
Total	28,288	28,028	26,990	26,861

[a]Circulating water flow rates assumed to be those given in Table 3.3.1

[b]Circulating water flow rate assumed to be 1.65×10^6 gpm.

Table 11.6.3-2

Supplementary Staff Estimates of Water Consumption in Squaw Creek Reservoir and in Wet Forced-draft Cooling Towers

	Water use (acre-ft)	
	Year 1956	Year 1971
Cooling tower with varying water flow[a]		
Evaporation	28,288	26,990
Drift	820	820
Total	29,108	27,810
Cooling tower with constant water flow[b]		
Evaporation	28,028	26,861
Drift	840	840
Total	28,868	[illegible] 701
Squaw Creek Reservoir		
Net total evaporation	41,330 (39,460)[c]	29,410 (27,970)[c]

[a]Circulating water flow rates assumed to be those given in Table 3.3.1.

[b]Circulating water flow rate assumed to be 1.65×10^6 gpm.

[c]Values given in Freese, Nichols and Endress, Consulting Engineers, (Engineering Report on Squaw Creek Reservoir, report prepared for) Texas Utilities Services, 1972.

estimated that this runoff would have been 4670 acre-ft in a dry year (1956) and 8040 acre-ft in an average year (1971).[1] Including these in the reservoir water budget, the staff estimate of the consumptive water use in the reservoir would have been 36,660 acre-ft in the dry year (1956) and 21,370 acre-ft in the average year (1971). Therefore, for an average year (1971), the staff concurs with the applicant that more makeup water from Lake Granbury would have been required for the cooling towers than for the reservoir. However, in a dry year (1956) more makeup water from Lake Granbury would have been required for the reservoir than for the cooling towers.

When considering the makeup water required for the cooling towers and Squaw Creek Reservoir, the staff considered the Brazos River Basin, not just Lake Granbury. As shown in Fig. 2.1.2, the Squaw Creek-Paluxy River confluence is about 4 miles downstream of the site. Also the Paluxy River-Brazos River confluence is only a few miles downstream of the De Cordova Bend Dam. Therefore, if the Squaw Creek runoff is not consumed at the CPSES, it will be available to a potential user in the Brazos River Basin downstream of the CPSES site. Because of this, it is the staff's conclusion that the Squaw Creek Reservoir consumptive water use will be more than a cooling tower heat dissipation system consumptive water use.

11.6.4 Cooling Tower Costs-(TUGCo, D-18 to D-20)

Staff Position (DES)
The capital cost of the cooling tower installation for CPSES has been estimated by the staff to be about the same as that for the reservoir heat dissipation system (Sect. 9.2.1.3).

Applicant Position
Cost data for cooling towers and reservoirs, as presented in the ER, refute any possibility that capital costs are comparable for the two methods (Appendix D, D-18 to D-20).

Staff Position (FES)
The staff estimates that the capital cost of a station with mechanical draft cooling towers is about the same as one with a cooling reservoir like Squaw Creek Reservoir (Table C-2).

The staff believes that the costs of the intake and discharge structures on Squaw Creek Reservoir do not appear to have been considered in the applicant's estimate of the cost of reservoir cooling system (Appendix D, D-18). The staff estimates the costs of these structures and connecting piping to be about $8 to 10 million. When the staff revised the applicant's cost estimates to include these costs, the costs of both cooling systems appear to be about the same.

[1] Freese, Nichols, and Endress, Consulting Engineers, Engineering Report on Squaw Creek Reservoir, report prepared for Texas Utilities Service, Inc., 1972.

11.6.5 Scheduling of Construction Activities-(TUGCo, D-21)

Staff Position (DES):
If preconstruction surveys indicate that spawning does occur in... (Lake Granbury and lower Squaw Creek)...adverse impacts would be reduced if construction activities were minimized during the spring and summer months (Sect. 4.3.2.2).

Applicant Position
The temporary construction activities to be scheduled on Lake Granbury for the CPSES makeup water diversion and discharge facilities will be limited to such a miniscule portion of the shoreline that the impact on the overall aquatic resources of the lake will be insignificant. In view of the crucial requirement for the CPSES facility to be placed in operation on schedule, any restrictions which would result in our construction schedules being impacted by this type of criteria are considered to be completely unjustified and would pose a severe hardship upon the timely implementation of the CPSES project (Appendix D, D-21).

Staff Position (FES)
The staff concluded that the erosion and runoff controls the applicant intends to employ will greatly limit the silt that might enter Squaw Creek. Because of the 2-year period required for dam construction, however, the staff also concluded that any siltation over such a long period could adversely affect the stream community and, therefore, recommended, as an additional precaution, that an attempt be made to reduce heavy excavation during periods of spawning and high stream production. The staff realizes that the spawning of many fish species continues for a number of months and that construction cannot be limited for the entire time or curtailed completely in the middle of the project. It appears to the staff that the months of May and June have the highest concentration of spawning for the most common species in both Squaw Creek and Lake Granbury (Table B-4).

The staff will require that the applicant include in the first year of its construction monitoring program monthly measurements of turbidity and total suspended solids in Squaw Creek water (to supplement the seasonal measurements shown in Table 6.1-1 of the Environmental Report). If these measurements indicate that the erosion and runoff controls are not keeping silt out of the stream, the applicant will be required to consult with the Texas Department of Parks and Wildlife to determine whether corrective actions (such as reduced construction activity) are necessary to mitigate adverse impact on spawning in Squaw Creek.

The staff concludes that siltation effects on Lake Granbury will be small because of the relatively small area involved in the lake and because the area does not appear to be conducive to heavy spawning.

11.6.6 Updated Land Use Acreage Data-(TUGCo, D-21 to D-23)

Staff Position (DES)
Land use acreage estimates were given in the DES in Sections 3.8, 3.9, 4.1, 4.3, and 5.1.

Applicant Position
The applicant has provided certain new data and identified minor discrepencies regarding land use acreages (Appendix D, D-21 to D-23).

Staff Position (FES)
The applicant's revised land use data was reviewed by the staff. The new numbers given by the applicant are considered to be reasonable. The applicant's estimate of total acreage affected is slightly less than that given in Table 4.1.1 and used by the staff in its assessment.

The staff concludes that the use of the applicant's revised information does not significantly affect the initial assessments made by the staff.

11.6.7 Groundwater Studies-(TUGCo, D-11)

Staff Position (DES)
The staff has insufficient data to concur with the applicant's assessment regarding the effect of groundwater use (Sect. 5.2.2).

Applicant Position
On April 24, 1974 the applicant submitted a report on groundwater availability which concludes that no adverse impact on ground water use and that mining of the Twin Mountain aquifer will occur as a result of CPSES operation.[2]

Staff Position (FES)
The staff has reviewed and analysed the data and information provided by the Applicant relevant to the potential environmental effects of groundwater withdrawal at the subject plant. The projected groundwater use rate and potential groundwater mining in the region have not been resolved. The staff has made certain normalizing assumptions in its review. Where possible, the staff has used a range of estimates of projected groundwater use to assess the potential environmental impacts.

[2] Ground Water Availability at Comanche Peak Steam Electric Station, prepared for Texas Utilities Services, Inc. by Singer Layne Texas Division, dated April 7, 1974.

a. Projected Plant Use of Groundwater - Discrepancies exist in the applicant's PSAR and ER related to the estimate of groundwater use. In addition, the applicant's recent submittal, "Ground Water Availability at Comanche Peak S.E.S." contains an additional and different estimate of ground water use. The "Availability Report" states that groundwater usage will average about 35 gallons per minute (gpm) with a peak demand of 360 gpm. Section 2.4.13.1.7 of the PSAR estimates total plant operating requirements to be 330 gpm. Section 2.5 of the ER estimates a maximum groundwater use during operation of 370 gpm (Refer to Sect. 3.3 and Fig. 3.3.1). Section 4.1.2.1 of the ER indicates groundwater use during construction will range from 200 to 250 gpm. Because of the inconsistency of the applicant's projected use of groundwater in these reports, the staff has assessed the potential environmental effect on groundwater for three projected use rates.

b. Drawdown of Groundwater Due to Plant Use - The Availability Report provided sufficient information and data to the staff to estimate drawdown of the groundwater surface as a result of the projected plant useage. The staff has analyzed the effect of three pumping rates and two durations; 250 gpm for five years to reflect construction activity, 30 gpm for 40 years to reflect only sanitary and potable supply demand, and 330 gpm for 40 years to reflect the plant operating demand as reported in the PSAR. The following Table displays the staff estimates of drawdown.

Pumping Rate (gpm)	Duration (years)	Drawdown in Feet Distance from Well in Miles 1	5	10	20
30	40	4	2+	2-	1
330	40	40	23	17	9
250	5	26	14	9	5

The above estimates are based on the applicant's estimate of the coefficient of transmissibility, apparently the highest observed during the reported pumping test. While the applicant did not fully substantiate the coefficient of transmissibility; the staff has no reason to doubt the reasonableness of the applicant's choice. If instead the smaller of the observed coefficients were used the drawdown at approximately 20 miles for the same rates and duration would be 4, 40, and 6 feet respectively.

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Principal wells in the area within 20 miles of the site are listed in Table 2.4.13.2.1.2-1 of the PSAR. All the wells in the site vicinity appear to be of small capacity and all are deep wells completed in the Twin Mountains aquifer. The Texas Water Development Board has completed a study (Refer to Section 2.2.3.1) indicating that pumpage for the Twin Mountains aquifer within 20 miles of the site totals about 100 acre-ft per year. This yearly pumpage is expected to increase to about 200 acre-ft per year by 2020. The use of the applicant's estimate of groundwater utilization within 20 miles of the plant with an estimated plant use of 350 gpm, would result in a 560 percent increase in the present withdrawal rate. Similarly, a 30 gpm demand would constitute a 50 percent increase in the present withdrawal rate. As indicated by the staff in the table above, the piezometric level in the Twin Mountains formation will be depressed locally by projected CPSES groundwater use.

c. Mining of Groundwater - The staff has previously expressed its concern that groundwater mining may be occurring in the region (refer to Section 5.2.2). In the "Availability Report" the applicant concludes that such is not the case. Insufficient information and data has been submitted to the staff to support the applicant's conclusion of non-mining. On the contrary, information submitted by the applicant (in Section 2.4 of the PSAR and specifically Table 2.2-12 of the ER) indicates there has been a general lowering of the groundwater level of 1 to 11 feet within the past seven years. Therefore, the staff can only conclude from the information available that groundwater mining is occurring. As discussed above, the estimated groundwater use by the plant will constitute a significant increase in the regional withdrawal of groundwater from the Twin Mountains aquifer.

d. Staff Conclusion Regarding Groundwater Use - Based on the information available to the staff, it appears that the local depression of the piezometric level in the Twin Mountains formation will not adversely effect existing wells withdrawing from the formation, if the withdrawal rate during construction is limited to 250 gpm and during operation to an annual average withdrawal rate 35 gpm. However, in view

of the large increase in the regional withdrawal of groundwater due to CPSES, coupled with the apparent present groundwater mining in the site vicinity; the staff will require that the construction permit for CPSES be conditioned as follows:

"The rate of groundwater withdrawal during construction of the station shall not exceed 250 gpm. Withdrawal of groundwater shall be reduced to an annual average of 30 gpm at the end of five years. During this period the applicant shall evaluate alternative actions which will mitigate potential adverse effects resulting from CPSES groundwater use. Such actions or measures shall include but not be limited to using an alternative source of water for station operation, monitoring neighboring wells to determine effects of the station's use of groundwater during construction and further analysis of regional data to determine whether groundwater mining is occuring in the vicinity of the site. The results of these applicant evaluations shall be submitted as part of the applicant's Environmental Report - Operating License Stage."

11.7 Department of Commerce

11.7.1 Long-term Storage of Gaseous Radioactive Wastes-(DOC, D-23)

The release rate of radioactive gaseous waste to the atmosphere will be governed by the limits specified in the Technical Specifications for this station. The staff assumed the release of gaseous effluents will occur over a period of days. Therefore, the staff use of the annual average dispersion factor to calculate annual total body and skin doses is deemed to be appropriate.

11.8 State of Texas

11.8.1 Office of the Governor

(1) Geology-(Tex, D-23)

See response to Department of Interior comments Sect. 11.5.3.

(2) Meteorology-(Tex, D-23)

The applicant's Environmental Report contains meteorological data to predict the deposition rate of airborne effluents. Using these data and atmospheric diffusion-deposition models along with other factors, the thyroid dose from radioiodine via the grass-cow-milk-human chain is calculated. The results of these calculations are located in Section 5.3.3.

(3) Highway Permits-(Tex, D-23)

Suggested changes were made in the text (Sects. 3.9.1 and 3.9.3).

(4) Monitoring Costs-(Tex, D-23)

The staff estimated capital cost of the station given in Table C-2, Appendix C, includes the cost of monitoring instrumentation and equipment. The staff estimated operating work force of 80 (Section 5.6.2) includes the personnel required to perform the monitoring. Even if 10 additional technical personnel are required, the annualized cost is expected to be only 0.3% higher for a nuclear plant. This small increase does not change the staff conclusions reached in Section 9.1.2.7.

(5) Archeological Survey-(Tex, D-24)

See response to Advisory Council on Historic Preservation Comment (Sect. 11.2.1).

(6) Radiological Monitoring of Groundwater-(Tex, D-24)

The staff considers the groundwater sampling for radiological monitoring program proposed for Comanche Peak to be adequate. This program includes sampling of one onsite well and the Glen Rose drinking water supply which is drawn from three of the wells nearest the site.

(7) Brush-clearing-(Tex, D-24)

The staff has recommended that vegetation in cove and upper lake areas of the proposed reservoir be left standing (Sects. 4.3.1.2, 4.3.2.4 and 4.5.2).

11.8.2 Bureau of Economic Geology-(Tex, D-24)

See response to Department of Interior comment Sect. 11.5.3.

11.8.3 Department of Agriculture

(1) Population Projections-(Tex, D-25)

The population projections given in Table 2.2.2 were based on data in Sections 2.2.1 and 6.1.4 of the Environmental Report which provide detailed description and documentation for these population projections. It is true that the Environmental Report projections differ from "established trends" for population growth as reported in published population studies. Part of the difference is explained by the fact that the applicant's studies take into account county-by-county variations in population growth trends. Of particular consequence is the fact that published projections do not reflect the continued and increasing thrust of urban and suburban development southwestward from the Fort Worth Metropolitan area. For example, the creation of Lake Granbury has had a major impact in local population growth, not reflected in other population studies. Relatively rapid growth over the next decade (in accordance with these trends in suburban residential development) followed by a decline in the rate of continued growth is expected, as described in the applicant's Environmental Report.

(2) Milkshed Characteristics and Tritium-(Tex, D-25)

As noted in Section 2.2.3 of the Environmental Report dairying is a minor activity in the proposed project area. The environmental Technical Specifications of any operating license for the CPSES will require a radiological monitoring program which includes sampling and analysis of milk from cows in the local environs of the station and monitoring of other food pathways (drinking water, groundwater, vegetables, etc).

The presence of tritium in the liquid effluents (Table 3.5.2) was noted and was considered in the dose calculations (Sect. 5.4).

(3) Thermal Effects on Aquatic Ecosystems - (Tex., D-25)

The staff evaluation of effects of construction and operation of CPSES on the aquatic ecosystems is given in Sections 4.3 and 5.5 respectively. Operation of CPSES is not expected to significantly affect the temperature of Lake Granbury, (Sect. 5.3.3). The temperature of Squaw Creek Reservoir was considered in the assessment (Sect. 5.5.2).

(4) Meteorology - (Tex., D-25)

See response to Office of the Governor comment (Sect. 11.8.1(1)).

(5) Consumptive Use of Water (Tex., D-25)

The cooling reservoir geometry is fixed by the terrain at the proposed site. Other sites were considered by the staff and found to have no less overall environmental costs (Sect. 9.1.2.5). The proposed lake could be somewhat smaller but the staff believes that the benefits of the additional storage capacity are greater than the increased environmental costs.

(6) Impacts on Local Institutions - (Tex., D-25)

The staff and the applicant have assessed the impact on the local institutions (Sect. 4.4.4 and 5.6.4 and Ref. 1, Sect. 4.4). The staff believes that the communities with the applicant's help will be able to provide the necessary services.

The applicant's Environmental Report in Chapter 8 provides a detailed discussion of possible impacts on local institutions and communities including increased demand for local governmentally-provided services. The expected growth in local population and increase in demand for all types of community services resulting from construction and operation of CPSES has been described and documented in the ER and it is expected that local authorities and the public at large in nearby communities will be well informed about the probable impacts (benefits and costs) on the local communities. In this connection, the Applicant has taken the initiative in working with local organizations that have basic responsibility for planning development and provision of required community services.

(7) Impact on Land Use (Tex., D25)

The staff believes that the historical trend of land use in the proposed site area is the best indication of the use that would be made over the next decade if CPSES is not built. An assumption of radical changes in agriculture in the area is considered speculative.

The impact of CPSES on land use and agriculture production has been described in the ER (Sections 4.3 and 8.2.2.4). Given the nature of present agriculture production on the CPSES site and the general availability of similar agricultural land resources in the region, the staff does not expect that present relative values of land for various uses in the region (agricultural, industrial, residential, recreational) will change significantly within the future time period of interest, even with the possibility of radical technological advances in agriculture.

(8) Assessment of Lignite Resources - (Tex., D-26)

The staff and the applicant's considerations of alternative fuels and energy sources are given in Sections 9 of the Environmental Statement and Environmental Report, respectively. New mining methods and coal gasification may have some effect on the cost of fossil fired station operation, but the staff believes the annualized cost of such stations with their transmission line facilities would not be less than that of a nuclear plant at the proposed site.

As stated by the applicant with respect to lignite, one must not only consider the absolute physical extent of the resource but also location and ownership, the nature of the deposits, and the comparative economics and environmental impacts of recovering or exploiting and using scattered and discontinuous, thin-seamed deposits (compared with resources presently planned for use). In short, long-term planning for additional power generating capacity necessarily includes consideration of various fuels and must determine the most appropriate time at which given fuel resources (and types of technology) can best be utilized.

11.8.4 Texas Highway Department - (Tex., D-26 and D-27)

The suggested changes have been made in the text.

11.8.5 Texas Water Rights Commission

(1) Monitoring Costs - (Tex., D-27)

See response to Office of Governor comment (Sect. 11.8.1(4)).

(2) Total Dissolved Solids - (Tex., D-28)

The average increase in total dissolved solids (TDS) at steady state in the Brazos River below Lake Granbury as a result of operation of CPSES is 2.5%. This is a long term average based on water flow records since 1924. Rainfall in the Brazos River Basin varies from 18 to 45 in. per year and therefore some variation in water flow is expected. The DeCordova Bend Steam Electric Station will increase the TDS another 0.5% on average in Lake Granbury. The staff concludes that this increase in TDS will not have any long-term adverse effects on the Brazos River.

11.8.6 Texas Historical Commission (Tex., D-30)

See response to Department of Interior comment (Sect. 11.2.1).

11.8.7 Texas Department of Health

(1) Liquid Effluents (Tex., D-31)

The staff evaluation assumed that 10% of the liquids processed through DCA and BRS would be discharged over the life of the plant. The discharges were assumed to occur to maintain the plant water balance, allow for periods of equipment downtime, and provide for anticipated operational occurrences. Although the wastes from the BRS and DCA could be processed through the solid waste system, the applicant has not proposed this in its description of the system. The staff has concluded that the liquid releases meet the Commission's "as low as practicable" guidelines.

(2) Radiological Monitoring of Groundwater (Tex., D-31)

The Applicant has committed to monitor water wells at the project site and at Glen Rose, the nearest community. All existing wells within the impoundment will be sealed to preclude intrusion of water from Squaw Creek Reservoir into the aquifer. For a discussion of this, see the Applicant's Preliminary Safety Analysis Report Section 2.4.

The staff evaluation of the radiological ground water sampling program is discussed in the reply to the Office of the Governor comment (Section 11.8.1(6)). Table 6.2.1 of the Environmental Report indicates that surface water from Lake Granbury will be examined quarterly for tritium, gross beta activity, and gamma isotopic activity.

11.8.8 Parks and Wildlife Department

(1) Siltation Effects (Tex., D-32)

See response to Texas Utilities Generating Company (Sect. 11.6.5).

(2) Brush Clearing (Tex., D32)

See response to Office of Governor comment (Sect. 11.8.1.(7)).

(3) Recreational Use of Squaw Creek Reservoir (Tex., D-32)

The applicant has stated that the surface of Squaw Creek Reservoir and applicant-owned acreage adjoining the reservoir has been offered to the Texas Parks and Wildlife Department for recreational development. (Refer to Section 11.11.24).

(4) Loss of Riparian Habitat - (Tex., D-32)

The loss of riparian habitat is discussed by the staff in Sections 4.3.1.2 and 4.3.2.1.

(5) Biomass and Productivity - (Tex., D-33)

See response to Department of Interior (Sect. 11.5.11). The staff also would like to note that the terms "biomass" and "standing crop" are equivalent.

(6) Releases to Lower Squaw Creek (Tex., D-33)

See response to Department of Interior (Sect. 11.5.14). The aeration discussed will reduce the concentration of H_2S in the waters released to lower Squaw Creek.

(7) Radiation Doses - (Tex., D-33)

The staff assessment of radiological impacts is given in Section 5.4. The staff has concluded that the releases of radioactive liquid and gaseous effluents are as low as practicable.

(8) Cooling Alternatives - (Tex., D-33)

The staff assessment of cooling alternatives is given in Section 9.2.1.

11.9 Citizen's Association for Sound Energy - (CASE)

11.9.1 Radiation Doses - (CASE, D-34)

See response to Texas Department of Parks and Wildlife comment (Sect. 11.8.8.(7)).

11.9.2 Radiation Monitoring of Operating Facilities - (CASE, D-34)

The "GAO study dated August 18, 1972" referred to by CASE was a Report to Congress on "Problems of the Atomic Energy Commission Associated with the Regulation of Users of Radioactive Materials for Industrial, Commercial, Medical and Related Purposes." That report was concerned with inspection and licensing of radioactive material users and did not consider any aspect of nuclear facility inspections, including the monitoring of radioactive effluent from nuclear power plants. The recommendations suggested in that report have been implemented.

The Directorate of Regulatory Operations conducts a comprehensive inspection program during construction and operation of nuclear power plants regarding all aspects which could conceivably affect the public health and safety. With regard to the licensee's program for monitoring of radioactive effluents, an initial inspection is conducted at least two years prior to the issuance of an operating license and a more detailed inspection is made about one year later. These inspections focus specifically on the operation of liquid and gaseous waste systems and monitoring of the various effluent streams. Just prior to the issuance of the operating license, another inspection is conducted to assure that the licensee has satisfactorily conducted his preoperational program and to determine if there are any outstanding items that may prevent issuance of the operating license. During the power ascension phase another inspection is made and thereafter waste management inspections are conducted annually to determine if programs are being properly managed and the requirements of AEC regulations and license conditions are being met. Present staffing enables the AEC to keep this schedule reasonably current.

Technical specifications for each operating reactor require each applicant to monitor releases of radioactive gaseous and liquid effluents. The Directorate of Regulatory Operations in cooperation with various state agencies also performs radiological environmental surveillance in the environs of nuclear power plants.

11.9.3 Operating Experience - (CASE, D-34)

The staff source-term calculations are based on the pa[illegible]ters for fission product leakage through the fuel cladding and the [illegible] product inventory in the core calculated by the ORIGEN and STEFFEC[illegible]s. These parameters and other bases are given in WASH-1258, Vol. 2, July, 1973. Variations in the thermal power level are accounted for in the fission product inventory calculations performed by the preceding codes. The release calculations are made for the appropriate thermal power level in the staff analysis. Therefore, the evaluation is applicable to Comanche Peak in spite of the sparsity of data for plants with its thermal power output.

11.9.4 Transportation of Radioactive Wastes (CASE, D-34)

The question of transportation of nuclear materials is covered generically in an AEC document, WASH-1238 "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," dated December 1972. The impact of transportation of nuclear fuel to and from the CPSES site is addressed in the environmental statement (Sects. 5.4.2.3.2 and 7.2).

11.9.5 Effect of Groundwater Use (CASE, D-34)

See response to Texas Utilities Generating Company comment (Sect. 11.6.7).

11.9.6 Environmental Effects of the Uranium Fuel Cycle (CASE, D-34)

The environmental effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials and management of low level wastes and high level wastes are within the scope of the AEC report entitled "Environmental Survey of the Uranium Fuel Cycle," WASH-1248, April 1974.

11.9.7 Price-Anderson Act - (CASE, D-35)

The Price-Anderson Act expires on July 31, 1977. The Commission in January 1974 released a staff study examining alternative approaches to the present Price-Anderson system. On January 31, 1974 and on March 27 and 28, 1974, the Joint Committee on Atomic Energy held hearings on possible extension or modification of the Price-Anderson Act. Additional hearings are scheduled at which time the Commission's proposed legislation will be discussed.

Additional information can be found in a report prepared by the Joint Committee on Atomic Energy. This report entitled "Selected Materials on Atomic Energy Indemnity and Insurance Legislation," dated March 1974 can be obtained from the U.S. Government Printing Office.

11.10 Federal Power Commission

11.10.1 Need for Power - (FPC, D-35 to D-37)

The Federal Power Commission (Appendix D, D-37) comments offer further substantiation of the need for power from CPSES.

11.10.2 Decrease in Hydroelectric Potential - (FPC, D-36)

The FPC correctly points out that the consumptive use of water by CPSES will reduce the potential hydroelectric generating capacity downstream of DeCordova Bend Dam. The staff estimates that the average decrease in the flow of the Brazos River as a result of CPSES operation will be 34,500 acre-feet/year which is about 3% of the average flow at Lake

Whitney. The loss in hydroelectric production potential at Lake Whitney and proposed stations at DeCordova Bend Dam and Bee Mountain Dam is estimated to be <10 MWe. This loss is considered by the staff to be justifiable to the CPSES production of 2300 MWe. Consideration of the loss does not change the staff conclusions in Section 10.4.5.

11.11 Environmental Protection Agency

11.11.1 Load-following Operation (EPA, D-38 - D-40)

The staff evaluation of the Comanche Peak Station is based on its expected operation over the 40-year life of the plant. Under load following operations, the quantity of liquid processed through the boron recovery system would be expected to increase. However, the staff has found the system capacity adequate to handle the additional volume. The parameters for fission product releases from the core include normal operation and expected operational occurrences. The liquid radioactivity releases are normalized to a higher value to cover these expected operational occurrences.

11.11.2 Radioiodine Release In Turbine Building Exhaust (EPA, D-40)

In general, turbine buildings designed for use with pressurized water reactors are not amenable to ventilation system sampling due to their relatively open design. Many turbine areas are not enclosed, and those that are enclosed have a high potential for exfiltration. For this reason, the turbine building releases are normally derived from calculational rather than monitoring methods.

11.11.3 Turbine Building Floor Drains - (EPA, D-40)

The applicant will be required to monitor turbine building floor drains in order to comply with General Design Criterion 64 of Appendix A of 10 CFR Part 50.

11.11.4 Load-following Operations and Dose Assessment - EPA, D-40)

As discussed in Section 11.11.1 the staff has concluded that the source term developed for CPSES appropriately reflects base-load or load-following operation. Therefore, the staff conclusion that radioactive releases from CPSES meets the requirements of Appendix I to 10 CFR 50 made in Section 5.4 is unchanged.

11.11.5 Other Radiological Pathways to Man (EPA, D-40)

It was suggested that game birds (such as bobwhite quail and mourning doves) might be a pathway to man via ingestion. Terrestrial organisms (such as the avifauna cited) receive approximately the same radiation dose as man; furthermore, as noted in Section 2.7.6.18 of the Environmental Report, "that native wildlife occurs in only a small fraction of the diet of a very few families". For these reasons, game birds as a pathway to man are not considered significant by the staff.

It was also suggested that irrigation might be a pathway to man. The use of irrigation water is made only on the Brazos River. The staff concludes that the quality of the water entering the river from Lake Granbury will not result in irrigation being a significant exposure pathway to man.

11.11.6 Effects of DeCordova Steam Electric Station (EPA, D-42)

The staff evaluation of the thermal interaction between CPSES and the DeCordova Station is discussed in Section 5.3.3. The staff evaluation of chemical interactions is discussed in Section 11.8.5.(2).

11.11.7 Dissolved Oxygen Content of Blowdown Releases to Lake Granbury - (EPA, D-39 and D-47)

The chemical effects of Squaw Creek Reservoir blowdown on Lake Granbury are discussed by the staff in Section 5.5.2.2. The staff did conclude that low dissolved oxygen levels will occur in the blowdown in June through September. As indicated by EPA the applicant must obtain two permits under Section 402 of the Federal Water Pollution Control Act. Since the applicant will be required to comply with Texas Water Quality Standards for dissolved oxygen levels at the blowdown discharge to Lake Granbury, supplemental aeration of the blowdown during critical months may be necessary to maintain the dissolved oxygen content at levels specified in the Station's 402 discharge permit. The staff concludes that the operation of CPSES can comply with applicable water quality criteria.

The applicant states in Appendix E of the Environmental Report that the area of Lake Granbury that will be influenced by the CPSES return line discharge will be small in extent compared to the larger reservoir body. In addition, this larger body will frequently exhibit zero dissolved oxygen in the region of the return line discharge. Therefore, any aeration introduced at that point by supplemental means would be consumed by the reservoir with little or no benefits gained.

11.11.8 Residual Chlorine Releases on Squaw Creek Reservoir (EPA, D-43)

The applicant has stated that proper condenser cleanliness cannot be maintained through the use of chlorine at levels of 0.1 ppm or less at CPSES. Therefore, the staff will require (Sect. 11.6.1) that the applicant be required to conduct an evaluation program prior to power operation to determine the minimum level of chlorine necessary for proper operation of the condensers, the various design steps that can be initiated to reduce the free residual chlorine levels that reach the receiving water and the effects of the various chlorine levels on the aquatic biota. The staff believes that this procedure will result in both protection for the aquatic environment and efficient operation of the CPSES.

11.11.9 Intake Velocity Squaw Creek Reservoir Structures - (EPA, D-43)

See response to Texas Utilities Generating Company comment (Sect. 11.6.2).

The applicant states that it has recently selected the manufacturer for the circulating water pumps, and, as a result, the actual pump house requirements are now known. As shown in Figure 3.4-5, ER Amendment 3, the intake structure proposed will yield a screen approach velocity of 1.2 fps.

The applicant's biological staff believes that the intake configuration needed to meet the suggested value of 0.5 fps, including greatly increased horizontal surface area, would increase, not decrease, impingement losses. Moreover, the installation of such a structure required to accomplish this low intake velocity (nearly 800 feet in width) along the Squaw Creek Reservoir shoreline would pose engineering and construction difficulties.

Finally, the increased cost of construction for a redesigned intake structure has been estimated by the applicant to be approximately $5.2 million. This value is for direct labor and materials alone, and does not include indirect construction costs, contingencies, engineering, escalation, applicant's direct and indirect costs, and interest during construction. The omitted items would approximately double the direct costs.

11.11.10 Intake Velocity Lake Granbury Structure - (EPA, D-43)

The staff evaluation on impingement impacts in Lake Granbury is given in Section 5.5.2.2.

11.11.11 Entrained Organisms in Make-up System - (EPA, D-43)

The staff recognized that data available is not sufficient to evaluate impact or organisms entrained in the make-up system. The staff recommended that if the monitoring procedures required in Sections 6.1.3.2 and 6.2.3.2 indicate a mortality at the outfall of the make-up system corrective action must be taken (Sect. 5.5.2.2).

The applicant states that with regards to the discharge of water into lower Squaw Creek, it operates numerous reservoirs whose makeup is supplied by pumping in a manner similar to the proposed CPSES. These include stations at Lakes Alcoa, Colorado City, Trinidad and Fairfield. Biological data is available at these plants on aquatic populations which demonstrate that no significant problems exist with regards to entrained organisms.

11.11.12 Maintenance of Flow in Lower Squaw Creek - (EPA, D-43)

It is the understanding of the staff that the Texas Water Rights Commission permit requires the applicant to maintain a continuous flow of 1.5 cfs in lower Squaw Creek.

The applicant indicates that a stream gaging station was installed on Squaw Creek in October of 1973 (Section 2.5 of the Environmental Report). Data collected to date indicate that the proposed 1.5 cfs to be released into lower Squaw Creek will exceed the average daily flow presently occurring. The applicant states it has a firm commitment to maintain this flow by agreement with the Texas Water Rights Commission, therefore, the question of impact due to variance from this flow rate need not be addressed.

11.11.13 Dissolved Oxygen of Releases to Lower Squaw Creek - (EPA D-43)

See response to Department of Interior comment (Sect. 11.5.14).

The applicant has stated that a turbulent discharge into lower Squaw Creek will be provided to insure aeration above a 5 ppm of dissolved oxygen level will be maintained.

11.11.14 Effect of Turbine Trips and Physics Testing on Source Term - (EPA, D-44)

The staff concludes that turbine trips and physics testing will have a negligible effect on the calculated source term. The bases for this conclusion is given in Draft Regulatory Guide 1.BB "Calculation of Releases of Radioactive Materials in Liquid and Gaseous Effluents from Pressurized Water Reactors", pgs. B98-B100, which is given in the "Attachment to Concluding Statement of Position of the Regulatory Staff, Public Rulemaking on Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low As Practicable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactors", February 20, 1974.

11.11.15 Dust Control During Construction - (EPA, D-44)

See response to Department of Health, Education and Welfare comment (Sect. 11.4.2) and refer also to item 4 in Section 4.5.1.

11.11.16 Effect of CPSES on Noise Level - (EPA, D-44)

See response to Department of Health, Education and Welfare comment (Sect. 11.4.2) and refer also to Section 4.4.1.

11.11.17 EPA Permits - (EPA, D-44)

The staff and applicant acknowledge EPA's involvement in the permit program authorized by the Federal Water Pollution Control Act Amendments of 1972 (FWPCA, P.L. 92-500).

11.11.18 Construction Effects on Spawning - (EPA, D-44)

See response to Texas Utilities Generating Company comment (Sect. 11.6.5).

11.11.19 Pipeline Leakage or Rupture - (EPA, D-44)

A rupture of the 36 inch gas line running along the bottom of Squaw Creek Reservoir may result in some destruction of fish in the vicinity of the break. The loss of aquatic species would be expected to be a small fraction of those in the reservoir. No permanent effect would be expected. The repair of the line may result in some additional aquatic impact. Again no permanent effect would be expected.

11.11.20 Total Dissolved Solids in the Brazos River - (EPA, D-44)

See response to Texas Water Rights Commission comment (11.8.5.(2)).

11.11.21 Hydraulic Flows of Plant, Lake, Reservoir and Creek - (EPA, D-44)

Flow diagrams depicting the source and discharge points of the flows between the CPSES, Lake Granbury, Squaw Creek Reservoir and Squaw Creek are given in the applicants Environmental Report.

11.11.22 Impact of Power Availability - (EPA, D-44)

The electrical power to be made available by the proposed CPSES will be transmitted primarily to the load centers of the Dallas - Fort Worth area. The availability of additional electricity will tend to support economic growth, and so will the taxes that will accrue to all levels of government in Texas. Economic growth, while incurring the attendant environmental problems of increased water and air pollution and losses of open space, is generally considered by society as a net benefit.

11.11.23 Energy Conservation - (EPA, D-45)

The staff evaluation of conservation of energy measures on forecasted demand of electricity is given in Section 8.2.3.

11.11.24 Plant Cooling System and FWPCA Requirements (EPA, D-38 and D-40)

The applicant has stated that it is aware of the technical difficulties associated with the use of Squaw Creek Reservoir as both a cooling lake and a multiple purpose reservoir under the guidelines issued by the Environmental Protection Agency for cooling water discharges from power plants. As outlined in the EPA comments on the CPSES Draft Environmental Statement the applicant has indicated two alternatives for the use of Squaw Creek Reservoir.

The first alternative indicated by the applicant is to utilize the reservoir strictly as a cooling pond and deny recreational use. Although the EPA comments mention the possibility of "limited recreational use", this term is undefined in the comments and the applicant states that it believes it is neither possible nor desirable to make Squaw Creek Reservior available for any recreational activity under conditions which would restrict the admittance of the interstate visitors, in an effort to preclude legally placing the reservior in the "navigable waters" context of the FWPCA.

The second alternative indicated by the applicant is the use of the 316(a) section of the Act (which might allow the reservoir to be classified as a navigable waterway) but with supplemental cooling not required because the guidelines would be more stringent than necessary to protect the indigenous aquatic biota. Although there is nothing in the history of power generation on reservoirs in Texas to indicate that the aquatic biota in Squaw Creek Reservoir will not be similar in diversity and productivity to other reservoirs in the State, the applicant does not consider the use of this possible exemption to be a viable alternative.

The applicant states it believes that in the interest of the consumers in its service area, it will be necessary to maintain construction schedules and plans by strict adherence to the proposed cooling system and to operate it in a manner to make it acceptable to EPA as a cooling lake.

The applicant states that it firmly believes in the mutliple use concept of Texas waters. Similar reservoirs in the applicant's system, located at Colorado City and Fairfield, are utilized by the State of Texas for park and recreational activities, each drawing over 150,000 visitors annually. In addition, several cooling reservoirs are used for municipal water supply and may serve as flood retardation structures. To deny this multiple use for the proposed Squaw Creek Reservoir does not appear to be in the best interests of the citizens of the State of Texas.

In summary, it is the applicant's stated position that the primary purpose of the proposed Squaw Creek Reservoir is to serve as a cooling pond for operation of the CPSES facility. The applicant will comply with whatever directives may be issued by the AEC or EPA regarding the conditions under which this reservoir may be operated as designed. In the event that this requires closing of the lake to public recreational usage, such action will be taken.

Appendix A

FLORA OF THE SITE

Staff compilation of material in Appendix C of the Environmental Report

Table A-1. Mean coverage (C) and frequency of occurrence (F) of trees and shrubs on Juniper-Threeawn Uplands

Data are for ten 30-m line transects in each stand. Trace (T) amounts are less than 1%

Species	C/F Cleared 1	C/F Cleared 2	C/F Uncleared
Juniperus spp. (juniper)	5.4/70	25.8/90	64.1/100
Prosopis glandulosa (honey mesquite)	5.6/70	2.7/20	T/20
Celtis laevigata (sugar hackberry)		2.4/10	1.1/30
Forestiera pubescens (elbowbush)		T/10	12.3/80
Ulmus crassifolia (cedar elm)	T/10		11.3/50
Rhus aromatica (skunkbush)			2.1/40
Bumelia lanuginosa (gum elastic)			T/10
Quercus virginiana (live oak)			T/10
Opuntia sp. (prickly pear)		T/20	
Mean percentage open ground	89.0	68.0	32.5

Table A-2. Mean percentage canopy coverage (C) and percentage frequency of occurrence (F) of ground cover vegetation occurring on cleared Juniper-Threeawn Uplands

Species	C/F Stand 1	C/F Stand 2
Monocotyledons		
Aristida spp. (threeawn)	16.1/80	11.4/60
Erioneuron pilosum (hairy tridens)	7.6/56	22.4/71
Bouteloua curtipendula (side oats grama)	8.9/38	7.7/49
Sporobolus sp. (dropseed)	8.3/45	1.1/11
Stipa leucotricha (Texas winter grass)	T/2	5.3/29
Leptoloma cognatum (fall witchgrass)	3.4/27	5.2/44
Bouteloua rigidiseta (Texas grama)		4.9/27
Andropogon saccharoides (silver bluestem)	2.4/20	4.7/36
Unknown grass		2.9/9
Muhlenbergia reverchonii (seep muhly)		1.3/11
Sporobolus asper (tall dropseed)		1.0/7
Nothoscordum bivalve (yellow false garlic)		T/18
Bouteloua hirsuta (hairy grama)	T/7	T/2
Schedonnardus paniculatus (tumble grass)	T/7	
Chloris verticellata (tumble windmill grass)		T/4
Panicum hallii (Hall's panic)	T/2	T/2
Andropogon ischaemum (King Ranch bluestem)	T/2	
Dicotyledons		
Xanthocephalum dracunculoides (common broomweed)	15.6/60	7.2/60
Sida filicaulis (spreading sida)	7.1/47	T/13
Salvia sp. (sage)	1.9/11	2.5/7
Phyllanthus polygonoides (knotweed leafflower)	2.7/22	T/2
Ambrosia psilostachya (Western ragweed)	T/2	2.2/20
Thelesperma filifolium (green thread)	T/2	1.9/33
Unknown forbs	1.2/16	T/13
Xanthocephalum texanum (Texas broomweed)	T/7	T/2
Cassia roemeriana (two-leaf senna)	T/7	
Verbena bipinnatifida (prairie verbena)	T/7	T/2
Croton monanthogynus (one-seed croton)	T/4	T/4
Tragia nepetaefolia (catnip noseburn)	T/2	T/4
Verbena sp. (verbena)	T/2	T/2
Verbena halei (slender verbena)		T/2
Liatris mucronata (gayfeather)		T/2
Desmanthus sp. (bundleflower)		T/2
Eriogonum annuum (annual wild buckwheat)	T/2	

Table A-3. Mean percentage canopy coverage (C) and percentage frequency of occurrence (F) of ground cover vegetation on uncleared Juniper-Threeawn Uplands

Species	C/F
Monocotyledons	
Aristida spp. (threeawn)	17.6/36
Cyperaceae	14.7/58
Bouteloua rigidiseta (Texas grama)	7.6/18
Sporobolus asper (tall dropseed)	3.6/24
Bouteloua hirsuta (hairy grama)	2.2/4
Nothoscordum bivalve (yellow false garlic)	T/13
Andropogon saccharoides (silver bluestem)	T/11
Stipa leucotricha (Texas winter grass)	T/7
Leptoloma cognatum (fall witchgrass)	T/4
Andropogon scoparius (little bluestem)	T/4
Panicum hallii (Hall's panic)	T/2
Hilaria belangeri (curly mesquite grass)	T/2
Panicum sp. (panic grass)	T/2
Dicotyledons	
Xanthocephalum dracunculoides (common broomweed)	3.1/33
Unknown forb	T/9
Thelesperma filifolium (green thread)	T/7
Oxalis dillenii (yellow wood sorrel)	T/4
Smilax sp. (greenbrier)	T/4
Heliotropium tenellum (pasture heliotrope)	T/4
Croton monanthogynus (one-seed croton)	T/2
Phyllanthus polygonoides (knotweed leafflower)	T/2
Sida filicaulis (spreading sida)	T/2
Verbena halei (slender verbena)	T/2

Table A-4. Mean percentage canopy coverage (C) and percentage frequency of occurrence (F) of vegetation on Juniper-Hairy Grama Slopes

Species	C/F
Monocotyledons	
Bouteloua hirsuta (hairy grama)	8.0/49
Aristida spp. (threeawn)	5.0/44
Bouteloua pectinata (tall grama)	4.2/29
Sporobolus sp. (dropseed)	2.6/27
Sporobolus asper (tall dropseed)	2.5/24
Erioneuron pilosum (hairy tridens)	1.5/27
Leptoloma cognatum (fall witchgrass)	1.3/20
Andropogon ischaemum (King Ranch bluestem)	1.3/9
Andropogon scoparius (little bluestem)	T/4
Yucca sp. (yucca)	T/2
Bouteloua curtipendula (side oats grama)	T/2
Dicotyledons	
Juniperus spp. (juniper)	32.2/100
Salvia sp. (sage)	2.1/27
Sida filicaulis (spreading sida)	1.9/42
Desmanthus sp. (bundleflower)	T/24
Unknown forb	T/11
Cassia roemeriana (two-leaf senna)	T/7
Verbena sp. (verbena)	T/7
Croton monanthogynus (one-seed croton)	T/4
Phyllanthus polygonoides (knotweed leafflower)	T/4
Tragia nepetaefolia (catnip noseburn)	T/4
Mammillaria sp. (nipple cactus)	T/2
Scutellaria resinosa (resin-dot skullcap)	T/2
Thelesperma filifolium (green thread)	T/2

A-6

Table A-5. Mean percentage canopy coverage (C) and percentage frequency of occurrence (F) of vegetation on Broomweed Beaches

Species	C/F
Monocotyledons	
Andropogon ischaemum (King Ranch bluestem)	25.6/53
Sporobolus asper (tall dropseed)	14.6/58
Muhlenbergia reverchonii (seep muhly)	8.3/36
Aristida spp. (threeawn)	2.3/16
Bouteloua rigidiseta (Texas grama)	2.0/7
Leptoloma cognatum (fall witchgrass)	1.9/13
Panicum hallii (Hall's panic)	T/4
Bouteloua hirsuta (hairy grama)	T/4
Stipa leucotricha (Texas winter grass)	T/4
Hilaria belangeri (curly mesquite)	T/2
Tridens albescens (white tridens)	T/2
Nothoscordum bivalve (yellow false garlic)	T/2
Andropogon saccharoides (silver bluestem)	T/2
Andropogon scoparius (little bluestem)	T/2
Cyperaceae (sedges)	T/2
Dicotyledons	
Xanthocephalum dracunculoides (common broomweed)	28.1/69
Iva angustifolia (narrowleaf sumpweed)	26.7/84
Prosopis glandulosa (mesquite)	11.1/80
Juniperus spp. (juniper)	2.8/40
Unknown forb	T/16
Ambrosia psilostachya (Western ragweed)	T/9
Croton monanthogynus (one-seed croton)	T/7
Thelesperma filifolium (green thread)	T/7
Verbena sp. (verbena)	T/7
Phyla incisa (sawtooth frogfruit)	T/4
Phyllanthus polygonoides (knotweed leafflower)	T/4
Sida filicaulis (spreading sida)	T/2
Desmanthus sp. (bundleflower)	T/2
Aster ericoides (heath aster)	T/2
Scutellaria resinosa (resin-dot skullcap)	T/2

A-7

Table A-6. Relative frequency (RF), relative dominance (RDO), relative density (RDE), and importance (I) of woody species in two strata in the Lower Riparian vegetation type

Species	Overstory				Understory			
	RF	RDO	RDE	I	RF	RDO	RDE	I
Ulmus crassifolia (cedar elm)	20	25	25	70	16	15	18	49
Quercus macrocarpa (bur oak)	10	35	8	53	T	T	T	1
Juniperus spp. (juniper)	16	4	21	41	18	18	18	54
Carya illinoensis (pecan)	9	8	8	25	7	3	7	17
Ulmus americana (American elm)	7	8	5	20	4	T	4	9
Fraxinus spp. (ash)	7	3	8	18	2	2	2	6
Celtis laevigata (sugar hackberry)	4	3	3	10	7	3	6	16
Quercus shumardii (Texas oak)	4	2	3	9	2	1	1	4
Quercus virginiana (live oak)	3	3	3	9	T	T	T	1
Juglans spp. (walnut)	3	T	3	7	1	3	2	6
Salix nigra (black willow)	3	T	3	7	T	1	T	1
Viburnum rufidulum (rusty black haw)	3	T	3	6	4	2	4	10
Populus deltoides (Eastern cottonwood)	T	4	T	6				
Sapindus drummondii (Western soapberry)	2	T	T	4	4	5	6	15
Platanus occidentalis (American sycamore)	T	T	2	4	T	T	T	1
Morus sp. (mulberry)	2	T	T	3				
Ilex decidua (possum haw)	T	T	T	2	4	2	3	9
Prosopis glandulosa (mesquite)	T	T	T	2	3	T	3	7
Melia azedarach (chinaberry)	T	T	T	2	T	T	T	1
Prunus sp. (wild plum)	T	T	T	2	T	T	T	1
Bumelia lanuginosa (gum elastic)	T	T	T	1	3	T	2	6
Callicarpa americana (American beautyberry)					7	34	6	47
Cornus drummondii (rough-leaf dogwood)					7	T	7	15
Forestiera pubescens (elbowbush)					4	2	3	9
Cercis canadensis (redbud)					2	2	T	5
Rhamnus caroliniana (Carolina buckthorn)					T	T	T	3
Rhus toxicodendron (poison oak)					2	1	T	3
Amorpha fruticosa (indigo bush)					T	T	T	2
Sambucus canadensis (elderberry)					T	T	T	2
Rhus copallina (flame-leaf sumac)					T	T	T	1

Table A-7. Relative frequency (RF), relative dominance (RDO), relative density (RDE), and importance (I) of woody species in two strata in the Upper Riparian

Species	Overstory				Understory			
	RF	RDO	RDE	I	RF	RDO	RDE	I
Ulmus crassifolia (cedar elm)	37	54	47	138	20	48	22	90
Juniperus spp. (juniper)	23	11	18	52	18	10	15	43
Quercus macrocarpa (bur oak)	9	19	6	34	1	1	1	3
Carya illinoensis (pecan)	11	8	6	25	1	6	2	9
Sapindus drummondii (Western soapberry)	4	2	7	15	9	3	3	15
Celtis laevigata (sugar hackberry)	6	1	3	10	1	2	1	4
Quercus virginiana (live oak)	5	2	3	10	1	T	1	2
Bumelia lanuginosa (gum elastic)	5	1	3	9				
Prosopis glandulosa (mesquite)	3	T	2	5	29	15	36	80
Viburnum rufidulum (rusty black haw)	3	T	2	5	1	3	1	5
Quercus shumardii (Texas oak)	T	1	T	3	1	T	1	3
Juglans sp. (walnut)	1	1	1	3				
Ilex decidua (possum haw)	T	T	T	2	1	T	2	3
Quercus sp. (oak)	T	T	T	2				
Ulmus americana (American elm)	T	T	T	2				
Forestiera pubescens (elbowbush)					9	2	7	18
Sophora affinis (Texas sophora)					1	5	8	14
Callicarpa americana (American beautyberry)					1	3	2	6
Fraxinus sp. (ash)					1	1	1	3
Rhus copallina (flame-leaf sumac)					1	1	1	3

Appendix B

BIOTA OF THE AQUATIC ENVIRONS

Table B-1. Staff summary of the phytoplankton found in Squaw Creek

Species	Cells per liter					
	March	April	May	June	July	August
		Chlorophyta (green algae)				
Chlorella-like		19,561	14,355	21,428	28,600	30,500
Eremosphaera		2,000	8,750	5,714	6,900	0
Dictyococcus		1,857	1,857	2,857	1,857	2,857
		Chrysophyta (diatoms)				
Achnanthes		6,742	5,700	5,714	5,000	0
Caloneis ventricosa		6,900	5,332	4,285	6,953	5,100
Cocconeis		1,857	0	1,857	0	0
Cyclotella		47,900	53,681	37,142	29,413	35,490
Cymbella		13,540	22,600	20,000	28,000	33,456
Fragilaria		44,750	30,800	35,714	29,600	44,111
Navicula sp. 1		17,800	20,215	18,571	17,630	
Surirella		2,547	5,880	7,142	3,500	6,100
Synedra sp. 2		0	1,857	2,857	0	0
		Cyanophyta (blue-green algae)				
Dermocarpa		7,591	8,334	7,142	9,873	8,583
		Euglenophyta				
Oscanemals	17	4	3	6	14	31
Euglenoid sp.		19,330	13,330	15,714	18,330	13,000
		Pyrrhophyta				
Ceratium hirundinella	0	1	4	1	0	0

Source: J. E. Ubelaker, "Summary of Data Obtained on Project for Texas Utilities during the Second Phase of Study," unpublished report, Oct. 21, 1973.

Table B-2. Staff summary of the zooplankton found in Squaw Creek

	Organisms per liter					
	March	April	May	June	July	August
Rotifera						
Asplanchnopus sp.	1	0	0	1	3	4
Brachionus caudatus egg cases	0	2	1	2	1	6
Filinia sp.	11	9	18	12	15	0

Source: J. E. Ubelaker, "Su[illegible] Obtained on Project for Texas Utilities during the Second Phase of Study," unpublished report

Table B-3. Staff summary of the benthic organisms found in Squaw Creek

	Organisms per square foot					
	March	April	May	June	July	August
Platyhelminthes						
Turbellaria						
Dugesia sp.	12	6	1	21	3	14
Annelida sp.	0	2	0	0	0	0
Arthropoda						
Crustacea						
Copepoda						
Ectocyclops phaleratus	0	0	0	3	11	15
Amphipoda						
Gammarus sp.	0	0	2	0	0	1
Decapoda						
Macrobrachium acanthurus	0	0	1	0	0	0
Insecta						
Coleoptera						
Berosus sp. (water scavenger beetle)	2	2	0	1	1	0
Tropisternus sp. (water scavenger beetle)	0	1	0	1	0	0
Diptera						
Harnischia sp. (midge fly)	33		0	46	45	33
Prodiamesa sp. (midge fly)	0	1	0	44		
Pentaneura sp. (midge fly)	0	0	76	0	0	0
Tendipes sp. (midge fly)	6	13	12	0	0	0
Tendipedinae pupae (midge fly)	4	23	7	0	0	0
Palpomyia sp. (biting midge)	0	0	0	1	0	0
Psychoda sp. (moth fly)	1	0	1	5	0	0
Simulium sp. larvae (blackfly)	0	1	24	2	40	0
Simulium sp. pupae (blackfly)	0	1	0	4	11	16
Tabanus sp. (horsefly)	1	0	0	2	0	1
Ephemeroptera (mayflies)						
Baetidae						
Ameletus sp.	0	0	0	1	0	0
Baetidae sp. 1	0	0	0	6	0	0
Baetidae sp. 2	4	0	4	9	0	1
Caenis sp.	4	1	0	4	11	16
Centroptilum sp.	1	4	0	25	9	45
Habrophlebia sp.	5	6	7	0	9	14
Paraleptophlebia sp.	0	0	0	2	0	0
Tricorythodes sp.	0	0	0	0	1	0
Heptageniidae						
Ironodes	10	0	0	1	0	2
Stenonema	6	1	0	4	0	11
Hemiptera						
Gerris remigis (water strider)	1	0	1	1	0	0
Odonata						
Dromogomphus sp. (dragonfly)	1	0	0	1	0	0
Gomphus sp. (dragonfly)	0	0	0	2	0	0
Argia sp. (damselfly)	1	0	0	5	0	3
Ischnura sp. (damselfly)	0	0	0	1	0	0

Table B-3 (continued)

	Organisms per square foot					
	March	April	May	June	July	August
Plecoptera (stoneflies)						
Neoperla clymene	0	0	1	0	0	1
Perlinella drymo	0	0	0	1	0	0
Trichoptera (caddis flies)						
Chimarra sp.	0	0	0	4	0	0
Hydropsyche simulans	11	10	6	25	12	29
Hydropsyche sp.	1	0	0	1	1	1
Polycentropus sp.	0	1	0	1	0	0
Ryacophila fenestra	0	0	2	0	0	0
Mollusca						
Gastropoda						
Gyraulus sp.	0	0	1	0	0	0
Physa virgata	0	0	0	1	2	1
Chordata						
Amphibia						
Rana tadpole	0	2	1	0	0	

Source: J. E. Ubelaker, "Summary of Data Obtained on Project for Texas Utilities during the Second Phase of Study," unpublished report, Oct. 21, 1973.

Table B-4. Staff summary of the fish species found in Squaw Creek and Lake Granbury

Key to abundance: VA, very abundant; A, abundant; C, common; F, frequent; R, rare; ?, present, but no quantitative data available with which to estimate abundance

Name	Relative abundance: Squaw Creek	Relative abundance: Lake Granbury	Sport value	Preferred habitat and adult food habits	Spawning temperature (°F), time, and site
Atherinidae					
Labidesthes sicculus brook silversides	R	A	Forage	Surface of lakes, quiet sections of streams.[32] Surface feeder – microcrustacea, insects[32,43,51]	68° (late spring)[11,32] Littoral areas around emergent aquatic vegetation, no nest building, eggs attached to plants by distinctive long filaments[11,58]
Menidia audens Mississippi silversides		?	Forage	Shallow surface waters in rivers of Miss. and Gulf drainages, large lowland reservoirs with sandy bottom and gradual off shore slope.[3,40] Surface feeder – microcrustacea, insects[32,43,51]	Late March–mid-July.[3] Brushy shore areas, eggs attached to vegetation[3]
Catostomidae					
Carpiodes carpio river carpsucker	R	A	Rough	Bottoms of silty rivers.[32,58] Omnivorous bottom feeder[32,57]	57–82° (March–July).[59] Eggs strewn randomly in shallow water (1–3 ft), over sand and silt or weed beds; ascends rivers to spawn in stronger current[50,59]
Ictiobus bubalus smallmouth buffalo		A	Rough	Channels of large rivers.[33] Omnivorous bottom feeder[6,49,52]	60–65° (April).[32,50] Shallow water (1–3 ft), over weeds and mud[50]
Moxostoma congestum gray redhorse	R	C	Rough	Bottoms of lakes, rivers, and slow streams.[32] Omnivorous bottom feeder[32,56]	50–60°.[56] Ascends smaller streams to spawn over gravel riffles (1–3 ft deep) or spawns over shallows in lakes[32,56]

Table B-4 (continued)

Name	Relative abundance: Squaw Creek	Relative abundance: Lake Granbury	Sport value	Preferred habitat and adult food habits	Spawning temperature (°F), time, and site
			Centrarchidae		
Lepomis cyanellus green sunfish	C	F	Game, forage	Warmer waters of small ponds, sluggish creeks.[32,58] Carnivorous – mainly insect larvae, plus crayfish and small fish[2,33]	60° (April–Aug.).[33,50] Nesting colonies in shallow water near shore[33,50]
Lepomis gulosus warmouth sunfish		R	Game	Over soft bottom in warm, sluggish, weedy water.[33,58,59] Carnivorous – mainly insect larvae, plus crayfish and small fish[33]	70° (April–Oct.).[50] Builds nests in weeds, logs, and snags in water less than 4 ft deep[33,50]
Lepomis humilis orangespotted sunfish	C	R	Forage	All sizes of streams and lakes, commonly in silty water.[32,58] Carnivorous – mainly insect larvae, plus crayfish and small fish[33,38]	75–90° (spring).[58,59] Nest-builder[58]
Lepomis macrochirus bluegill sunfish	C	C	Game, forage	Clear, quiet pools with vegetation.[32,59] Omnivorous – mainly insect larvae, plus vegetation[2,28,33,38,54]	70° (May–Sept.).[10,50] Nests in quiet shallow littoral water (1–4 ft)[50]
Lepomis megalotis longear sunfish	A	F	Game, forage	Sluggish waters of small streams and lakes.[32] Carnivorous – insects, small fish[2,33]	71–73° (May–July).[48] Nests over gravel bars,[33] brush-free areas with gradually sloping gravel substrate[48]

Table B-4 (continued)

Name	Relative abundance: Squaw Creek	Relative abundance: Lake Granbury	Sport value	Preferred habitat and adult food habits	Spawning temperature (°F), time, and site
Lepomis microlophus redear sunfish	C	R	Game, forage	Large warm rivers, clear lakes with vegetation.[32,59] Omnivorous – mainly insect larvae, plus vegetation[28,32]	75° (April–July).[7,10] Nesting beds in water up to 10 ft deep[7,33]
Micropterus punctulatus spotted bass	A	R	Game	Medium-sized streams, rivers, lakes.[32] Carnivorous – fish, insects, crayfish[2,19,33,44]	64° (spring).[33,54] Nest builders, upstream in small tributaries[33]
Micropterus salmoides largemouth bass	A	C	Game	Weedy or brushy mud-bottomed lakes and ponds, sluggish streams.[32,58] Carnivorous – mainly fish, plus large insects[2,5,19,27,33,54]	60° (Feb.–May).[22,24,[illegible]] Nests in quiet water (2–8 ft) on any bottom but soft mud[33]
Pomoxis annularis white crappie	R	F	Game	Warm, turbid rivers and lakes.[32,58] Carnivorous – insects, small fish[26,29,33]	65–75° (March–May).[10] Nest beds on gravel or hard bottom (2–8 ft);[33] eggs adhesive on plants[16,20]
			Clupeidae		
Dorosoma cepedianum gizzard shad	R	A	Rough	Open surface waters of large rivers, lakes, reservoirs.[32,57,59] Bottom filter feeder on detritus, molluscs, also on plankton[46,53]	64–75° (May–Aug.).[50] Spawns randomly in shallow water over gravel bars or silt beds[50]
Dorosoma petenense threadfin shad		F	Forage	Large rivers, lakes, reservoirs, attracted by currents.[32,57] Filter feeder on pelagic plankton[8,31]	70°.[13] Adhesive eggs released in open water or near shore over plants[13]

Table B-4 (continued)

Name	Relative abundance		Sport value	Preferred habitat and adult food habits	Spawning temperature (°F), time, and site
	Squaw Creek	Lake Granbury			
			Cyprinidae		
Campostoma anomalum stoneroller	VA		Forage	Clear streams and small rivers with sand and gravel bottoms, especially with riffles.[57,50] Diatoms, blue-green algae, chironomids[57]	60° (May - June)[50] Small streams over gravel bottom, edges of pools[50]
Cyprinus carpio carp		A	Rough	Warm muddy rivers and lakes.[33,58] Omnivorous bottom feeder[39,45]	62°[18] Adhesive eggs strewn in very shallow water over muck bottom with debris[18,33]
Notemigonus crysoleucas golden shiner	R	R	Forage	Ponds, quiet sections of streams.[57] Omnivorous[57]	68°[57] Eggs adhesive on vegetation[57]
Notropis lutrensis red shiner	A	A	Forage	Clean sand-bottomed streams and running water.[59] Omnivorous - mostly insects, plus crustaceans and algae[25,57]	68° (June - July)[50] Nests in newly flooded weeds and debris in streams, pools[57,50]
Notropis venustus blacktail shiner	A	A	Forage	Deep waters of large creeks and rivers.[59] Omnivorous - mostly insects, plus crustaceans and algae[25,57]	April - Aug.[40] Quiet shallow shoal waters of larger streams[40]

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Table B-4 (continued)

Name	Relative abundance		Sport value	Preferred habitat and adult food habits	Spawning temperature (°F), time, and site
	Squaw Creek	Lake Granbury			
Pimephales vigilax bullhead minnow	F	?	Forage	Backwaters and pools of rivers and clear streams.[32,59] Bottom feeder-ooze, insects[57]	April - June[40] Shoal areas[49]
Pimephales promelas fathead minnow	R	R	Forage	Silty lakes and streams.[32] Bottom feeder-diatoms, bottom algae[57]	61° (May - Aug.)[50] Quiet, shallow water (<3 ft), eggs attached[17,57,50]
			Cyprinodontidae		
Fundulus notatus black-striped topminnow	F		Forage	Surface of quiet marginal stream and lake waters where current is moderate or lacking.[32,40] Surface feeder - insects, floating material[32,57,58]	March - July[40] Clean, fresh water of pools, lakes, and streams, where there is little if any current[40]
Fundulus kansae plains killifish	A		Forage	Shallow streams rarely with sandy bottoms, upper reaches of rivers.[12,57,58] Surface feeder, may also feed on bottom[12,57]	80° (April - Aug.)[50] Shallow streams over gravel bottoms[12,50]
			Lepisosteidae		
Lepisosteus oculatus spotted gar		R	Rough	Weedy bayous and lakes.[32,58] Predaceous - mostly on forage fish in surface water[14,32,33,36,58]	68 - 86° (April - May)[14,50] Shallow, quiet water over dead vegetation and algal mats[14,33]
Lepisosteus osseus longnose gar		C	Rough	Near surface in open rivers, lakes.[33] Predaceous - almost exclusively on forage fish[14,36]	68 - 86° (April - May)[14,50] Shallow, quiet water over dead vegetation and algal mats[14,33]

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Table B-4 (continued)

Name	Relative abundance: Squaw Creek	Relative abundance: Lake Granbury	Sport value	Preferred habitat and adult food habits	Spawning temperature (°F), time, and site
Ictaluridae					
Ictalurus melas black bullhead	A	R	Rough	Sluggish creeks and rivers, with shallow, silty water, avoids large bodies of water.[32,58] Omnivorous[32,54]	68° (May–June)[50] Water 2–4 ft deep over mud or sand[50]
Ictalurus natalis yellow bullhead	A		Rough	More common in clear, clean water with vegetation.[32,58] Omnivorous[32,33]	68° (May–June)[57] Nests in mud bottom[33]
Ictalurus punctatus channel catfish	A	C	Game	Lakes, larger rivers, and streams with stronger currents.[32,58] Omnivorous[9,32,33,37]	75° (May–June)[33,37,50] Nests in dark, secluded places (logs, rocks, etc.)[33,58]
Pylodictus olivaris flathead catfish		R	Game	Large, quiet, slow rivers.[58] Carnivorous-fish, live invertebrates[21,33]	75° (late May–August)[33,50] Nests in dark, secluded places (logs, rocks, etc.)[33,58]
Percidae					
Etheostoma spectabile orangethroat darter	VA	R	Forage	Shallow, gravelly riffles in small upland hard-water creeks.[32,58,61] Carnivorous, mainly insect larvae[61]	Spring.[58] Buries eggs in fine gravel on riffles[32]
Etheostoma gracile slough darter	?		Forage	Lowland streams, ponds, sloughs.[59] Carnivorous-invertebrates, fish[32]	Spring.[58] Buries eggs in fine gravel on riffles[32]

Table B-4 (continued)

Name	Relative abundance: Squaw Creek	Relative abundance: Lake Granbury	Sport value	Preferred habitat and adult food habits	Spawning temperature (°F), time, and site
Percina caprodes logperch	R	R	Rough	Shallow riffles in clear streams, shallow water on gravel lake bottom.[32,58] Carnivorous bottom forager[43]	54–72° (spring).[58,60] Scatters eggs over sand or gravel bars[32,58]
Poeciliidae					
Gambusia affinis mosquitofish	F	F	Forage	In shore vegetation and debris of sluggish and standing water (often stagnant), either fresh or brackish.[40] Surface feeder-mosquito and other insect larvce and pupae, algae, small fish[57,58]	March–late Sept.[40] Bear young alive[58,40]
Sciaenidae					
Aplodinotus grunniens freshwater drum		C	Rough	Large silty rivers and lakes.[33,57] Bottom feeder-molluscs, chironomids, crustaceans, small fish[15,33,58]	64–76°.[15] Semibuoyant eggs broadcast over gravel or clay[15,33]
Serranidae					
Morone chrysops white bass		F	Game	Large rivers and lakes.[58] Carnivorous (predaceous)-mostly fish, plus crustacea, insects[30,33,47,58]	58–75° (March or April).[42] Migrate up tributaries or spawn at surface over gravel shoals or hard bottom in reservoirs or lakes[33,42,47,58]
Morone saxatilis striped bass		?	Game	Salt water of east coast.[33] Carnivorous (predaceous)-mostly fish, plus crustacea, insects[33,34]	60–75° (early spring).[33,34,35] Migrate upriver to spawn in fresh water, prefer fast-flowing water, eggs semibuoyant[33,34]

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Table B-5. Staff summary of phytoplankton found in Lake Granbury in area of CPSES makeup and blowdown lines[a]

	Cells per milliliter											
	May 1971			July 1971			October 1971			January 1972		
	0.5 m	10 m	17.5 m	0.5 m	10 m	15 m	0.5 m	10 m	17.5 m	0.5 m	10 m	17 m
Chlorophyta												
Actinastrum gracillum	3200	9943	3973	10,000	10,966	4,933	7246	3104	6093	5689	4635	4557
Crucigenia	1.3		1.3									
Chlorella-like				66.7	133.3	466.7	40	66.7		20.7	23.3	
Crucigenia	5.3											
Dactylococcus	39.3	15.3						40.0				
Desmid zygospores		3.3										
Eremosphaera	10.7	4.7	9.3									
Malleochloris			14.7									
Protococcus								106.7				
Scenedesmus	16.0	58.7								10.7		
Spirogyra		2.7										
Tetmemorus			2.7									
Trochiscia	7.0	1.3										
Ulothrix			10.7									
Cryptophyta												
Cryptochrysis					33.3		13.3	40.0	40.0			
Cryptomonas											14.7	
Cyanophyta												
Anabaenopsis				433.3		233.3						
Dermocarpa	48.0	59.3	16.0	33.3			53.3	66.7	13.3			1.3
Stichosiphon	18.6	20.7	17.3					40.0	26.7	0.7		
Chrysophyta												
Amphora			12.0	33.3								
Cocconeis	2.7	2.0	52.0									
Coscinodiscus	7.3	7	100.0									0.7
Cyclotella				166.7	166.7	500.0	66.7	13.3	106.7	76.7	48.0	58.7
Cymbella			5.3		100.0	33.3			1.3			7
Diatomella			2.7									
Diploneis		2.0	16.0	66.7	33.3	133.3	93.3	13.3	13.3	38.7	123.9	202.0
Epithemia			4.0									
Fragilaria	8.7	4.0	1077	500.0	33.3	466.7						7
Gyrosigma	1.3		1.3									
Hantzschia			2.7									
Mastogloia			5.3									
Melosira			6.7									
Navicula			22.7		66.7							
Opephora			13.3									
Pinnularia			9.3	33.3		33.3						
Rhoicosphenia curvata	1.3		13.3	33.3	33.3							
Surirella			1.3									
Synedra				66.7								
Pyrrhophyta												
Ceratium sp.	0.007	0.001										

Source: J. O. Mecom, "A Limnological Survey of Lake Granbury, Texas," S.M.U., submitted to Texas Power and Light Co., May 12, 1972; station F.

[a]Five additional species, whose density or collection location in the lake was not given, might occur in the area. These are three species of diatoms (*Campylodiscus*, *Stephanodiscus* and *Rhopalodia gibba*), one species of green algae (*Cosmarium*), and one euglenoid (*Euglena convoluta*) (J. E. Ubelaker, "Summary of Data Obtained on Project for Texas Utilities during the Second Phase of Study," unpublished report, Oct. 21, 1973).

Table B-7. Staff summary of the benthic organisms in area of makeup and blowdown lines on Lake Granbury

	Organisms per square foot			
	April 1971	July 1971	October 1971[a]	January 1972
Annelida				
Limnodrilus claparendianus	2	0		0
Limnodrilus hoffmeisteri	3	0		6
Diptera				
Chaoborus sp.	0	0		186
Pentaneura sp.	0	0		2
Tendipes sp.	1	0		2

Source: J. O. Mecom, "A Limnological Survey of Lake Granbury, Texas," S.M.U., submitted to Texas Power and Light Co., May 12, 1972.

[a]No samples were taken in October due to equipment failure.

Table B-6. Staff summary of zooplankton found in Lake Granbury in area of CPSES makeup and blowdown lines[a]

	Organisms per liter											
	May 1971			July 1971			October 1971			January 1972		
	0.5 m	10 m	17 m	0.5 m	10 m	15 m	0.5 m	10 m	17.5 m	0.5 m	10 m	17 m
Crustacea												
Cladocera												
Bosmina coregoni			3									
Bosmina longirostris	55	11	4					1		8	3	9
Daphnia pulex	1	4		1					2			
Immatures	2	2										
Copepoda												
Cyclops sp.			4				3	3	5			
Osphrancticum labronectum		6										
Immatures	6	2	2	1	2	1	21	25	6	5	2	6
Rotifera												
Asplanchna sp. 1							1	3				
Asplanchna sp. 2										13		
Brachionus caudatus	1	6	5	8	14	9	3	1	3			
Brachionus sp. 2										14	20	24
Keratella quadrata	8	2	1	1						3		
Notholca										1		

Source: J. O. Mecom, "A Limnological Survey of Lake Granbury, Texas," S.M.U., submitted to Texas Power and Light Co., May 12, 1972; station F.

[a]17 additional species, whose density or collection site was not given, might occur in the area. These are 9 species of Rotifera (*Asplanchna* sp. 3, *Brachionus angularis*, *B. calyciflorus*, *B. pterodinoides*, *Keratella cochlearis*, *K. gracilenta*, *K. taurocephala*, *Pedalia* sp., and *Platyias quadricornis*), 3 species of Cladocera (*Daphnia longispina typica*, *D. longispina galeata*, and *Leptodora kindtii*), 2 species of Copepoda (*Ectocyclops phaleratus* and *Ergasilus* sp.), and 1 protozoan (*Amoeba* sp.) (J. F. Ubelaker, "Summary of Data Obtained on Project for Texas Utilities during the Second Phase of Study," unpub. rep., Oct. 21, 1973).

Appendix C

COST ESTIMATES FOR ALTERNATIVE BASE-LOAD GENERATION SYSTEMS

The staff elected to use a recently developed computer program to rough check the applicant's capital cost estimate for the Comanche Peak Nuclear Station and to estimate the costs for a coal-fired alternative generation system. This computer program, called CONCEPT,[1-3] was developed as part of the program analysis activities of the AEC Division of Reactor Research and Development, and the work was performed in the Studies and Evaluations Program at the Oak Ridge National Laboratory. The code was designed primarily for use in examining average trends in costs, identifying important elements in the cost structure, determining sensitivity to technical and economic factors, and providing reasonable long-range projections of costs. Although cost estimates produced by the CONCEPT code are not intended as substitutes for detailed engineering cost estimates for specific projects, the code has been organized to facilitate modifications to the cost models so that costs may be tailored to a particular project. Use of the computer provides a rapid means of calculating future capital costs of a project with various assumed sets of economic and technical ground rules.

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DESCRIPTION OF THE CONCEPT CODE

The procedures used in the CONCEPT code are based on the premise that any central station power plant involves approximately the same major cost components, regardless of location or date of initial operation. Therefore, if the trends of these major cost components can be established as a function of plant type and size, location, and interest and escalation rates, then a cost estimate for a reference case can be adjusted to fit the case of interest. The application of this approach requires a detailed "cost model" for each plant type at a reference condition and the determination of the cost trend relationships. The generation of these data has comprised a large effort in the development of the CONCEPT code. Detailed investment cost studies by an architect-engineering firm have provided basic cost model data for pressurized water reactor nuclear plants[4] and coal-fired plants.[5] These cost data have been revised to reflect plant design changes since the 1971 reference date of the initial estimates.

The cost model is based on a detailed cost estimate for a reference plant at a designated location and a specified date. This estimate includes a detailed breakdown of each cost account into costs for factory equipment, site materials, and site labor. A typical cost model consists of over a hundred individual cost accounts, each of which can be altered by input at the user's option. The AEC system of cost accounts[6] is used in CONCEPT.

To generate a cost estimate under specific conditions, the user specifies the following input: plant type and location, net capacity, beginning date for design and construction, date of commercial operation, length of construction workweek, and rate of interest during construction. If the specified plant size is different from the reference plant size, the direct cost for each two-digit account is adjusted by using scaling functions which define the cost as a function of plant size. This initial step gives an estimate of the direct costs for a plant of the specified type and size at the base date and location.

The code has access to cost index data files for 20 key cities in the United States. The data for Dallas, Texas, were used for the Comanche Peak cost estimates. These files contain data on cost of materials and wage rates for 13 construction crafts as reported by trade publications over the past twelve years. These data were used to determine historical trends of material costs, providing an estimate for the materials costs as of mid-1972. Cost escalation after mid-1972 was based on labor rates, labor productivity, and labor and materials escalation rates estimated by the staff for the Dallas-Ft. Worth area.

This technique of separating the plant cost into individual components, applying appropriate scaling functions and location-dependent cost adjustments, and escalating to different dates is the heart of the computerized approach used in CONCEPT.

ESTIMATED CAPITAL COSTS

The assumptions used in the CONCEPT calculations are listed in Table C-1. Table C-2 summarizes the total plant capital investment estimates for the Comanche Peak Nuclear Station with an artificial impoundment providing a "cooling pond" and presents comparative results for the station with mechanical draft evaporative cooling towers. The cost differential for evaporative cooling towers is lower than some which have been quoted in the literature, but are thought to be realistic for new plant installations. Reduction in intake velocities from 2.0 feet per second to 0.5 fps has caused a large increase in cost of cooling water intake structures for the artificial impoundment case. Also, reductions in allowable temperature rise through the condenser has increased the size and cost

Table C-1. Assumptions Used in CONCEPT Calculations for the Comanche Peak Power Plant

Plant type	Two-unit PWR
Alternate plant types	Two-unit coal-fired
Unit size	1,150 MW(e)-net, each unit
Plant location	Dallas, Texas area
Start of Construction date	
PWR NSSS ordered	October 1972
Fossile alternatives	January 1974
Commercial operation date	
Unit 1	January 1980
Unit 2	January 1982
Length of workweek	40 hours
Interest during construction	7%/year, compound
Escalation rates	
Site labor	7%/year
Site materials	4%/year
Purchased equipment	5%/year

Table C-2. Plant Capital Investment Summary for the Comanche Peak Nuclear Station, with Alternative Heat Rejection Systems

Heat Rejection System Plant Net Capability, MW(e)	Artificial Impoundment 2,300	Mech. Draft Evap. Towers 2,300
(Direct Costs (Millions of Dollars)		
Land and cooling body	20*	20*
Physical plant		
Structures and site facilities	73	67
Reactor plant equipment	145	146
Turbine plant equipment	141	146
Electric plant equipment	40	42
Miscellaneous plant equipment	7	7
Subtotal (physical plant)	406	408
Spare parts allowance	3	3
Contingency Allowance	25	25
Subtotal (total physical plant)	434	436
Indirect Costs (Millions of Dollars)		
Construction facilities, equipment and services	25	25
Engineering and construction management services	64	64
Other costs	20	20
Interest during construction	170	170
Total Costs		
Total plant capital cost at start of project		
Millions of dollars	733	735
(Dollars per kilowatt)	(319)	(320)
Escalation during construction	176	176
Total plant capital cost at commercial operation		
Millions of dollars	909	911
(Dollars per kilowatt)	(395)	(396)

*Includes cost of artificial impoundment or certain cooling tower facilities.

of condensers in the artificial impoundment case. Systems using closed-cycle cooling towers are not influenced significantly by the above ecological considerations. In closed-cycle systems, the temperature rise across the condenser is not limited. Also, the quantity of makeup water is small compared to once-through flows, so the intake structures have a lower cost. Thus, the reductions in intake structure and condenser cost partially offset the cost of the cooling towers.

Estimated costs for an alternative coal-fired plant are presented in Table C-3. The estimated costs for SO_2 removal equipment are based on a study performed by Oak Ridge National Laboratory.[7] The assumptions used in that study are summarized in Table C-4.

As stated previously, the above cost estimates produced by the CONCEPT code are not intended as substitutes for detailed engineering cost estimates, but were prepared as a check on the applicant's estimate and to provide consistent estimates for the nuclear plant and fossil-fired alternatives.

Table C-3. Total Plant Capital Investment Cost Estimated for a 2,300-MW(e) Coal-Fired Power Plant as an Alternative to the Comanche Peak Nuclear Station

	With SO_2 Abatement System	
	With Artificial Impoundment	Mechanical Draft Towers
Direct Costs (Millions of Dollars)		
Land and cooling body	20*	20*
Physical plant		
Structures and site facilities	52	48
Boiler plant equipment	167	170
Turbine plant equipment	113	120
Electric plant equipment	31	32
Miscellaneous plant equipment	5	5
Subtotal (physical plant)	368	375
Spare parts allowance	3	3
Contingency allowance	23	23
Subtotal (total physical plant)	394	401
Indirect Costs (Millions of Dollars)		
Construction facilities, equipment and services	31	31
Engineering and construction management services	33	33
Other costs	14	14
Interest during construction	144	148
Total Costs		
Total plant capital cost at start of project		
Millions of dollars	636	647
(Dollars per kilowatt)	(277)	(281)
Escalation during construction	106	108
Total plant capital cost at commercial operation		
Millions of dollars	742	755
(Dollars per kilowatt)	(323)	(328)

*Includes cost of artificial impoundment and certain cooling tower facilities.

Table C-4. Basis for SO_2-Removal Equipment Cost Estimate

Type of process	Wet scrubbing of flue gas by a limestone slurry
Cost basis	Integrated installation in a new plant (no back-fitting required)
Fuel Composition (Design Values)	Coal-Fired
Sulfur content, % by weight	5
Ash content, % by weight	25
Energy value	10,000 Btu/lb
Abatement level, % SO_2 removal (minimum)	76
Plant Operating Data	
Plant net output,* MW(e)	
Without SO_2 control	1,180
With SO_2 control	1,150
Assumed plant load factor	0.80
Annual fuel consumption	3,700,000 tons
Limestone used, tons/year	910,000
Sulfur removed, tons/year	142,000
Waste products, tons/year	
Slurry	1,030,000
Fly ash	820,000

*With once-through cooling.

REFERENCES FOR APPENDIX C

1. *CONCEPT: A Computer Code for Conceptual Cost Estimates of Steam-Electric Power Plants — Status Report*, USAEC Report WASH-1180 (April 1971).

2. R. C. DeLozier, L. D. Reynolds, and H. I. Bowers, *CONCEPT: Computerized Conceptual Cost Estimates for Steam-Electric Power Plants — Phase I User's Manual*, USAEC Report ORNL-TM-3276, Oak Ridge National Laboratory, October 1971.

3. H. I. Bowers, R. C. DeLozier, L. D. Reynolds, and B. E. Srite, *CONCEPT-II: A Computer Code for Conceptual Cost Estimates of Steam-Electric Power Plants — Phase II User's Manual*, USAEC Report ORNL-4809, Oak Ridge National Laboratory, April 1973.

4. *1000-MWe Central Station Power Plant Investment Cost Study, Volume I, Pressurized Water Reactor Plant*, USAEC Report WASH-1230 (Vol. I), United Engineers and Constructors, Inc., Philadelphia, Pa., June 1972.

5. *1000-MWe Central Station Power Plant Investment Cost Study, Volume III, Coal-Fired Fossil Plant*, USAEC Report WASH-1230 (Vol. III), United Engineers and Constructors, Inc., Philadelphia, Pa., June 1972.

6. *Guide for Economic Evaluation of Nuclear Reactor Plant Designs*, USAEC Report NUS-531, NUS Corporation, January 1969.

7. M. L. Myers, *Cost Estimate for the Limestone — Wet Scrubbing Sulfur Oxide Control Process*, USAEC Report ORNL-TM-4142, Oak Ridge National Laboratory, July 1973.

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50-446

Advisory Council
On Historic Preservation
[illegible]
Washington D.C. [illegible]

March 8, 1974

RECEIVED MAR 11 1974

Mr. Daniel R. Muller
Assistant Director for Environmental
Projects
Directorate of Licensing
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Muller:

This is in response to your request of February 15, 1974, for comments on the environmental statement for the Comanche Peak Steam Electric Station, Units 1 and 2, Somervell County, Texas. Pursuant to its responsibilities under Section 102(2)(C) of the National Environmental Policy Act of 1969, the Advisory Council on Historic Preservation has determined that while you have discussed the historical, architectural, and archeological aspects related to the undertaking, the Advisory Council needs additional information to adequately evaluate the effects on these cultural resources. Please furnish additional data indicating:

> Compliance with Executive Order 11593 "Protection and Enhancement of the Cultural Environment" of May 13, 1971.
>
> Under Section 2(a) of the Executive Order, Federal agencies are required to locate, inventory and nominate eligible properties under their control or jurisdiction to the National Register of Historic Places. The Council requests that your agency apply the National Register Criteria to the historical and archeological sites listed in Section 2.3.1 and Appendix A of the applicant's environmental report and supply us with a determination as to each property's eligibility for inclusion in the National Register. The Advisory Council is particularly concerned with regard to Section 2(a) compliance in light of the statement on page 4-5 of the Draft Environmental Statement that "a number of sites or buildings of local historical interest are situated near the reservoir site." It should be emphasized that sites of local significance are just as eligible for National Register designation as sites of state and national significance. The National Register Criteria are set forth in Section 800.10 of the Advisory Council's "Procedures for the Protection of Historic and Cultural Properties" (for your convenience, a copy of these procedures is enclosed).

The Advisory Council also requests that it be provided with a statement concerning compliance with Section 1(3) and 2(b) of the Executive Order. Section 1(3) requires that Federal agencies institute procedures to assure that Federal plans and programs contribute to the preservation and enhancement of non-federally owned sites. Section 2(b) requires the same consideration for properties under the control or jurisdiction of the Federal government and obligates Federal agencies to exercise caution during the 2(a) inventory stage to assure that any federally owned property that might qualify for nomination is not inadvertently transferred, sold, demolished or substantially altered.

Under Section 800.4 of the Advisory Council's "Procedures for the Protection of Historic and Cultural Properties," Federal agencies are required to make a determination of "no effect," "no adverse effect" or "adverse effect" with respect to the contemplated impact of their undertaking on properties included in or eligible for inclusion in the National Register of Historic Places. The Commission's determination "that the construction of the Squaw Creek Reservoir and power generating station will have no impact of serious consequence on the historical and archeological resources available in the general region (Section 11.22.8 ER) is inacceptable for the purposes of compliance with the Council's procedures. Therefore, the Advisory Council requests that your agency review its undertaking and supply us with a determination of effect in conformance with the Council's procedures.

Should you have any questions or require any additional assistance, please contact Jordan Tannenbaum (202-254-3974) of the Advisory Council staff.

Sincerely yours,

Ann Webster Smith
Ann Webster Smith
Director, Office of Compliance

Enclosure

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The Council is an independent unit of the Executive Branch of the Federal Government charged by the Act of October 15, 1966 to advise the President and Congress in the field of Historic Preservation.

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DEPARTMENT OF THE ARMY
FORT WORTH DISTRICT, CORPS OF ENGINEERS
P. O. BOX 17300
FORT WORTH, TEXAS 76102

REPLY TO
ATTENTION OF:

SWFED-PR

5 March 1974

Mr. Daniel R. Muller
Assistant Director for Environmental Projects
Directorate of Licensing
ATTN: Docket No. 50-445, 50-446
U.S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

Copies of your draft environmental impact statement for Comanche Peak Steam Electric Station, Amendment 2, have been forwarded to this office by the U.S. Army Corps of Engineers, Southwestern Division, Dallas, Texas.

We have reviewed this statement and concluded that the proposed construction will not affect existing, authorized, or proposed Corps of Engineers activities.

We thank you for the opportunity to present our comments.

Sincerely yours,

J. L. JOHNSON
Acting Chief, Engineering Division

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DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS
U.S. COAST GUARD (G-WS/73)
400 SEVENTH STREET S.W.
WASHINGTON, D.C. 20590
PHONE (202) 426-2262

50-445/446

Mr. Daniel R. Muller
Assistant Director
Environmental Projects
Directorate of Licensing
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

This is in response to your letter of 15 February 1974 addressed to Mr. Benjamin O. Davis concerning the draft environmental impact statement for Comanche Peak Steam Electric Station Units 1 and 2, Texas.

The Department of Transportation has reviewed the material submitted. We have no comments to offer nor do we have any objection to the project.

The opportunity to review this draft statement is appreciated.

Sincerely,

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UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

P. O. Box 648
Temple, Texas 76501

March 27, 1974

RECEIVED APR 2 1974

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
United States Atomic Energy Commission
Washington, D. C. 20545

50-445

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Dear Mr. Muller:

We have reviewed the draft environmental statement and environmental report for the proposed Comanche Peak Steam Electric Station, Hood and Somervell Counties, Texas.

The statement describes the environmental impact of the proposed project and contains measures to minimize adverse effects.

We offer the following suggestions for your consideration:

1. The statement could be improved if the section on the impact on agricultural operations is expanded. Isolated statements such as on page 3-47, "accessibility to parts of some farms will be reduced," lead the reader to believe the impact on 940 acres of cropland could be more severe than the description indicates. Stockpiling topsoil on pipe line projects and the reapplication of such would help minimize the loss of production.

2. You may not wish to limit yourself to seeding with native grasses because there are introduced grasses which are adapted to the area and will do a superior job of erosion control.

3. The following changes are suggested to improve the technical adequacy of the soils section.

   a. 2.7.5 - Delete the word "general" in the first sentence of the second paragraph. A soil series is a taxonomic unit or concept.

   b. 2.7.5 - Delete the third paragraph for the following reasons:

      (1) All soil series named in the paragraph are derived from the Paluxy sandstone formation.

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      (2) Other soils may be partially derived from the Paluxy sandstone formation.

      (3) The Hassee and Pedernales soils are not considered of the Cross Timbers Land Resource Area(Cross Timber soils) and Selden soils are of the Cross Timbers Land Resouce Area.

      (4) Nothing is mentioned about the land resource areas for other soil series.

   c. 2.7.5.6 - Delete the first sentence since it is better not to point out that Windthorst is the last of the Cross Timbers soils.

The statement, especially the inventory section, is very comprehensive. We appreciate the opportunity to review this draft and make appropriate comments.

Sincerely,

J D Abbott

for Edward E. Thomas
State Conservationist

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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Southeastern Area, State and Private Forestry
Atlanta, Georgia 30309

8420

50-445/446

April 2, 1974

Daniel R. Muller
Assistant Director of Environmental Projects
Directorate of Licensing
U.S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

Here are Southeastern Area, State and Private Forestry comments on the Proposed Comanche Peak Steam Electric Station (Units 1 and 2) draft environmental statement.

The amount of land area which will be lost to productive use after decommissioning of the facility is of primary concern in determining the relationship between short-term use and the maintenance and enhancement of long-term productivity. What is the estimated acreage which will require perpetual maintenance under the proposed "Third Level" of decommissioning?

We commend your inclusion of decommissioning costs as a part of the total power operating cost of this term facility. Hopefully, the total cost of decommissioning (including perpetual maintenance required) will be amortized during the productive life of the facility so as not to be an impact upon future, non-benefiting, generations.

To help mitigate the loss of the Squaw Creek riparian community, we recommend forestation of the shoreline of the Squaw Lake Reservoir and all adjacent sites with sufficient moisture for tree growth. The Texas Forest Service can advise you on suitable species and planting techniques.

Thanks for the opportunity to review and comment on this draft environmental statement.

Sincerely

For FREDERICK W. HONING
Area Environmental Coordinator

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APR 5 1974

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DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

APR 1 1974

RECEIVED
APR 5 1974
U.S. ATOMIC ENERGY COMMISSION
Regulatory
Mail Section

Mr. Daniel R. Muller
Assistant Director for Environmental Projects
Directorate of Licensing
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

Pursuant to your request of February 15, this Department has reviewed the draft Environmental Impact Statement for the Comanche Peak Steam Electric Station, Units 1 and 2. Based on the review by appropriate program agencies and regional offices, we offer the following comments:

From the information contained in the draft report, it appears that this facility may be constructed and operated without undue impact on the environment or on the health of individuals in the surrounding area. Predicted radiation doses from normal operation of the plant are within the "low as practicable" guidelines of the Atomic Energy Commission. The highest projected dose of 4.4 millirems to the thyroid of a child through milk ingestion from the nearest dairy herd. The calculated dose to a child's thyroid who would drink milk from a cow located at the site boundary would be less than 15 millirems per year. As the proposed Squaw Creek Reservoir will be used for water sports, such as fishing and swimming, doses to the individuals utilizing this reservoir have been computed and are well below those considered acceptable, with the highest dose being that to the whole body from the ingestion of fish. This dose would be 1.2 millirem per year.

The draft statement considers doses that would be received by individuals and to the population within 50 miles of the facility, due to 8 classes of postulated accidents. The highest dose projected would be from a class 8 accident resulting in loss of coolant due to a large break in the cooling system. The highest dose to an individual computed from such an accident would be 180 millirem with a resulting population dose to the inhabitants within 50 miles of the facility of 410 man-rem.

It is noted that chipping and shredding of brush removed during site clearing operations for use as a mulch in lieu of disposal by on-site open air burning would reduce the adverse impact on local air quality. Cutting larger trees into firewood suitable for

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home consumption rather than mass on-site burning is also desirable.

Monitoring the operations of construction equipment and vehicles for compliance with appropriate Federal, State, and local requirements for air pollution and noise abatement controls as a part of the construction contracts should be considered.

Section 3.6.1.1 Chemical Effluents, indicates the total dissolved solids concentration in Lake Granbury resulting from the blowdown from Squaw Creek Reservoir will be between 2 and 3% assuming complete mixing. What is the basis for assuming complete mixing?

Section 3.6.1.2 Evaporation Pond, indicates the pond bottom and sides will be lined with tamped clay to prevent ground water contamination. As the water level drops, the clay will be subject to shrinkage and cracking allowing escape of pond water through the cracks as the water level rises again. It is also mentioned that, if necessary, sludge will be removed from the pond to gain additional capacity. Assuming the sludge will be dredged (to avoid shutting down use of the pond by draining it and removing the sludge with other equipment such as bulldozers, etc.) how will the clay liner be maintained to protect ground water quality?

What effect, if any, will construction of the towers and overhead transmission lines have on local television reception, telephone communications, and aircraft operations for crop-dusting, etc. on, along, and adjacent to the proposed route?

Section 4.1.1 Station Site and Squaw Creek Reservoir Dam, indicates that on the average 50 to 55 truck deliveries per day to the site of sand, cement, aggregate, and steel will have a significant impact on farm roads FM 201 and 51 and that local road maintenance requirements will increase substantially. What changes will this bring about in the present type, level, and extent of service the roads provide for non-construction related traffic?

Section 3.5.3 Solid Waste, indicates radioactive wet solid wastes occurring as a result of plant operation will be placed in 55 gallon steel drums for shipment off-site. Considering the corrosion rate of steel, would it be more appropriate to use non-corrosive plastic containers or liners for steel drums as an additional safeguard even though the Environmental Report notes the wastes will be combined with cement and vermiculite to form a solid matrix?

Section 4.4.4 Impact on Local Institutions, states the proposed project's construction effort will have significant indirect impacts on the cities of Glen Rose and, to a lesser extent, Granbury, but neither community has taxing authority with respect to the Comanche Steam Electric Station. It appears this issue must be resolved and included as a part of the Environmental Report to assure that there is no reduction in the present type, level, or extent of services in these communities due to the proposed facility.

As mentioned in the statement, the AEC staff states that there will be an increase in tax revenues as construction on the facility progresses, but that in the first few years, the revenues may not be sufficient for the increased services needed. Based on a site visit, August 1973, and information provided by the applicant, the AEC staff has concluded that the applicant has identified the major impacts and has shown the capability of insuring that local jurisdictions receive financial aid in sufficient time to provide the services required to ameliorate construction-related effects to the extent that the impact will be acceptable.

Thank you for the opportunity to comment on this statement.

Sincerely,

Charles Custard
Director
Office of Environmental Affairs

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United States Department of the Interior 50-445 50-446

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

In reply refer to:

PEP ER 74/259

APR 8 1974

Dear Mr. Muller:

Thank you for your letter of February 15, 1974, requesting our comments on the Atomic Energy Commission's draft statement, dated February 1974, on environmental considerations for Comanche Peak Steam Electric Station, Units 1 and 2, Hood and Somervell Counties, Texas.

General

Many of the AEC staff's recommendations cited throughout the statement will mitigate adverse effects of the powerplant and its associated facilities. However, there is an apparent lack of post-construction monitoring of the aquatic and terrestrial environment and questions as to how successfully the recommendations will be implemented by the applicant.

It appears that the project site will provide a highly desirable recreation area if a joint planning effort by concerned State, Federal, and local agencies is solicited.

Our specific comments are presented according to the format of the statement or according to subjects.

Regional Demography, Land Use, and Water Use

The second paragraph on page 2-8 should include Big Rocks City Park in the City of Glen Rose, Lake Whitney Recreation Area four miles southeast of Glen Rose, and the Somervell County Historical Museum at Glen Rose.

Historic and Archeological Sites and Natural Resources

The final statement should include a sentence indicating consultation with the National Register of Historic Places or a sentence similar to that given in paragraph 1, page 2.3-1, Volume I, of the applicant's environmental report. We also

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suggest that the more recent listing in the Federal Register of February 19, 1974, Part II, should be substituted for the one on page 2.3-5 of Volume I, reference 1.

The draft statement does not adequately assess the impact of the overall project upon archeological resources with the exception of the reservoir site. The statement should contain information on archeological resources related to the plant site, transmission lines, relocated pipelines, borrow areas, access roads, etc. These areas should be surveyed by a professional archeologist and the final statement should cite the resulting report. The final statement should also include actions which will be taken to mitigate adverse impacts on the archeological resources.

Geology

Sections on geology and seismology in the draft environmental statement (p. 2-11 to 2-13) are extremely brief, the latter section being limited to a single sentence plus a reference to the applicant's environmental report. Reference has also been made to geological data presented in the Preliminary Safety Analysis Report (PSAR). Under previous arrangements, the Geological Survey has completed a preliminary review of geologic aspects related to construction of the Comanche Peak Steam Electric Station, as presented in the PSAR. This review was transmitted to the AEC Division of Reactor Licensing on November 12, 1973. Nevertheless, we feel that the environmental statement should provide a more comprehensive summary of the geologic and seismologic environment for the benefit of other independent reviewers. In addition, the statement should provide assurances that geology and seismology of the Comanche site have been taken into account in an appropriate manner, as prescribed in AEC's "Seismic and Geologic Siting Criteria for Nuclear Power Plants" (10 CFR 100, Appendix F, Federal Register, Vol. 36, No. 228, Nov. 25, 1971).

Data on geology and seismology provided in the environmental statement (p. 2-11 to 2-13, 2-19, 2-20, 5-3) and in Amendment 2 (p. 2.4-3 to 2.4-6; Figs. 2.4-3 and 2.4-6; Ecology Report page 7-11, etc.) are inadequate for an independent assessment of the geologic environment. The only information on the physical properties of the geologic materials on which the plant would be founded is a general discussion relevant to permeability of the limestone beds of the Glen Rose formation. However, we are concerned particularly with the physical properties of the "clay stone" layers that are interbedded with the limestone (p. 2-11) and any effects that the proposed groundwater pumping and any resulting changes in piezometric surface may have on their physical properties. In regard to the proposed pumping, it is stipulated that the

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"applicant must show . . . that this will not cause any adverse impacts on other users" (p. 10-1). However, we feel that assurances are also needed that this activity would not have other adverse environmental impacts, including subsidence, that might result from a change in physical properties of layers below the plant foundations. In regard to seismic design, it is stated that "a conservative value of 0.2g horizontal acceleration was chosen for the Safe Shutdown Earthquake" (p. 2.4-6, Amendment 2). However, no adequate explanation has been provided of the basis for selecting this ground acceleration or the manner in which the proposed facilities have been designed to accommodate the seismic environment.

Lake Granbury

The water to be returned to Lake Granbury is mentioned on page 2-15 and 3-5; however, the effects on water quality are not discussed. The operational effects of the water exchange system on the quality of the water in Lake Granbury should be included in the final environmental statement.

Birds

Reference is made on page 2-32 to a 1970 publication by this Department in designating the classification of certain raptorial birds and the golden-cheeked warbler. We suggest that a later reference be used. Based on the U.S. Department of the Interior's Resource Publication 114, "Threatened Wildlife of the United States," and U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, "List of Endangered Native Fish and Wildlife," October 1973, the southern bald eagle and American perigrene falcon are considered endangered. The golden-cheeked warbler and the prarie falcon are designated as threatened. This correction should also be made in paragraph three, page 4-11.

Heat Dissipation System

A generalized layout of the Comanche plant (fig. 3.4.1) shows an evaporation pond situated southwest of the plant area. However, a map included in Amendment 2 (fig. 2.1-3a) fails to show this pond but shows two larger evaporation ponds due west of the plant area. A third map (fig. 4.1.1) shows still another configuration of the evaporation pond, completely different from the other two. Although it is acknowledged that "the exact configuration of the station facilities has

not been established" (p. 4-10), the ponds would evidently be of significant size, covering about 600,000 square feet. The environmental statement apparently provides no discussion of the design or construction of the ponds or their perimeter dikes, of the depth or amount of excavation required to construct them, or of any related environmental impacts.

Solid Radioactive Wastes

The solid radioactive wastes that would result from operation of the two units have been estimated to include annually about 2,100 55-gallon drums having a total activity estimated to be approximately 14,400 curies. These wastes are described as consisting mainly of spent demineralizer resins, filter sludges, evaporator bottoms, chemical drain tank effluents, ventilation air filters, contaminated clothing and paper, and miscellaneous items such as tools and laboratory glassware. According to page 7-7, the wastes would be shipped to an offsite burial ground either at Morehead, Kentucky, or at Sheffield, Illinois. It is stated on page 3-31 that "greater than 90% of the radioactivity associated with the solid waste will be longlived fission and corrosion products, principally Cs-134, Cs-137, Co-58, Co-60, and Fe-55." Because of the considerable storage period required for environmental protection, it would be advisable to discuss Federal and State licensing provisions, criteria, and responsibilities for the burial site in connection with: (1) its hydrogeologic suitability to isolate solid wastes of the Comanche plant from the biosphere; (2) surveillance and monitoring of the disposal site; and (3) any remedial or regulatory actions that might be necessary during the period in which the wastes would be hazardous.

Squaw Creek Reservoir

It is indicated on page 4-12 that to the maximum extent possible, rock and earth fill for the dam will be obtained from the reservoir site, thus minimizing the construction impacts. Also, figure 4.1.1 identifies borrow and prospective borrow areas. However, the statement does not contain an adequate description of the borrow areas within the reservoir and below the dam. We suggest that the final statement include a more complete description of these areas.

The effects on displaced fauna is mentioned on page 4-13. The second paragraph should be expanded to also indicate that an equivalent quantity of displaced fauna will probably be eventually lost due to the limiting carrying capacity of those areas and the likelihood that the area is presently near biological equilibrium.

As stated on page 4-13, a positive impact on terrestrial ecosystems will be the suspension of cattle grazing. Suspension of all grazing may be an improvement over heavy grazing, however, an interim grazing program would provide a more desirable effect on wildlife habitat and possibly the total environment.

The AEC staff recommendation that brush clearing of small dense juniper and mesquite thickets be done in certain areas should be administered only under a wildlife management plan . The plan should be reviewed by the appropriate State and Federal fish and wildlife agencies.

Construction of Squaw Creek Dam

The inference on page 4-20 that a greater biomass production will result in a beneficial effect from a fisheries management viewpoint is misleading. Aquatic biomass doesn't always denote a productive fishery. As indicated in the preceeding paragraph, after the 4th or 5th year rough fish usually make up approximately 75 percent of the total fish by weight in Texas reservoirs.

The cut-off segment of the channel and the channel relocation should have a much more complete description than that given on page 4-20 if the impacts are to be adequately identified.

The effects of siltation on Squaw Creek is discussed on pages 4-21 and 4-22; however, the effects on the Puluxy and Brazos Rivers are not described. This section should be expanded to include a discussion of the effects that will occur as a result of construction on Puluxy and Brazos Rivers as well as Squaw Creek. A time period for recovery should also be projected for each river.

A discussion of dissolved oxygen levels for water withdrawn from Lake Granbury and discharged into Squaw Creek is given on page 4-22. Due to the low dissolved oxygen levels during May, June, July, and August and possible high hydrogen sulfide levels, a method of reaeration should be described along with methods of water release into Squaw Creek.

Recreational Impacts

We are pleased that the applicant intends to make the Squaw Creek Reservoir available for public recreation. This action will also help preserve and protect important fish and wildlife habitat and resources.

According to page 5-3, the applicant will make the reservoir available to the Texas Parks and Wildlife Department for recreation development, but plans are still in preliminary stages. We suggest that the final environmental statement include an up-to-date discussion of recreation development plans, including maps showing types of recreation facilities under consideration.

The above reference is related to recreational development for Squaw Creek Reservoir only. However, the map on pg. 3-6 shows a parcel of land within the applicant's property line that is available for recreational use. It is not clear whether this area is connected with the Texas Parks and Wildlife's recreational programs. This needs clarification. We also suggest that the relationship between the exclusion zone and recreation use should be explained, especially clarifying whether recreation will or will not be allowed along the shoreline within the exclusion zone.

Lake Granbury, to the north, and the proposed Squaw Creek Reservoir will be connected by a 48-inch-diameter makeup water pipeline and a 36-inch-diameter return pipeline to return blowdown from the plant to Lake Granbury. Because of this physical connection, we view Lake Granbury as part of the project. Lake Granbury apparently provides a rapidly expanding range of water-related outdoor recreation opportunities, according to pages 2-5, 2-8, 4-7, 4-33, and 5-2 of the draft statement. The final statement should present a discussion of the general recreation picture at the Lake. The discussion should include types of recreation activities pursued, use data by activity (quantified, if possible), and some indication of the economic impact to the local economy resulting from the recreation development which has taken place since 1969. One reason for suggesting this is (notwithstanding the statements on pages 4-7 and 5-2) that the applicant's judgment that the intake for the makeup water pipeline and the discharge of the return pipeline will not adversely impact on existing recreation is largely unsupported. At present, the judgment of "no adverse impact" is based solely on the fact that the pipelines will be located in an area closed to recreational boating. A map showing the closed area in relation to the entire Lake would be of help in this regard.

Under Section 5.6.5 (page 5-45), the draft statement acknowledges an adverse esthetic impact where the CPSES-related transmission lines cross Lake Granbury. According to Figure 3.8.2 (page 3-45), the transmission lines (one 138 kV and one 345 kV) will cross the Brazos River at three points and Lake Granbury at one point about three miles upstream from the De Cordova Bend Dam. The final statement should include a discussion of what mitigating measures will be undertaken by the applicant to minimize adverse esthetic impacts at the River and Lake crossings.

The Texas Parks and Wildlife Department is currently finalizing the Texas Statewide Comprehensive Outdoor Recreation Plan (SCORP). In responding to comments regarding the recreation environment, the AEC Staff and/or the applicant may wish to consult the SCORP regarding such matters as recreation use, demand, and the recreation potential of the project area. Should such consultation be necessary, the contact is:

Texas Parks and Wildlife Department
Comprehensive Planning Section
John H. Reagan Building
Austin, Texas 78701

Attention: Mr. Jim Riggs
Telephone: 512-475-4366

Applicant's Thermal Analysis

Both the applicant and the AEC have evaluated temperature distributions in the cooling reservoir and are essentially in agreement. It is not clear in the report if recirculation and hence possible temperature buildup has been considered in the analysis. Figure 5.3.4 (p. 5-10, applicant's data) indicates a temperature difference between the intake and discharge of 12.7°F whereas the text indicates that ΔT will be 14.2°F (paragraph 3.3). Figure 5.3.5 (AEC's data) would seem to indicate similar results. Thus, we are not convinced that recirculation will not be significant and possible temperature buildup may result in higher than predicted temperatures in blowdown water going to Lake Granbury.

Effects of Transmission Lines

The probable effects on birds from collisions with the proposed transmission lines and towers should be identified and discussed. As mentioned earlier, the route of the De Cordova transmission lines cross the Brazos River at three locations and also Lake Granbury. Since this area is used by waterfowl, raptors, and song birds, a careful study should be made to identify impacts that may occur as a result of the construction and operation of the plant.

Entrainment

Entrainment of aquatic organisms is discussed on page 5-36. The estimated loss of aquatic organisms due to entrainment should be presented to better appraise the productivity of the Squaw Creek Reservoir.

A reservoir total circulation time of 14 days is estimated based on a condenser cooling-water flow of 4,902 cfs and reservoir volume of 135,360 acre-feet. It is unlikely that this reservoir volume can be considered effective due to probable short circuiting and it is likely that a turnover time of the "effective volume" is considerably less.

Monitoring Programs

An interagency meeting of concerned State, Federal, and local agencies and the applicant should be scheduled at a future date to discuss and develop guidelines for preconstruction, construction, and post-construction monitoring of hydrological, terrestrial, and aquatic conditions. These guidelines should locate sample collection areas, frequency, and methods of collection. Sampling data should subsequently be distributed to the concerned agencies for their review and comments.

It is indicated on page 6-1 that the water quality measurements at the Squaw Creek Station below the Squaw Creek Dam shall start at least six months before construction is initiated. Due to variations in normal seasonal flows and quality, we suggest that this requirement be changed to at least one full year of data instead of 6 months.

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Environmental Effects of Accidents

Discussion of accident probabilities is purely qualitative, and discussion of the most serious (class 9) accidents is limited largely to the statement that "the probability of their occurrence is judged so small that their environmental risk is extremely low" (p. 7-3). The most serious class of accidents was not conceived as a purely hypothetical exercise, as seems to be implied by Table 7.1 and the accompanying discussion, and we believe that the subject merits at least a quantitative estimate of probability, environmental consequences, and environmental risk.

Although these factors have evidently not been estimated as yet, we understand that a group of about 50 specialists, are currently performing a study for AEC to assess more quantitatively these risks and that initial results of these efforts are expected to be available in early 1974 (p. 7-3). We presume that the environmental effects of class 9 accidents are being evaluated, despite their low probability, and believe that this information should be included in the final environmental statement.

Irreversible and Irretrievable Commitments of Resources

The following should be added as item (7) to the first paragraph on page 10-8: Archeological resources salvaged prior to or encountered and salvaged during the construction phase.

We hope these comments will be helpful in the preparation of the final environmental statement.

Sincerely yours,

Royston C. Hughes

Assistant Secretary of the Interior

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
Atomic Energy Commission
Washington, D. C. 20545

TEXAS UTILITIES GENERATING COMPANY

TXX-233

April 8, 1974

Mr. J. F. O'Leary
Directorate of Licensing (DOL)
U. S. Atomic Energy Commission
Washington, D. C. 20545

COMANCHE PEAK STEAM ELECTRIC STATION
DOCKET NOS. 50-445 and 50-446
TRANSMITTAL OF APPLICANT COMMENTS
ON DRAFT ENVIRONMENTAL STATEMENT
FILE NO. 10020

Dear Mr. O'Leary:

We have reviewed the Draft Environmental Statement (DES) for the Comanche Peak Steam Electric Station (CPSES). Our comments were discussed verbally with Mr. Frank Miraglia, DOL Project Manager, in his offices on March 21 and 22, 1974.

While the majority of our comments regarding the DES were of an editorial nature, and were favorably received by Mr. Miraglia and his staff, there remain certain key issues on which our position is at variance with that of the AEC. In the attached sections, we will discuss the subjects listed below in more detail:

1. Operational Chlorination Practices (Attachment 1)
2. Intake Structure Design/Water Velocities (Attachment 2)
3. Cooling Towers: Water Consumption & Costs (Attachment 3)
4. Scheduling of Construction Activities (Attachment 4)

We are also providing (as Attachment 5) updated land use acreage data for appending to the Final Environmental Statement (FES) to be published in May, 1974.

C-197

Mr. J. F. O'Leary
U. S. Atomic Energy Commission

April 8, 1974
Page 2

Our previously discussed comments regarding the DES, plus the revised land use data attached hereto will be reflected in a general updating of our ER which will be published as Amendment No. 3 around mid-May, 1974. In this respect, the amended ER should be consistent with the contents of the FES.

In addition, we plan to provide further data regarding the groundwater studies being conducted as soon as the test results are compiled. This information will be formally submitted to AEC around May 1, 1974, and will be included in ER Amendment No. 3 as applicable.

In accordance with the Commission's requirements, we are submitting herewith three (3) signed and forty (40) conformed copies of this letter and the comments attached thereto, for docketing purposes. It is our understanding that these remarks will be incorporated into the appendix to the FES.

A total of ten (10) copies each of the reports referenced in our comments on chlorination (Attachment 1) are also provided by this transmittal.

Respectfully submitted,

TEXAS UTILITIES GENERATING COMPANY

Perry G. Brittain

Perry G. Brittain
Executive Vice President

PGB/SEC:GRM
Attachments

Attachment 1
April 8, 1974

COMANCHE PEAK STEAM ELECTRIC STATION
DOCKET NOS. 50-445 and 50-446

OPERATIONAL CHLORINATION PRACTICES

AEC Position:

"The Applicant shall design the station to control the addition of chlorine to the circulating water systems such that the concentration of total residual chlorine at the point of discharge to Squaw Creek Reservoir is 0.1 ppm or less at all times." (Page vi of DES)

Applicant Position:

For many years the operating companies of the Texas Utilities System and other utilities in Texas have utilized the chlorination procedures that are described for the CPSES in Section 3.6 of the ER with no observable adverse environmental effects. This determination has been repeatedly verified by independent biological studies conducted on heated reservoirs in the CPSES region.

The reduction to 0.1 ppm total residual chlorine at the point of discharge into Squaw Creek Reservoir as an operating requirement will be below the level required to maintain necessary control of biological organisms. Moreover, mechanical techniques for condenser tube cleaning have been found to be inefficient and unacceptable in terms of biocide control. Therefore, chlorination is the only viable method for control of biological organisms in the circulating water system.

As chlorination is a costly, however necessary, practice, a lower than present level of dosage would have already been adopted if it were adequate to accomplish the purpose. The chlorination practices presently employed have been proven over the years to be both environmentally sound and efficient from a plant operation point of view. The AEC requirement for a 0.1 ppm residual level appears to be even more stringent than that set forth in the EPA's proposed effluent guidelines which, in fact, also make provision for exceptions based upon mitigating circumstances and demonstration of the need for higher residual chlorine levels. Therefore, we feel there is no justifiable basis for this severe and, in the CPSES region, ecologically unwarranted operational penalty.

Basis for Applicant's Position

The efficient operation of CPSES will require chlorination of the circulating and service water supply systems at levels comparable to those used for other reservoir-based generating stations in the Texas Utilities System. The general chlorination practices of Texas Power & Light and Texas Electric Service Company are similar, varying only in frequency and intensity (dependent on reservoir fertility and temperature). Both utilities use shock chlorination to residuals of 0.5 to 1.0 ppm at the condenser outlet for periods of 30 minutes to one hour. The length and amount are determined by chlorine demand and system needs. The frequency varies from three hourly periods a week to twice daily during warmer weather at the Sandow plant on Lake Alcoa. On Lake Arlington, operations require the Handley station to chlorinate once daily for 30 minutes in the winter to a maximum of three 30-minute treatments daily during the summer.

Chlorination requirements are very temperature dependent and with rapidly fluctuating air and water temperatures no rigid operational schedule can be maintained. Because of seasonably changing chlorine demand, chlorine concentrations between 1.0 and 2.0 ppm injected ahead of the traveling screens have been found necessary to maintain the 0.5 ppm residual needed to achieve organism control. Chlorine requirements are determined by station chemists for each plant and actual amounts used vary with changing demand. The attached chlorination chart shows chlorination procedures for the reservoirs in the CPSES region discussed herein.

Although virtually all power plants in Texas located on reservoirs use shock chlorination and some biological information is available on at least 18 of these, the six plants with the most biological data will be used in this discussion. These six reservoirs have a total of 93 years of operation with chlorine releases and three have had no significant water flow through in at least 8 years.

The fish populations of five of these reservoirs have been sampled for many years by the Texas Parks & Wildlife Department. In a report prepared for the Texas Water Quality Board by the Radian Corporation*, Dr. Grubb and Mr. Sharp concluded that, "Fish production in heated lakes appeared to be as good if not better than that in non-heated lakes." and that "A Mann-Whitney test of the data showed that heated reservoirs ranked significantly higher than non-heated ones in three parameters describing game fish productivity.", demonstrates that the CPSES can be operated with a 0.5 ppm chlorine residual with no deterimental effects on the aquatic biota. Although this analysis was made in relation to water temperature standards, it is equally applicable to chlorine use.

In February of 1974, Espey, Huston & Associates submitted a report prepared by Paul T. Price to Texas Electric Service Company entitled: Review of Phytoplankton Studies Conducted on Five Texas Reservoirs. One of the conclusions drawn from this study was that "...thermal effluents from electric generating facilities cannot be shown to be responsible for any effects on the phytoplankton populations of reservoirs used for cooling."

In addition, the following benthic studies show that chlorination has not adversely affected populations of benthic organisms in Lake Arlington, Eagle Mountain and Possum Kingdom Lakes, all of which are in the CPSES region:

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* Grubb, J. C. and B. Bryan Sharp, 1973. Biological Investigations-Inland Waters. In Review of Surface Water Temperatures and Associated Biological Data as Related to the Temperature Standards in Texas.

Chlorination Chart

Plant	Maximum MW	Reservoir	Surface Acres	Chlorination Frequency (Hrs. week)	Chlorine Residual Condenser Outlet (mg/l, colorimetric)	No. Years Chlorinated
Morgan Creek	633	Colorado City	1600	3.5-10.5	.5	24
Sandow	345	Alcoa	800	3-14	.5-1	19
Handley	525	Arlington	2200	3.5-10.5	.5	16
Graham	615	Graham	2500	3.5-10.5	.5	14
San Angelo	85	Nasworthy	1600	2.3-8	.75	9
Oak Creek	77	Oak Creek	2300	2.3-8	.75	12
Eagle Mountain	665	Eagle Mountain	8500	3.5-10.5	.50	20
Trinidad	430	Trinidad	750	3-14	.5-.75	10

"Species Diversity and Density of the Benthic Macroinvertebrates Inhabiting a Reservoir Receiving a Heated Effluent", Thesis by Frank M. Hall, University of Texas at Arlington, July, 1972.

Texas Electric Service Company Research Project 173: "A Quantitative and Qualitative Survey of the Plankton and Benthic Invertebrates including Bivalves of Eagle Mountain and Possum Kingdom Lakes", Part II: Benthos, Donald E. Keith, Texas Christian University, Fort Worth, Texas, 1973.

As a further example, Oak Creek Reservoir was impounded in 1954 and a steam electric station was placed on the reservoir in 1961. Chlorination was begun when the plant commenced operation. Based on Parks & Wildlife Department sampling data, the reservoir has shown both increased total production and increased total weight of game species since 1962, certainly a reversal of typical Texas reservoir trends. Chlorination has apparently not reduced aquatic productivity in this reservoir.

Channel catfish have been commercially produced at Handley, Trinidad and Morgan Creek. The cage culture operation at Morgan Creek has produced approximately 180,000 lbs. of catfish in three years of commercial operation. The project is located 4,000 feet below the condenser outlet in the canal before chlorine dilution occurs. The Texas Parks & Wildlife Department has used this location to hold or grow flathead catfish, blue catfish and a redear x green sunfish hybrid. Channel catfish have spawned in the canal and the fry have been raised in this discharge water. These canals are elevated and for at least 8 years no movement of wild fish into the canal except through the condensers has been possible. A very productive continuing population exists in these canals and no species which occurs in the reservoir is known to be excluded from the canal.

Redear x green hybrids, green sunfish, redear sunfish and channel catfish have been grown from advanced fingerlings to an average weight of 0.25 lbs. in the discharge of the Eagle Mountain plant. In this joint project between the Texas Parks & Wildlife Department and Texas Electric Service Company, cages were placed in the canal less than 300 feet downstream from the discharge. The fish were grown to a more desirable size before being released into Eagle Mountain Lake.

At the Handley station on Lake Arlington two small ponds (.08 acre) were constructed adjacent to the discharge canal approximately 300 feet below the condenser outlet. To test the desirability of using the warm discharge water for increased winter growth of game species, Texas Electric Service Company and the Texas Parks & Wildlife Department stocked these ponds with 6-ounce bass. These fish were a Texas strain crossed with a Florida strain and were considered a very desirable sports fish. The fish were stocked in late October 1972 and by March 1973 the fish averaged 16 oz. in weight. These 10-month old fish spawned in the ponds in late February and fingerlings were removed in April of 1973.

Water supply and temperature control for the experiment was a continuous flow through of 250 - 600 gpm siphoned directly from the discharge. The fish were fed with forage species seined from the discharge canal and put in the ponds. During this period, threadfin shad, gizzard shad, tidewater silversides, pugnose minnows, spottail shiners, red shiners, bluegill, green sunfish, goldfish, golden shiners, logperch and mosquito fish were introduced to the ponds as forage. No unusual mortality was found and no erratic behavior was observed. Individuals of all species were recovered in April when the ponds were drained. The excellent growth and reproduction of these bass further indicates that chlorination is not a serious biological problem. A second similar experiment is continuing with bass and catfish at the present time and growth is excellent.

Texas A&M University is conducting a caged culture project in the discharge at the Trinidad Steam Electric Station, also in the Applicant's system. Production is high and densities of approximately 1100 lbs/M^3 have been obtained. Similar densities have been realized at the Morgan Creek project.

The biological information available on reservoirs which have received residual chlorine from power plant operations show no decrease in productivity. Numerous fish culture activities in the discharge water before dilution with lake water indicates that no biologically significant problems have been encountered with the use of chlorination at levels recommended for CPSES. Because chlorination to a 0.5 ppm residual will be required to maintain projected operational levels, the requirement of a maximum of 0.1 ppm is considered unjustified and will impose a severe operating handicap upon the proposed Comanche Peak Steam Electric Station.

Attachment 2
April 8, 1974

COMANCHE PEAK STEAM ELECTRIC STATION
DOCKET NOS. 50-445 AND 50-446

INTAKE STRUCTURE DESIGN/WATER VELOCITIES

AEC Position:

"The Applicant shall redesign the circulating water intake and the service water intake to reduce the velocity at the trash racks and ahead of the screens to no more than 0.8 fps.' (Page v of DES)

Applicant Position:

Generating stations in the Applicants' system have operated for many years with circulating water intake velocities up to 1.3 fps. During this time, no significant adverse impingement/entrapment problems have been detected.

Actual fish losses due to impingement have been measured in the field by Texas Electric Service Company and have consistently been limited to only a few pounds on a monthly basis. When compared with the productivity of the cooling reservoirs as a closed ecosystem, this loss is not only insignificant, but is naturally compensated for with such rapidity as to be of unmeasurable impact.

An examination of three alternative intake structure designs, any of which would reduce velocities to 0.8 fps, reveal cost increases above the present proposed design of from nearly 1.0 to 1.5 million dollars. Therefore, such redesign of the structure to reduce velocities to this level would constitute a burden and expense totally out of proportion to any conceivable benefits.

Basis for Applicant's Position:

Steam electric stations based on cooling ponds in Texas have been circulating water through intake structures of varying sizes and designs for as long as 50 years. These reservoirs have maintained game fish populations as good or better than reservoirs of equivalent age which are not used for cooling.

The Morgan Creek Steam Electric Station located on Lake Colorado City is located in Mitchell County, Texas, 0.65 km southwest of Colorado City on Morgan Creek, a tributary of the Colorado River. The first two units at this station in the Applicant's system (22 mw each) went on line in 1950. The third (44 mw) in 1952, the fourth (70 mw) in 1954, the fifth (175 mw) in 1959 and the sixth unit (500 mw) in 1966 for a total of 833 mw. The lake has a capacity of 31,600 acre-feet and a maximum area of 1,637 acres. In 1970, the area was down to 981 ac, and because of the semi-arid climate is well below its maximum area most of the time.

Unit #6 takes in 240,000 gpm (533.33 cfs) circulating water through two bays each containing one ten-foot wide traveling screen and one pump of 120,000 gpm (266.67 cfs) capacity. The bottom of the intake structure is at 2034.5 ft. elevation. In 1971, the lake level was at a low reading of 2052.9, a level which was approaching the minimum for operation. At that elevation, the average screen approach velocity was calculated to be 1.37 fps. At the highest water level since 1968 (2063.35 ft. elevation), the calculated average screen approach velocity was 0.924 fps. Due to the fluid dynamics of water approaching the screens, velocities greater than the average occur at several places in front of the screens. Therefore, it is a valid assumption that screen approach velocities have been equal to or greater than 1.0 fps for the entire 6 years that Unit #6 has been on line. It is probable that much of the time these velocities have equaled or exceeded the predicted 1.20 fps screen approach velocity for water elevation 770' for the CPSES (Table 3.4-2, ER).

In the Radian Corporation report mentioned in Attachment 1, Sharp and Grubbs analyzed Texas Parks & Wildlife gilnetting data for 15 reservoirs, 5 of which have received heated effluents for as long as 23 years (Lake Colorado City), and compared thirteen parameters including total weight of game fish/100' net, average weight of game fish/100' net, number of game fish/100' net, and percentages by number and weight of game fish and bass.

Lake Colorado City ranked second in this study in weight of game fish per 100' net (2.4 times the average of the fourteen other reservoirs), second in number of bass per 100' net, first in weight of bass per 100' net, first in average weight of game fish, second in average weight of bass and first in percentage of game fish by weight.

The majority of estimates of intake structure impact on fish populations has been based primarily on theory. The Applicant has acquired actual data from known operating conditions and contends there is no observable damage to desirable fish populations caused by screen approach velocities within the range predicted for the CPSES in the design presented in the ER.

In addition to the questionable benefits of reducing the intake velocities to 0.8 fps, there is an incurred cost penalty associated with construction of an appropriately redesigned intake structure. The attached table illustrates three alternative design schemes which have been developed to achieve this criteria.

A detailed cost estimate for each of the three alternative schemes has been prepared and the incremental costs are summarized below:

Proposed Design:	Base
Alternate A:	$1,436,711
Alternate B:	$1,109,942
Alternate C:	$ 853,881

As can be readily seen, the incremental costs incurred represent a burden which can in no way be justified by any potential benefits due to reduction of fish losses already shown to be negligible. We are, therefore, strongly opposed to the imposition of such a design requirement which has no factual or practical basis.

COMPARISON OF ALTERNATE CIRCULATING WATER INTAKE STRUCTURE DESIGNS

Parameter	Proposed Design	Alternate A	Alternate B	Alternate C
Intake velocity, fps	1.50	0.8	0.8	0.8
Number of Screens	12	12	12	14
Screen Width, ft	10	10	12	12
Screen Height, ft	67	91	81	72
Pump House Width, ft	159	159	183	213
Floor Elevation	700	705	716	[illegible]

Attachment 3
April 8, 1974

COMANCHE PEAK STEAM ELECTRIC STATION
DOCKET NOS. 50-445 AND 50-446

COOLING TOWERS: WATER CONSUMPTION & COSTS

AEC Position:

"Although there is less induced evaporation from the reservoir than from cooling towers, the sum of natural and evaporative losses from the reservoir is greater than the losses from the cooling towers." (Page 9-16 of DES)

"The capital cost of the cooling tower installation for CPSES has been estimated by the staff to be about the same as that for the reservoir heat dissapation system." (Page 9-19 of DES)

Applicant Position:

Experience in the Applicant's service area has shown cooling ponds to offe significant water conservation advantages when compared to alternative forms of cooling, such as mechanical-draft wet towers. The consumptive water use, as presented in the DES, for the proposed Squaw Creek Reservoir appears to be excessive, while cooling tower water requirements appear unrealistically low. In addition, cost data for these alternative cooling schemes, as presented in the ER, refute any possibility that capital costs are comparable for the two methods. The following paragraphs will present the basis for the Applicant's position in full detail.

Basis for Applicant's Position:

Water Consumption

The AEC Staff has analyzed the consumptive use of cooling water for the CPSES utilizing the Squaw Creek Reservoir as proposed by TUSI, and Staff estimates appear to be in close agreement with estimates given in the ER. The Staff has also estimated cooling water consumption and makeup requirements for a wet forced-draft cooling tower installation as an alternative cooling system for CPSES and has concluded that ". . . the sum of natural and induced evaporative losses from the reservoir is greater than the losses from the cooling towers". In the same discussion (DES, p9-16) the Staff explicitly takes exception to the conclusion in the ER (ER, p.9.2-23) that the proposed reservoir system is most advantageous in terms of quantitative use of water.

Water resource management is one of the overriding concerns of the Applicant in selecting a power plant site and the selection of a cooling system for a particular plant, whether fossil fueled or nuclear. As described in the ER and documented in supporting studies and reports, the Applicant has determined that the proposed Squaw Creek Reservoir for CPSES will result in less consumptive use of water and a smaller makeup requirement from Lake Granbury, by a significant margin, compared with cooling tower systems.

Forced or induced evaporation losses are a major determinant of total water consumption in reservoir systems as well as cooling tower systems. The AEC Staff estimates of forced evaporation losses for Squaw Creek Reservoir are in close agreement with data reported in the ER and in supporting engineering studies. However, the AEC Staff estimates of forced and induced evaporation losses for cooling tower installation (as alternatives to the Squaw Creek Reservoir) are substantially lower than these losses as shown in the ER. The ER estimates are based upon a general planning factor relating induced evaporative loss to overall cooling water flow rate through the towers. The AEC Staff methodology used to estimate induced evaporation losses from cooling towers seeks explicitly to relate evaporation losses to monthly variation in circulating water flow rates and variations in temperature and humidity.

The general validity of the methodology is not questioned, but there is substantial concern that the methodology does not adequately reflect the specific climatic and meteorological conditions that prevail in the CPSES project area, particularly with respect to the relative importance of evaporative heat transfer or loss and sensible heat transfer. Because of the low relative humidity and high temperatures prevailing in the north central area of Texas, it is recognized that a very high proportion of heat transfer is accomplished by evaporative loss of cooling water. Moreover, it is the general experience of the applicant, that the forced evaporation losses estimated by the AEC Staff would be unrealistically low for a hypothetical cooling tower installation at the CPSES.

The Applicant has reviewed the AEC Staff estimates of total water consumption for the Squaw Creek Reservoir and the cooling tower alternatives (described in Section 9.2 of the ER) and finds that cooling reservoir water consumption estimates presented in the DES are substantially misleading. Without further questioning of the estimates of induced evaporation losses for cooling towers (as described in the paragraphs above), it is noted in Table 9.2.1 in the DES that total water consumption for the cooling tower installation would be 27,880 acre feet in a typical year (1971) compared with 29,410 acre feet for the cooling reservoir.

The estimates for natural evaporation loss appropriately take account of direct precipitation falling on the reservoir surface but this critical summary in Table 9.2.1 does not take account of local runoff feeding into the reservoir. The AEC Staff did indicate in an earlier section of the DES (Table 5.3.8) that such runoff should be included in estimating net makeup water requirements for the Squaw Creek Reservoir.

When DES Table 9.2.1 is appropriately revised to take account of local runoff (see attached table) the AEC Staff estimate of comparative water consumption in 1971 is as follows:

	Acre Feet Per Year
Squaw Creek Reservoir	21,370 (29,410)
Cooling Towers	27,880 (27,880)

Attachment 3
April 8, 1974

The figures in parentheses are the Staff estimates as given in the DES. As indicated, no modification has been made in the above comparison for the Staff estimates of cooling tower evaporation losses. The acre feet consumption estimates included in DES Table 9.2.1 are critical measures of merit as used in DES Table 9.2.3, which compares alternative heat dissipation systems for CPSES. The estimate for Squaw Creek Reservoir should be reversed downward from 29,410 to 21,370 acre feet. This will thus indicate a very significant lower water consumption advantage for the reservoir system for CPSES.

The above estimates of water consumption for Squaw Creek Reservoir and for cooling towers should not be interpreted as estimates of the total flow of water to be diverted from Lake Granbury. As noted by the AEC Staff (DES p. 9-17), a return of blowdown water to Lake Granbury in the amount of 55 cfs (39,818 acre feet per year) would be required to maintain TDS concentration in the circulating water at a maximum of 2400 ppm. The comparable figure for the reservoir would be 37 cfs or 26,787 acre feet per year. If a cooling tower system allowing a maximum TDS of 4800 ppm were adopted, about 11,945 acre feet of water per year would be blown down to an evaporative pond.

In the ER (Table 9.2-5) total water requirements for system alternatives are shown. This table (attached) has been revised utilizing 1971 data and evaporation estimates developed by AEC Staff (from DES Table 9.2.1). As shown in the revised ER table, total diversion from Lake Granbury would amount to 48,157 acre feet per year compared with 67,698 acre feet for the cooling tower alternative returning blowdown to Lake Granbury. This revised table is based upon the evaporation losses estimated by the AEC Staff and would favor the cooling reservoir even more giving somewhat higher cooling tower evaporation losses appropriate for the area as suggested by the applicant's experience. Even with these estimates of evaporation losses, however, the cooling reservoir appears highly advantageous with respect to water consumption as can be seen from the summary below (from ER Table 9.2-5, Revised):

	Acre Feet		
	Reservoir (TDS=2400)	Tower (TDS=2400)	Tower (TDS=4800)
Diversion from Granbury	48,157	67,698	39,825
Return to Granbury	26,787	39,818	0
Discharge to Pond	0	0	11,945
Net Consumptive Use	21,370	27,880	27,880
Net Makeup from Granbury	21,370	27,880	39,825

On the basis of the foregoing, it is the applicant's firm conclusion that the reservoir system affords a most significant advantage in lower water consumption and water resource management as compared with cooling tower alternatives for CPSES.

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ER TABLE 9.2-5

REVISED ON THE BASIS OF AEC STAFF ESTIMATES OF
INDUCED EVAPORATION LOSSES FOR SQUAW CREEK RESERVOIR AND COOLING TOWERS FOR TYPICAL YEAR
(ORIGINALLY ENTITLED WATER REQUIREMENTS FOR ALTERNATIVE COOLING SYSTEMS FOR CPSES)

	Estimated Quantities of Water (Acre-Feet Per Year)		
	I Cooling Pond Max TDS=2400	II Cooling Tower Max TDS=2400	III Cooling Tower Max TDS=4000
A. System Input			
1. Diversion from Lake Granbury	48,137	67,698	39,325
2. Runoff to Squaw Creek Reservoir	8,040[a]	0	0
3. Direct Precipitation	10,630[a]	0	0
4. Total Input	66,847	67,698	39,325
B. System Output			
1. Return to Lake Granbury	26,787[b]	39,818[c]	0
2. Discharge to Evaporation Pond	0	0	11,945[f]
3. Cross Natural Evaporation	17,750[c]	0	0
4. Forced Evaporation	22,310[d]	27,060[d]	27,060[d]
5. Drift Losses	0	820[e]	320[e]
6. Total Output	66,847	67,698	39,325
C. Consumptive Use			
1. Net Evaporation and Drift Losses	21,370[g]	27,880	27,880
2. Net Makeup Requirements from Lake Granbury	21,370	27,880	39,325

Notes:

a. DES Table 5.3.8
b. DES Section 9.2.1.3, cooling tower blowdown at 55cfs and reservoir blowdown at 37cfs
c. Net natural evaporation from DES Table 9.2.1 and direct precipitation from DES Table 5.3.8
d. Induced evaporation as estimated in DES Table 9.2.1
e. As estimated by AEC Staff (DES Table 9.2.1)
f. Assumes that allowing TDS concentration to increase to 4800 ppm would allow cooling tower blowdown to be no more than 30 percent of that required to hold TDS concentration to a maximum of 2400 ppm.
g. Natural and forced evaporation less local runoff and direct precipitation from DES Table 5.3.8

DES TABLE 9.2.1 REVISED TO TAKE ACCOUNT OF LOCAL RUNOFF

(ORIGINALLY ENTITLED: STAFF'S ESTIMATES OF WATER CONSUMPTION IN SQUAW CREEK RESERVOIR AND WET FORCED DRAFT COOLING TOWERS DURING THE YEAR 1971)

Month	Water Use (Acre-Ft.)						
	Squaw Creek Reservoir				Cooling Towers		
	Net Total Evaporation	Net Local Runoff[d]	Net Natural Evaporation[a]	Induced Evaporation[c]	Induced Evaporation[c]	Drift	Total
January	2,220	130	640	1,710	1,950	70	2,020
February	1,940	120	360	1,700	1,840	70	1,910
March	2,330	120	1,280	1,370	1,580	50	1,630
April	1,760	120	760	1,120	1,600	40	1,640
May	1,160	710	490	1,380	2,350	70	2,420
June	3,880	140	1,860	2,160	3,170	90	3,260
July	2,840	840	1,030	2,650	3,340	90	3,430
August	2,930	410	910	2,430	3,110	90	3,200
September	3,920	90	1,220	2,790	3,000	90	3,090
October	- 490	1,[illegible]00	-1,000[b]	2,310	2,260	70	2,330
November	1,300	[illegible]00	340	1,260	1,460	40	1,500
December	-2,620	3,160	- 790[b]	1,430	1,400	50	1,450
Total	21,370	8,040	7,100	22,310	27,060	820	27,880

[a]Total natural evaporation less direct rainfall from Freese, Nichols and Endress, Consulting Engineers, Engineering Report on Squaw Creek Reservoir, report prepared for Texas Utilities Services Inc., 1972 (as modified by AEC Staff in DES).

[b]Negatives values are where the rainfall exceeds direct evaporation.

[c]Estimates by AEC Staff per DES.

[d]In accordance with DES Table 5.3.8 and Engineering Report cited in footnote "a" above.

Cooling Tower Costs

The AEC Staff has concluded that the capital cost of a cooling tower installation for CPSES would "be about the same" as the capital cost of the reservoir heat dissipation option adopted by the Applicant.

In the ER, the Applicant has presented the results of an analysis and comparison of the costs and operating characteristics of a reservoir versus cooling tower cooling system for CPSES. As developed in Section 9.2.3.4 of the Environmental Report, it was found that the capital cost of a cooling tower system for CPSES would be approximately $10 million to $12 million more than the proposed Squaw Creek Reservoir system, depending upon the means selected for disposal of cooling tower blowdown.

In analyzing possible configurations of a cooling tower system for CPSES, the Applicant directed attention to the basic alternatives. The first alternative assumed that cooling tower blowdown water is returned to Lake Granbury (the source of makeup water) and the second alternative assumed that cooling tower blowdown is disposed of in an evaporation pond. The first alternative allows total dissolved solids (TDS) in blowdown water to reach 2400 ppm (about twice the typical concentration of makeup water). The second allows TDS concentration in blowdown water to reach 4800 ppm. Design features and conditions associated with these two cooling tower system concepts are summarized and compared with the CPSES reservoir system in ER Table 9.2-4 (attached).

There are significant differences in the capital costs of these three alternatives: I (cooling reservoir); II (cooling tower with 2400 ppm blowdown to Lake Granbury); and III (cooling tower with 4800 ppm blowdown to evaporation pond). The capital costs of each of these alternative cooling water systems are compared in ER Table 9.2-6 (attached) and summarized below:

	Total Estimated Cost
Cooling reservoir system (I)	$ 20.6 million
Cooling tower system (II)	30.6 million
Cooling tower system (III)	32.8 million

These capital cost estimates include provision for all cooling system and related elements sensitive to the basic design concept of the system.

The cost of all land and easements for CPSES with the Squaw Creek Reservoir is estimated at $5.5 million, while land for the station with a cooling tower installation (returning blowdown to Lake Granbury) would be no more than $2.5 million. The land for the plant with a cooling tower system with a 1500 to 2500 acre evaporation pond would be about $5.0 million (almost as much as for system with Squaw Creek Reservoir) because a large, relatively level site for the evaporation pond would be required. Such land would be substantially more costly than the average cost of land for the entire CPSES property.

The cost of reservoir site preparation, dam construction, diversion and return pipelines, and safe shutdown impoundment totals an estimated $15.0 million for the cooling reservoir system:

	Millions
Reservoir site preparation	$ 0.8
Dam and spillway (including SSI)	10.0
Diversion pipeline	2.0
Return pipeline	1.2
Pipeline relocations	0.5
Other (including pump stations)	0.5
TOTAL	$ 15.0

This element of cost would be substantially reduced with either of the cooling tower systems as indicated below.

	Millions	
	Cooling Tower II (2400 TDS)	Cooling Tower III (4800 TDS)
Diversion & return pipelines & pump station	$ 4.5	$ 2.5
Safe shutdown impoundment	1.0	1.0
Evaporation pond	-	1.6
TOTALS	$ 5.5	$ 5.1

The cost of the cooling towers and directly related costs are major elements of cost which for the CPSES has been estimated at $22.5 million. This is in addition to costs of land, pipelines and pump station, SSI and the evaporation pond indicated above. A general breakdown of this estimate includes:

	Millions
Pump house	$ 3.0?
Concrete tunnels	8.26
Cooling tower foundations	2.18
Cooling towers (including erection)	6.50
Electrical work	1.20
All other (crossovers, etc.)	1.35
TOTAL	$ 22.49

It is expected that a cooling tower system with TDS concentration as high as 4800 ppm would require additional circulating water treatment equipment compared with other alternatives. However, the difference would be insignificant as indicated in the summary of alternative system costs below.

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TABLE 9.2-4

DESIGN CONDITIONS FOR COMPARISON OF RESERVOIR VERSUS COOLING TOWERS
(Alternatives I-III)

	I Cooling Reservoir* (C=2)	II Cooling Tower (C=2)	III Cooling Tower (C=4)
General Plant			
Plant Capacity(MWe)	2,300	2,300	2,300
Average annual load factor(%)	70	70	70
Design atmospheric conditions	---	Temperature:	wet bulb = 76 dry bulb = 110
Assumed site location	Squaw Creek	Squaw Creek	Squaw Creek
Assumed cooling water source	Lake Granbury	Lake Granbury	Lake Granbury
Condenser			
Circulating water design pump capacity(gpm)	2,200,000	1,690,000	1,690,000
Condenser inlet temperature	95	90	90
Condenser discharge temperature	110	105	105
Condenser back pressure (in Hg.abs.)	3.5	3.5	3.5
Cooling Reservoir and Tower			
Size of cooling reservoir(acres)	3,228	x**	x
Size of cooling tower(LxWxH in feet)	x	360x75x60	360x75x60
Number of cooling towers	x	8	8
Additional circulating pump power required (KW)	x	16,500	16,500
Size of evaporative pond (acres)	x	x	1,500-2,500
Blowdown System			
Volume of blowdown (acre-ft/yr)	26,400	26,340	13,820
Destination of blowdown	Lake Granbury	Lake Granbury	Evaporative Pond
Quality of blowdown:			
TDS (ppm)	2,400	2,400	4,800
Temperature (°F)	Variable	90	90

* CPSES and SCR utilized as base-line system in Alternative I.
** "X" indicates that the feature or values does not apply to particular alternative.

1/21/74 Amendment 2

Amendment 3
April 8, 1974

	Capital Costs (millions)		
	Cooling Reservoir I (2400 TDS)	Cooling Tower II (2400 TDS)	Cooling Tower III (4800 TDS)
Land	$ 5.5	$ 2.5	$ 5.0
Reservoir, dam, pipelines, SSI evaporation pond	15.0	5.5	5.1
Water treatment equipment	.13	.13	.20
Cooling towers (and directly related costs)	0	22.5	22.5
TOTALS	$ 20.63	$ 30.63	$ 32.82

The difference in capital cost of the cooling tower systems and the Squaw Creek Reservoir system, as estimated in the foregoing, is significant. These estimates take into account the Applicant's particular local situation with respect to land costs and site suitability for dam construction and reservoir development. In another part of the country the local situation with respect to land costs, costs and difficulties of dam construction, and other local and regional features might well cause the comparative capital cost advantage of reservoir versus cooling tower systems to be reversed. However, in the Applicant's situation the comparative capital cost advantages of a reservoir cooling system for the CPSES is clear.

In addition to the lower capital cost, the reservoir offers economic advantages in lower maintenance costs and in less internal use of power for operation of the power plant, as compared with cooling tower systems. In Table 9.2-7 from the ER (table attached), it is shown that total operating and maintenance costs are estimated to be about three percent higher for cooling tower systems. This takes into account greater requirements of cooling tower systems for routine maintenance, periodic heavy maintenance, water treatment and consumable supplies as compared with the reservoir system. The permanent operating force for CPSES with a cooling tower installation would thus be significantly larger than projected for CPSES with the cooling reservoir system.

Other factors, such as water resource management, were also significant in the Applicant's selection of the cooling reservoir system over cooling tower systems for CPSES, but it is clear that the cooling reservoir system affords substantial advantages both in lower capital costs and operating costs as well as in lower maintenance requirements and higher overall plant reliability. Thus the cooling reservoir system was selected by the Applicant for incorporation in plans for construction of CPSES.

TABLE 9.2-6

COOLING SYSTEM DIFFERENTIAL COST FACTORS*
(Investment Cost in Millions of Dollars)

	I Cooling Reservoir (2400 TDS)	II Cooling Tower (2400 TDS)	III Cooling Tower (4800 TDS)
Land and Easements, Total			
Site and Rights-of-Way**	$ 5.5	$ 2.5	$ 5.0
Reservoir			
Site preparation	15.0	x***	x
Reservoir and dam		x	x
Diversion pipeline and pump station		4.5	2.5
Return pipeline and pump station			x
Safe shutdown impoundment		1.0	1.0
Cooling Tower			
Cooling tower construction, equipments, and installation	x	22.5	22.5
Evaporative pond	x	x	1.62
Water Treatment Equipment			
Circulating water system	0.13	0.13	0.20
Total	$20.63	$30.63	$32.82

* Includes all major elements of investment cost that are sensitive to cooling system design concept.
** Includes allowance for all rights-of-way as well as land for plant, reservoir, and cooling pond, as appropriate.
*** "X" indicates that the feature does not apply to the particular alternative.

TABLE 9.2-7

TOTAL POWER GENERATING COST
COMPARISON OF COOLING RESERVOIR AND
COOLING TOWER STEAM ELECTRIC STATIONS

	millions of dollars		
	Cooling Reservoir Plant	Cooling Tower Plant (TDS-2400)	Cooling Tower Plant (TDS-4800)
1. Capital Costs (1980 dollars)	$ 765.98	$ 775.98	$ 778.17
2. Operating Costs (1973 dollars)	34.41	35.44	35.57
3. Power Generating Costs (total 30-year costs discounted to 1980)			
Investment	765.98	775.98	778.17
Operating Cost (1980-20H)	581.83	599.28	6[illegible]1.47
Total (1880 value)	$1,347.81	$1,375.26	$1,3[illegible].64
Annualized Costs	$ 141.48	$ 1[illegible]4.36	$ 144.82
4. Annual Power Output (million kwh)			
Penalty in internal use	base	101	101
Net available for distribution	14,104	14,002	14,002
5. Average Cost per Kilowatt Hour Available for Distribution			
Annualized Cost (mils per kwh)	10.03	10.31	10.34

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Attachment 4
April 8, 1974

COMANCHE PEAK STEAM ELECTRIC STATION
DOCKET NOS. 50-445 AND 50-446

SCHEDULING OF CONSTRUCTION ACTIVITIES

AEC Position:

"If preconstruction surveys indicate that spawning does occur in.... (Lake Granbury and lower Squaw Creek)...adverse impacts would be reduced if construction activities were minimized during the spring and summer months." (Page 4-26 of DES)

Applicant Position:

The temporary construction activities to be scheduled on Lake Granbury for the CPSES makeup water diversion and discharge facilities will be limited to such a miniscule portion of the shoreline that the impact on the overall aquatic resources of the lake will be insignificant. In the case of both lower Squaw Creek and Lake Granbury, field surveys and accumulated biological data have shown that spawning activities in these waters is virtually continuous, with such cycles overlapping amoung the various species of aquatic life. There is essentially no point in time when spawing for some species is not taking place.

In view of the crucial requirement for the CPSES facility to be placed in operation on schedule, any restrictions which would result in our construction schedules being impacted by this type of criteria are considered to be completely unjustified and would pose a severe hardship upon the timely implementation of the CPSES project. We further feel a restriction of this type is unwarranted from an environmental impact standpoint.

Attachment 5
April 8, 1974

COMANCHE PEAK STEAM ELECTRIC STATION
DOCKET NOS. 50-445 AND 50-446

UPDATED LAND USE DATA

There are a number of minor discrepancies in the land use acreage estimates given in the DES as compared with the data in the Applicant's Environmental Report as shown in Amendments 2 and 3 (in progress). Revisions in acreages are for the most part the result of additional and more detailed land use classification studies made by the Applicant in response to AEC questions or requests for additional information.

In the DES the AEC has made use of ER Fig. 3.9-1 and Fig. 4.0-1 (DES Figures 3.8.1 and 3.8.2). These two figures have been redrawn to update, correct certain inaccuracies, and better protray the location of CPSES facilities and the general alignments of rights-of-way. In addition, ER Figures 3.9-2 and 3.9-3 which show in more detail transmission line alignments in the areas of Comanche Peak SES and DeCordova SES, have been updated. These four corrected figures are being resubmitted in Amendment 3 to the ER and are provided at this time for inclusion in the FES, as appropriate.

Total land requirements for various CPSES facilities and installations are summarized in DES Table 5.1.1 As indicated, there are certain minor inaccuracies in earlier ER data and this table. Table 4.3-1 of the ER (as part of Amendment 3) is included here as an updating or correction to the DES Table 5.1.1, referred to above. It should also be noted that CPSES property is shown to include 8876 acres (excluding off-site rights-of-way). Property acquisition is not fully complete and the final property take line (in one portion of the site) might vary somewhat. However, the total acreage of the CPSES property when all acquisition is complete should not vary more than a very few hundred acres from the present 8876 estimated total.

After initial submission and docketing of the Applicant's ER, the AEC requested additional detailed information on present land use in the reservoir and along the transmission line right-of-way. Table 3.9-2 in the ER has been revised substantially in Amendment 3. This ER table is included here as an updating and correction or replacement for DES Table 4.3.2 and Table 4.3.3. A particular point to be noted is that a 230-foot wide transmission line right-of-way is specified for the parallel 345 kV (double circuit) and 138 KV (single circuit) lines for the entire 14.21 mile distance from CPSES to DeCordova SES. In the area of DeCordova SES (from Benbrook Junction across Lake Granbury into the DeCordova Switchyard), several other lines parallel the CPSES lines, but the right-of-way acreage for these lines has now been excluded from the CPSES transmission line right-of-way acreage.

Amendment 3 of the Applicant's ER will provide detailed estimates of land required by transmission line towers and losses in agricultural productivity attributable to transmission lines (see ER Tables 4.2-1, 4.2-2, and 4.2-3). Amendment 3 also contains a breakdown of present land use and estimates of loss in agricultural production for land required for Squaw Creek Reservoir and for the 390-acre plant site (see ER Tables 4.3-2, 4.3-3, and 4.3-4 in ER Amendment 3).

Attachment 5
April 8, 1974

ER TABLE 4.3-1

DISTRIBUTION OF LAND USE RESULTING FROM CONSTRUCTION OF CPSES

Within CPSES Property (8.876 acres)	Acres
Plant site	390
Squaw Creek Reservoir (at 775 feet above MSL)	3,228
Dam and spillway	60
Transmission lines (excluding 22 acres within plant site)	186
Rail spur (excluding 12 acres within plant site)	13
Access road (excluding 8 acres within plant site)	6
Makeup pipeline (negligible)	–
Blowdown pipeline	7
Subtotal	3,890
Additional Off-Site Land Required for Rights-of-Way (ROW)	
Transmission lines	217
Rail spur	160
Access road	5
Makeup pipeline (excluding 7 acres within transmission ROW)	8
Blowdown pipeline (excluding 6 acres within transmission ROW)	12
Subtotal	402
Recap	
Total acreage directly impacted or occupied by CPSES project facilities	4,292
Additional but unutilized acreage within CPSES property	4,986
Total acreage committed to project	9,278

ER TABLE 3.9-2

SUMMARY LAND USE CLASSIFICATION OF CPSES TRANSMISSION LINE RIGHTS-OF-WAY

Type of Land Use	CPSES-DeCordova 345 KV & 138 KV		CPSES-Weatherford 345 KV		CPSES-Venus 345 KV		Total
	Acres	%	Acres	%	Acres	%	
Cultivated Land	76.0	19	1.6	10	0	–	77.6
Improved Pasture	23.4	6	0	–	0	–	23.4
Cleared Grazing Land	190.4	48	11.3	72	7.9	59	209.6
Woodland*	53.7	14	2.7	18	5.5	41	61.9
Other**	52.8	13	0	–	0	–	52.8
Total	396.3	100	15.6	100	13.4	100	425.3

ACREAGE OF TRANSMISSION LINE CORRIDORS INSIDE AND OUTSIDE OF CPSES PROPERTY, BY LAND USE

Type of Land Use	ROW Inside CPSES Property***	ROW Outside CPSES Property	Total
Cultivated Land	22.4	55.2	77.6
Improved Pasture	0	23.4	23.4
Cleared Grazing Land	155.4	54.1	209.5
Woodland	28.3	33.7	62.0
Other	2.1	50.7	52.8
Total	208.2	217.1	425.3

Note: CPSES-DeCordova lines require a 14.21 mile, 230-foot wide ROW. 345 KV line is double circuit, 138 KV line is single circuit.

CPSES connection to Weatherford-Parker line is 0.80 miles in length with 170-foot wide ROW for 2400 feet and 150-foot ROW for remainder.

CPSES connection to Venus line is 0.74 miles in length with 150-foot wide ROW for entire distance.

---

* Includes limited grazing use.

** Includes riparian vegetation, rivers, roads, and industrial land (no agricultural use).

*** Includes all of CPSES-Weatherford and CPSES-Venus line ROWs.

Amendment 3

C-209

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington, D.C. 20230

April 10, 1974

Mr. Daniel R. Muller
Assistant Director for Environmental
Projects
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dockets: 50-445 and 50446

Dear Mr. Muller:

The draft environmental impact statement for Comanche Peak Steam Electric Station, Units 1 and 2, for the Texas Utilities Generating Company, which accompanied your letter of February 15, 1974, has been reviewed and the following comments are offered for your consideration.

We have concluded that long-term storage of radioactive gaseous wastes is possible but not over the life of the plant without periodic discharges to the atmosphere. The frequency and duration of these discharges is not specified. With eight separate tanks available for storage and assuming, a 90-day holdup of the gases in any tank, releases could be scheduled every two weeks if the release duration was short (1 hour). This would amount to about 26 hours of release during the year. Consequently, the use of average annual relative diffusion rates (chi/Q) is inappropriate for the cloud inhalation dose path-way (table 5.4.2).

Thank you for giving us an opportunity to provide these comments, which we hope will be of assistance to you. We would appreciate receiving a copy of the final statement.

Sincerely,

Sidney R. Galler
Sidney R. Galler
Deputy Assistant Secretary for
Environmental Affairs

50-445
50-446

DOLPH BRISCOE
GOVERNOR

OFFICE OF THE GOVERNOR
DIVISION OF PLANNING COORDINATION

JAMES H. ROSE
DIRECTOR

April 11, 1974

Mr. John O'Leary
Director of Licensing
United States Atomic Energy Commission
Washington, D. C. 20540

Dear Mr. O'Leary:

The Draft Environmental Statement (DES) related to the proposed Comanche Peak Steam Electric Station, submitted by the Directorate of Licensing, United States Atomic Energy Commission, has been reviewed by the Governor's Division of Planning Coordination and by other interested State agencies.

Review participants have submitted the following comments which warrant your consideration:

1. It was noted by the Bureau of Economic Geology that the numerous fractures in the Glen Rose limestone within the project area may pose leakage problems in the Squaw Creek Reservoir.

2. The Texas Department of Agriculture indicated that the meteorology section of the DES does not contain data on thermal gradients, updrafts, inversions and other factors necessary to predict the deposition rate of particulate and gaseous effluents released by the station.

3. The Texas Highway Department recommended that the wording of certain paragraphs in the DES pertaining to the railroad spur and to the return water pipeline (pp. 3-47, 3-48) be amended in order to conform with Department permit requirements; the changes could be reflected in the Final Environmental Statement.

4. It was recommended by the Texas Water Rights Commission that the measurement and monitoring costs be included in the Cost-Benefit Balance section. A question was also raised concerning

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P. O. BOX 12428, CAPITOL STATION, AUSTIN, TEXAS 78711
Phone 512/475-2427 Offices Located in Sam Houston State Office Building

the increases in total dissolved solids (p. 1-17), and whether this increase was an annual cumulative increase or total increase over the life of the project.

5. The Texas Historical Commission recommended that the total project area be subjected to an intensive archeological survey, and that proper mitigation measures be implemented, so as to insure the protection or preservation of significant cultural resources.

6. The Texas State Department of Health suggested that the proposed baseline and operational radiological monitoring programs be expanded to include all ground water supplies which potentially could be influenced by waters from the proposed Squaw Creek Reservoir.

7. It was recommended by the Texas Parks and Wildlife Department that vegetation in the cove and upper lake areas of the proposed reservoir be left standing, thereby enhancing the fish spawning areas.

Since extensive effort has been made in the preparation of the enclosed comments, we recommend that they be reviewed in their entirety. If we may be of further assistance, please let us know.

Sincerely,

JAMES M. ROSE
Director

JMR/wsb
Enclosures
cc: Dr. W. L. Fisher, Bureau of Economic Geology
Hon. John C. White, Texas Department of Agriculture
Mr. B. L. DeBerry, Texas Highway Department
Mr. A. E. Richardson, Texas Water Rights Commission
Mr. Hugh C. Yantis, Jr., Texas Water Quality Board
Mr. Truett Latimer, Texas Historical Commission
Mr. G. R. Herzik, Jr., Texas State Department of Health
Mr. James H. Harwell, Texas Industrial Commission
Mr. Clayton Garrison, Texas Parks and Wildlife Department

THE UNIVERSITY OF TEXAS AT AUSTIN
BUREAU OF ECONOMIC GEOLOGY
AUSTIN, TEXAS 78712
March 25, 1974

University Station, Box X
Phone 512—471-1534

Mr. Wayne N. Brown, Chief
State Planning and Development
P. O. Box 12428, Capitol Station
Austin, Texas 78711

Dear Mr. Brown:

The staff of the Bureau of Economic Geology has reviewed the draft environmental statement for the Comanche Peak Electric Station (Somervell County). We offer the following comments:

Most technical data regarding hydrology and geology are not presented in the environmental statement but are contained in a separate environmental report to the Atomic Energy Commission. As the Bureau of Economic Geology did not receive this report, we cannot address ourselves to many salient points of this draft statement.

In general we can say that the geologic substrate is structurally stable and is in a zone of extremely low seismic risk. However, the statements that: "the Glen Rose limestones are essentially impermeable" (p.2-19) and "frequent fractures ... are notably absent" (p.2-20) are incorrect. There are numerous fractures in the Glen Rose limestone in Somervell County and nearby areas. The presence of such fractures might pose leakage problems from the Squaw Creek Reservoir.

Best regards.

Sincerely,

Charles M. Woodruff, Jr.
Research Scientist

CMW:dv

C-211

EDMUND L. NICHOLS
Assistant Commissioner

March 26, 1974

Mr. Wayne N. Brown, Chief
State Planning and Development
P.O. Box 12428, Capitol Station
Austin, Texas 78711

Dear Mr. Brown:

We have received the AEC Draft Environmental Statement for the Comanche Peak Electric Station as conveyed with your memorandum of March 7, 1974. The Department of Agriculture comments are contained in this letter.

The population projections given in Table 2.2.2 appear to follow neither natural trends nor established trends for rural areas. The rapid growth projected for the rural sectors as compared to that projected for suburban areas needs explanation. Also the relatively rapid growth shown for the next decade followed by a drop in growth rate merits elaboration.

The description of the site does not contain any discussion of the milk shed characteristics. This should be examined as the milk shed can play a significant role in the food chain to man; e.g.; both the iodine and trituim sequences from release to foliage and water to cows to milk to man are well known. Ordinarily for radionuclides in quantities released by power reactors the concentrations ingested by man are innocuous nonetheless. This chain needs to be examined for each reactor to determine whether there is something unusual in this specific milk shed chain that might lead to abnormal concentrations.

The descriptions of the aquatic ecosystems, particularly in the impounded waters, are all in terms of the prevailing water temperatures. These temperatures are bound to change as the water bodies are used as heat sinks so the aquatic ecosystem analyses must consider effects of changes in temperature.

The site meteorology section does not contain data on vertical thermal gradients, up-drafts, inversions and other factors necessary to predict the deposition rate of particulate and gaseous effluents released by the station. Assessments of the impacts of such releases can not be made without reasonable estimates of where, when and in what quantities the effluents will be deposited into the terrestrial and aquatic ecosystems.

Texas Department of Agriculture, John C. White, Commissioner, P.O. Box 12847, Austin, Texas 78711

The section discussing the station describes a specific plan for water cooling. This plan calls for use of an existing body of water, Lake Granbury, and impounding Squaw Creek to form a new reservoir. The total water loss from evaporation is expected to be in the range of 100,000 acre feet per year. This is a lot of water and in Texas, water is a precious commodity. It would be nice to see some comparative evaluations of alternative systems which might result in less water loss. Impoundment systems that are deeper but with smaller surface areas might help. Returning the water to reservoirs at higher temperatures might reduce vaporization losses; however, this would interact with the nature and value of the aquatic ecosystems. Trade-off analyses of the above and other concepts should be made to assure the water isn't lost for spurious or insufficient reasons.

The radioactive waste section does not discuss the possible entry of radionuclides into food chain or ingestion systems. Further some nuclides such as tritium aren't mentioned at all. As stated above these may turn out to be acceptable concentrations; however, that conclusion should be supported by analyses of data rather than by generalizations and assumptions.

The section discussing impacts on local institutions is very weak. The section essentially only identifies some of the critical interfaces and concludes that the applicant has "shown the capability of insuring that local jurisdictions receive the financial aid in sufficient time to provide the services..." More specificity as to the nature of the required services and extent of financial aid would be reassuring. Particularly critical item such as medical facilities, hospitals and the like are hardly mentioned. These should be planned in some detail.

Chapter 5 on the Environmental Effects of Operation of The Station and Transmission Facilities does little to overcome the defects pointed out above. For example, no alternative approaches to cooling which might consume less water are considered. The pathways for radionuclides through food chains to man are vague and general relying on experience elsewhere which may or may not be pertinent to the Comanche Peak situation. Finally the impact on land use is evaluated solely in terms of todays situation. Agricultural growth and advances might radically change the land and water value situation. It is urged that further analysis of the possible effects be made.

As in the preceding section the discussion of impacts on people and local institutions is so general as to be almost meaningless and fails to consider several important items such as medical facilities and other health related services.

Section 6 on Environmental Measurements and Monitoring Programs and Section 7 on Environmental Effects of Accidents appear to be adequate.

The Department of Agriculture concurs with the conclusion of Section 8 that the need for the generating capacity is growing and that initiation of construction of a generating plant is warranted.

The cost/benefit analysis of Section 9 is clearly very superficial. The assessment of the lignite resource, for example, is much more restrictive than that of recent studies by the Bureau of Economic Geology of the University of Texas at Austin. Further, only current technology for recovering and using the lignites are considered. New mining methods and the in situ gasification technology could radically change the cost/benefit analysis of the fuel resource. The selection of the PWR reactor type appears to be arbitrary and is not justified in this statement. Other reactor types such as the HTGR are widely considered to be more efficient, safer and with modest modification have the potential to use the more abundant thorium fuel, thus conserving our limited uranium supplies. The whole cost/benefit analysis should be enlarged to consider the factors cited above and perhaps others not identified here.

Judgement on Section 10, Conclusions, can not be made until the deficiencies and omissions cited for the preceding sections have been overcome.

Thank you for providing us this opportunity to comment.

Sincerely,

Edmund L. Nichols

ELN/yv

COMMISSION

REAGAN HOUSTON, CHAIRMAN
DEWITT C. GREER
CHARLES E. SIMONS

TEXAS HIGHWAY DEPARTMENT
11TH AND BRAZOS
AUSTIN, TEXAS 78701

STATE HIGHWAY ENGINEER
B. L. DEBERRY

March 22, 1974

IN REPLY REFER TO
FILE NO. D-5

SUBJECT: Draft Environmental Statement,
Comanche Peak Steam Electric Station,
Hood and Somervell Counties

Mr. Wayne N. Brown, Chief
State Planning and Development
Division of Planning Coordination
Office of the Governor
P. O. Box 12428, Capitol Station
Austin, Texas 78711

Dear Sir:

In response to your memorandum of March 7, 1974, we have reviewed the draft environmental statement for the proposed Comanche Peak Steam Electric Station and Squaw Creek Reservoir which are to be constructed by Texas Utilities Generating Company in portions of Hood and Somervell Counties. Negotiations are presently under way with the sponsors of the project for the reconstruction of farm to market roads in the area, and in anticipation of the successful completion of these negotiations, our comments concerning the statement will be limited to the following:

1. At the end of the first paragraph of Section 3.9.1 Railroad spur, page 3-47, add the following statement: "Authority to cross Farm to Market Road 51 must be obtained from the Texas Highway Department." At the end of the second paragraph, add the following: "---and the crossing on Farm to Market Road 51 must conform to the requirements of the Texas Highway Department."

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2. At the end of the second paragraph of Section 3.9.3.2 Return water pipe-line, page 3-48, add the following statement: "Placement of the lines under State Highway 144 will require a permit from the Texas Highway Department."

Please accept our gratitude for the opportunity of reviewing the referenced statement.

Sincerely yours

B. L. DeBerry
State Highway Engineer

By: Marcus L. Yancey, Jr.

Marcus L. Yancey, Jr.
Assistant State Highway Engineer

TEXAS WATER RIGHTS COMMISSION

SAM HOUSTON STATE OFFICE BUILDING

March 28, 1974

Mr. James M. Rose, Director
Governor's Division of Planning
Coordination
P. O. Box 12428, Capitol Station
Austin, Texas 78711

Attention: Mr. Wayne N. Brown, Chief
State Planning and Development

Re: "Draft Environmental Statement by the Directorate of Licensing, United States Atomic Energy Commission, related to the proposed Comanche Peak Steam Electric Station, Units 1 and 2, Texas Utilities Generating Company, Docket Nos. 50-445 and 50-446." Issued: February 1974.

Dear Mr. Rose:

In reply to the request in your Memorandum of March 7, 1974, the staff of the Texas Water Rights Commission has reviewed the referenced Draft Environmental Statement (DES).

The staff finds that:

1. The referenced document appears to comply with the comprehensive requirements contained in the United States Atomic Energy Commission (USAEC) Regulatory Guides 4.2, 1.59, and 1.70.1. However, due to the special weight that the staff gives to the requirements, contained in Section 6 of the USAEC Regulatory Guide 4.2, pertaining to environmental measurement and monitoring programs, it is believed that the measurement and monitoring programs costs should be recognized in the cost-data analysis contained in Section 10.4.2, pages 10-16 through 10-18 of the DES; and also, the cost data contained in Table C-2.

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Appendix C, page C-4 of the DES. The staff appreciates the possibility of numerous unknown effects, and the necessity of proper and continuous monitoring and surveillance of the project region both before and after construction. These programs will entail advanced instrumentation technology involving substantial costs. This is recognized in Section 6.1 of the USAEC Regulatory Guide 4.2, which states in part:

> ". . . .
> Sampling design, frequency, methodology . . .and instrumentation for both collection and analysis should be discussed as applicable. Information should be provided on instrument accuracy, sensitivity and, especially the highly automated systems, reliability. Where standard analytical or other techniques are used, they need only be identified and referenced."

The comprehensive monitoring and surveillance programs described above would appear to be essential in order to comply with the special limitation to be contained in the USAEC construction permit, as described in paragraph 7g, page vi, of the DES.

2. The document would be enhanced if more detailed clarification were given to the statement made in the second subparagraph of Section 10.4.2.4, page 10-17 of the DES, regarding the long-range effects of the increase in total dissolved solids in Lake Granbury and in the Brazos River downstream of the Lake, insofar as its impact on downstream water users is concerned. Specifically, clarification should be given whether the 2-1/2 percent increase in total dissolved solids concentration is the total increase over the 30-year life of the project, or whether it is the annual cumulative increase.

The foregoing comments are presented with constructive intent of enhancing the design of facility and the operational plan thereof.

If you have any questions on the foregoing comments, please call Dr. Alfred J. D'Arezzo, Environmental Sciences Analyst, Texas Water Rights Commission, telephone 512-475-2678.

Sincerely yours,

A. E. Richardson

AER-AJD:ll

TEXAS WATER QUALITY BOARD

[illegible]
[illegible]
AUSTIN, TEXAS

March 27, 1974

RE: Draft Environmental Statement,
Texas Utilities Generating Co.
(Comanche Peak Electric Sta.
Units 1 and 2)

Mr. James M. Rose, Director
Division of Planning Coordination
Office of the Governor
P. O. Box 12428, Capitol Station
Austin, Texas 78711

Dear Mr. Rose:

The staff of the Texas Water Quality Board has reviewed the draft environmental statement for the Comanche Peak Electric Station, units 1 and 2, referenced above, and offer the following comments.

The Texas Electric Generating Company submitted an application on September 13, 1973 for permission to discharge effluent to Lake Granbury from an off-stream company-owned cooling reservoir impounded on Squaw Creek. The proposed effluent is compatible with the stream standards established by the Texas Water Quality Board. This, in combination with a favorable Hearing Examiner's Report relative to a Public Hearing held in Waco on January 31, 1974, resulted in staff recommendation for approval. The Board approved the permit in regular meeting on the 26th of February, 1974 and authorized the Executive Director to issue a letter to the Atomic Energy Commission certifying that the applicant had been authorized to discharge into state waters within specified volumes and pollutant limitations.

The commitments by the applicant to specific measures and controls to limit adverse effects during construction have been noted and the measures pertaining to water quality or water pollution control will be monitored for adherance by this agency.

We appreciate the opportunity to review and comment on this environmental statement. If we may be of further assistance, please let us know.

Very truly yours,

Emory G. Long

Emory G. Long, Director
Administrative Operations Division

C-216

Texas Historical Commission
Box 12276, Capitol Station
Austin, Texas 78711
Truett Latimer
Executive Director

March 29, 1974

Mr. Wayne N. Brown, Chief
State Planning and Development
Office of the Governor
Division of Planning Coordination
P.O. Box 12428, Capitol Station
Austin, Texas 78711

RE: Draft Environmental Statement: Texas Utilities Generating Company
(Comanche Peak Electric Station, Units 1 and 2)

Dear Mr. Brown:

In response to your request for review and comment on the above-referenced D.E.S., we have examined our records and offer the following comments:

1. The total project area (physical plant, cooling measures) and especially, the related facilities have not been subjected to an intensive archeological survey to locate, record, appraise, and identify the nature and importance of the cultural resource.

2. Measures for dealing with the mitigation of the loss of these resources cannot be formalized or completed until the survey mentioned above has been conducted.

3. The statement that mentions that the project will have "no impact of serious consequence" is based on incomplete data and is inadequate.

In sum, the project has not been subjected to measures necessary to assess impact. For this reason, we make the following recommendations:

1. Subject the total project area to an intensive archeological survey.

2. Sites which fulfill criteria for inclusion within the National Register of Historic Places be submitted, with the concurrence of the State Board of Review and the recommendation by the State Historic Preservation Officer, to the National Register.

3. Recommendations for ameliorating the loss of significant resources be followed, through testing, conservation, and stabilization or protection from the standpoint of preserving the resource for future generations and from the standpoint of accessibility for present and future scientific investigations.

4. Until these measures are undertaken, and the loss of significant cultural resources is mitigated, it will be most difficult to review the project for adequacy concerning the treatment of cultural resources. A permit for construction of the facility should not be granted by the A.E.C. until this matter is resolved.

Thank you for the opportunity to comment on this D.E.S. If we may be of further assistance, please advise.

Sincerely,

Truett Latimer
Executive Director

By

Alton K. Briggs
Archeologist

AKB:pc

C-217

Texas State Department of Health

JAMES E. PEAVY, M.D., M.P.H.
COMMISSIONER OF HEALTH

FRATIS L. DUFF, M.D., Dr.P.H.
DEPUTY COMMISSIONER

AUSTIN, TEXAS

March 25, 1974

Honorable Dolph Briscoe
Governor of Texas
State Capitol
Austin, Texas

ATTENTION: Mr. James M. Rose, Director
Division of Planning Coordination

Dear Governor Briscoe:

The Division of Occupational Health and Radiation Control has reviewed the "Draft Environmental Statement by the Directorate of Licensing, USAEC related to the proposed Comanche Peak Steam Electric Station Units 1 and 2, Texas Utilities Generating Company Docket Nos. 50-445 and 50-446" and the applicant's Environmental Report. We find that construction and operation of the plant as planned will not be inimical to the health and safety of the citizens of Texas.

In our review we noted that the AEC's and the applicant's estimates of releases of radioactivity differed, the most noticeable being the releases from the Boron Recycle System (BRS) and Drain Channel A (DCA). The applicant assumed no release, while the AEC assumed releases due to DCA and BRS reprocessing system malfunctions of 10 percent of BRS and DCA liquid. In our discussions with the applicant it was learned that the applicant's plans for such an equipment malfunction consist of solidification of such wastes, rather than discharge.

We also are of the opinion that baseline and operational radiological monitoring programs should include all ground water supplies which potentially could be influenced by waters from Squaw Creek reservoir. All water wells within several kilo-

meters of the site should be included in this survey, unless good reason exists for excluding any particular well. It is also our opinion that surface water sampling stations should be located upstream and downstream of Lake Granbury.

In summary, we believe that the proposed CPSES can be constructed and operated with negligible radiological impact on the population and the environment under normal and accident conditions through a Class 8 accident. We are also of the opinion that chances of an accident more severe than a Class 8 accident are so small that its environmental impact can be neglected, but emergency procedures for it will be developed by the applicant and this office nonetheless, which should minimize the impact on the population in the exceedingly unlikely event of a catastrophic accident.

If further information is desired you may contact Mr. Martin C. Wukasch or Mr. Lewis M. Cook in the Division of Occupational Health and Radiation Control.

Sincerely,

G. R. Herzik, Jr., P.E.
Deputy Commissioner
Environmental and Consumer
Health Protection

C-218

INDUSTRIAL COMMISSION

March 15, 1974

Mr. Wayne Brown, Chief
State Planning and Development
Division of Planning Coordination
Office of the Governor
P. O. Box 12428
Capitol Station
Austin, Texas 78711

Dear Wayne,

At the request of Mr. James Harwell, Executive Director of the Texas Industrial Commission, I have reviewed the draft environmental statement:

TEXAS UTILITIES GENERATING COMPANY
(Comanche Peak Electric Station Units 1 and 2)

In view of the fact that Texas has experienced shortages in electrical generating capacity, I feel that this generating company is absolutely necessary for future economic growth. I would hope that this project would be given high priority for completion.

As a consequence of this review and the future demand for electric energy for economic development purposes in the state of Texas, the Texas Industrial Commission has no negative comments to make at this time.

If we may be of further service in this matter, please do not hesitate to contact me.

Sincerely,

Frank

Frank Call
Director
Planning and Research

dcj

TEXAS
PARKS AND WILDLIFE DEPARTMENT

COMMISSIONERS
JACK R. STONE, Chairman, Wells
JOE K. FULTON, Vice-Chairman, Lubbock
PEARCE JOHNSON, Austin

CLAYTON T. GARRISON
EXECUTIVE DIRECTOR
JOHN H. REAGAN BUILDING
AUSTIN, TEXAS 78701

COMMISSIONERS
BOB BURLESON, Temple
JOHN M. GREEN, Beaumont
LOUIS H. STUMBERG, San Antonio

April 8, 1974

Mr. Wayne N. Brown, Chief
State Planning and Development
Office of the Governor
P.O. Box 12428, Capitol Station
Austin, Texas 78711

Attention: Mr. Brice Barnes

Dear Mr. Brown:

This Department has reviewed the draft environmental statement, Texas Utilities Generating Company (Comanche Peak Electric Station, Units 1 and 2). The following comments are made relative to impacts upon fish and wildlife.

1. The conclusion made (p. 4-12) that Squaw Creek as well as Paluxy and Brazos Rivers will recover from siltation effects after project construction is questionable. If gradual water releases have a stabilizing effect on the stream by reducing erosion and scouring associated with floods, how is the stream bottom cleaned? A stable substrate of fine silt particles will not result in higher production of periphyton and benthic invertebrates.

2. Vegetation in all cove and upper lake areas should be left standing. Clearing of trees should be kept to a minimum.

3. Construction of the proposed project would create a sport fishery. However, there is some question if the lake will be open for public use.

   Moreover, since this area of Texas has numerous fishing lakes, the contribution of a new lake and its fishery probably will not be very significant.

4. Relative to the recreational impact of the project on people (paragraph 4.4.5 and 5.6.5), the Comprehensive Planning Branch,

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Texas Parks and Wildlife Department, estimated requirements for rural opportunities in 1968 to be as follows:

Activity Facility	1968 Estimated Requirements
Surface acres of water for boating, fishing & skiing	0
Campsites	426
Picnic sites	297
Boat slips & stalls	415
Square yards of designated freshwater swimming area	198,936
Miles of nature study, walking, & biking trails	9

5. Because of the great diversity of animals that make use of Squaw Creek, the proposed project is questionable from an ecological point of view. The diversity and production (term used in its true sense) of an upland stream is certainly greater than that found in a lake and, therefore, much more interesting.

6. The statement is made (p. 4-20, paragraph 3) that a reservoir will be more productive in terms of biomass than an intermittent stream. Biomass does not reflect the quality or degree of recreational benefits. "Standing crop" would be a better expression of the relative degree of productivity.

7. Page 4-22, paragraph 4. When Lake Granbury becomes stratified, the possibility of releasing waters which are heavily charged with hydrogen sulfide into Squaw Creek could be avoided by using epilimnic waters from Granbury.

8. Relative to radiation as discussed on page 5-21, paragraph 1, it should be noted that no level of exposure is acceptable, as any radiation can cause undesirable effects.

9. The summary of annual total bodily doses of radiation (p. 5-33) to the population within 50 miles is very misleading. Because it is based on the population's background, dosage appears higher due to the fact that the population at 50 miles is much greater than that in the restricted area.

10. Of the cooling system alternatives listed, this Department favors the use of mechanical-draft wet cooling towers. The use of towers would result in the station having less detrimental impact upon the native flora and fauna than would the double reservoir system proposed herein.

Sincerely,

CLAYTON T. GARRISON
Executive Director

CTG:WJS:ac

C-220

CASE
Box 34626 Dallas, Texas 75234
Telephone 241-8840

April 16, 1974

RECEIVED APR 26 1974

Directorate of Licensing
United States Atomic Energy Commission
Washington, D. C. 20545

50-445/446

Gentlemen:

Enclosed are the comments concerning the Draft Environmental Statement for the proposed Comanche Peak Steam Electric Station, Units 1 and 2. Although there are many areas of concern, we shall address our comments to three areas: radiation emission and standards; waste shipment; and ground water intrusion.

The "permissible" dose level of 175 MREM to the general public has been sighted by the NCRP and Gofman and Templin as being too high by a factor of 10. The EPA has stated that level should be reduced by a factor of 5. Why can't this be done inasmuch as no level is known to be safe? The variation of "permissible" dose levels for the general public, plant site, and reprocessing plant lead one to suspect that the levels are what industry, not people, can live with.

Recent studies by Dr. Petkau for Atomic Energy of Canada indicate that cellular membrane rupturing occurs at very low dose rates. Exhaustive studies by Alice Stewart and G. W. Kneale indicate that the fetus is anywhere from 25 to 150 times more sensitive to radiation than adults. Children are ten times more sensitive than adults. There are three schools within a 10 mile radius of the plants, one of which is only 4 miles distant. This fact alone should require lower "permissible" dose emissions.

According to a GAO study dated August 18, 1972, the AEC is deficient in proper monitoring of radiation emissions from nuclear facilities. The AEC has only 22 full time inspectors and 3 investigators to monitor 1,877 institutions across this country. There is sufficient documentation to suggest that AEC monitoring leaves much to be desired. Humboldt Bay, Surrey #1, and Shippingport are just a few of many examples of leakage, non-compliance, and poor monitoring by the AEC.

On page 5-26, it is stated the probable releases from Comanche Peaks is based on operating experience at other plants. AEC Commissioner William Doub has stated the experience level for 800-1000 MWe plants is minimal. There are only four plants operating that are 1000 MWe or larger and none of these for more than a year.

Approximately 1180 drums of radioactive material will be shipped off-site annually. Any detailed environmental study should contain the mode of transportation, frequency of shipments and routes to be used. It is disturbing to note that railroad accidents are on the increase. Penn Central's rate shot up 80% last year, much of it due to worn tracks and equipment. General Electric's rail casks will contain about six times the amount of radioactivity found in a Hiroshima-sized bomb. Another GAO study on AEC Transportation of Radioactive Material dated 1973, stated the AEC doesn't have the expertise to evaluate transportation cask designs nor do they insist upon proof testing of a great variety of casks now being used. AEC regulations don't require drivers to have special training for carrying nuclear waste. The drivers have no radioactive testing gear. The vehicles are not inspected. Any route can be used and no two-way radios are installed. In short, no exceptional safeguards are instituted -- the drivers could just as well be carrying a load of melons.

The AEC study on pg. 5-29 fails to consider the gaseous release of cesium, which would be very possible in an accident and resultant loss of cask coolant water.

The entire matter of radioactive material shipments by any mode needs to be reevaluated.

CASE agrees that the applicant has displayed insufficient data concerning the effects of using local groundwater. This is a vital point to many residents of the area. Apparently, the water tables in the Glen Rose area have been lowering for years. Any added intrusion the size of the CPSES operation (600-1200 GPM) could seriously affect surrounding wells. The applicant was very vague on this matter, mainly, we feel, because they just don't know what the effect will be. Absolutely no doubt should exist prior to construction or the applicant should be forced to obtain water from another source.

In summation, CASE feels that the draft statement is very detailed in many respects, but, overall, it completely misses the point. In discussing just the plant itself without discussing the entire uranium fuel cycle, one is looking at the tip of an iceberg and saying that's all there is. The AEC and the nuclear industry cannot possibly claim a complete environmental impact study unless it considers the mining, enrichment, transportation, plant safety, reprocessing, and waste disposal. This type of public assessment, along with proposed cost-benefit studies should be made available to the citizens of this country before any further nuclear expansion continues.

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3706

Directorate of Licensing - 3 - April 16, 1974
United States Atomic Energy Commission
Washington, D. C. 20545

An absolute requirement is the immediate repeal of the Price-Anderson Act. Much has been stated recently by industry concerning government interference with the "free enterprise" system as it applies to the energy field. The Price-Anderson Act introduces government interference of the most dangerous kind. It stimulates growth and removes liability. Chairwoman Ray and nuclear industry representatives have been shouting praises of the Rasmussen study, saying there is one chance in a billion of an accident. To state that figure and then renew the Price-Anderson Act yet another time would be a most callous disregard for honesty and responsibility by all parties. It would completely destroy any visage of credibility the AEC, JCAE, and the nuclear industry have left.

The energy situation is complex and critical, but, in the final analysis, the direction this country takes will be decided by all its citizens, not by a government bureaucracy, utilities or energy companies. The citizens must be appraised honestly and responsibly of the situation and the alternatives, for if not, this country is in for a very disturbing future.

Sincerely,

CASE (Citizens Association for Sound Energy)

Robert W. Pomeroy

Robert W. Pomeroy
Chairman

RWP/je

50-445
50-446

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20425

APR 25 1974

RECEIVED MAY 2 1974

Mr. Daniel R. Muller
Assistant Director
for Environmental Projects
Directorate of Licensing
Office of Regulation
U. S. Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Muller:

This is in response to your letter dated February 15, 1974, requesting comments on the AEC Draft Environmental Statement related to the proposed issuance of a construction permit to the Texas Utilities Generating Company (Applicant) for the Comanche Peak Steam Electric Station, Units 1 and 2 (Docket No. 50-445 and 50-446) to be located on an 8,876-acre site in Somervell County, Texas. The 1,161-megawatt Units 1 and 2 are scheduled for commercial operation in January 1980 and January 1982, respectively.

These comments by the Federal Power Commission's Bureau of Power staff are made in compliance with the National Environmental Policy Act of 1969 and the August 1, 1973, Guidelines of the Council on Environmental Quality, and are directed to the need for the capacity represented by the Comanche Peak Steam Electric Station and to related bulk power supply matters.

In preparing these comments, the Bureau of Power staff has considered the AEC Draft Environmental Statement; the Applicant's Environmental Report and Addendments thereto; related reports made in accordance with the Commission's Statement of Reliability and Adequacy of Electric Service (Docket No. R-362); and the staff's analysis of these documents together with related information from other FPC reports. The staff generally bases its evaluation of the need for a specific bulk power facility upon long-term considerations as well as upon the load-supply situation for the peak load period immediately following the availability of the new facility. It should be noted that the useful life of each Comanche Peak generating unit is expected to be 30 years or more. During that period, each unit will make a significant contribution to the reliability and adequacy of electric power supply in the Applicant's service area.

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3871

The Applicant is a corporate affiliate of the joint owners and will act as agent in matters concerning the construction, licensing and operation of the proposed Comanche Peak station for the joint owners: Dallas Power and Light Company, Texas Electric Service Company, and Texas Power and Light Company. The Applicant and the joint owners are subsidiaries of Texas Utilities Company, and with other subsidiaries comprise the Texas Utilities Company System (TUCS). The joint owners are members of the Electric Reliability Council of Texas (ERCOT) which coordinates the planning of the members' bulk power facilities.

The Applicant's electric system (TUCS) and its associated systems are summer-peaking systems. TUCS's service area, located in central Texas, supplies energy to approximately one-third of the state including the Dallas-Fort Worth load center. No seasonal diversity exists within the ERCOT region and diversity exchanges between member systems is not practiced. The Applicant complies with the ERCOT reliability criterion which requires a reserve margin of 15 percent of the projected peak load.

The projected TUCS peak loads for the 1974-1984 period contained in the Draft Environmental Statement are extrapolated at an annual rate equal to the 1963-1972 annual growth rate of load. The Applicant's scheduled new capacity of 11,241 megawatts including the Comanche Peak units for the 1974-1982 period results in reserve margins during that period in the range of 16.3 to 19.1 percent of the projected annual peak loads. The reserve margins for the initial operating periods of the units at the 1980 and 1982 summer peak periods with the units available total 3,232 megawatts, or 18.9 percent of the 1980 annual peak load, and 3,274 megawatts, or 16.3 percent of the 1982 annual peak load. Without the Comanche Peak units, these reserve margins would be reduced, respectively, to 2,071 megawatts, or 12.1 percent of the 1980 peak load, and 952 megawatts, or 4.7 percent of the 1982 peak load. Based on currently scheduled new capacity, the Applicant would not meet the desired reserve margin according to the stated criterion, if the Comanche Peak units were delayed beyond the scheduled commercial operating dates.

The proposed Comanche Peak Steam Electric Station would utilize water from the Squaw Creek Dam and Reservoir for condenser cooling. The Dam and Reservoir would be constructed on Squaw Creek, a tributary of the Brazos River. Water from Lake Granbury administered by the Brazos River Authority would be used for initial filling of the proposed Squaw Creek Reservoir over a three year period and for maintaining

acceptable water levels and water quality during operation of the proposed plant. The owner companies have negotiated a contract with the Brazos River Authority (which has been approved by the Texas Water Rights Commission under Permit No. 2871 issued June 13, 1974), which authorizes diversion and use of up to 38,300 acre-feet of water per year from Lake Granbury to be used by the Applicant for the proposed Comanche Peak 2-unit plant. An existing conventional hydroelectric project, Morris Sheppard Dam and Reservoir, operated under Federal Power Commission jurisdiction as Licensed Project No. 1490 by the Brazos River Authority, is located upstream of the confluence of Squaw Creek with the Brazos River.

Brazos Electric Power Cooperative, Inc. has filed with the Commission an application for preliminary permit for the study of a project (No. 2733) which would consist of a proposed Village Bend Pumped-Storage development with estimated dependable capacity of 730 megawatts which would be located on the Brazos River between the existing Possum Kingdom and Grandbury Reservoirs and a proposed DeCordova 60-megawatt conventional hydroelectric power plant. This proposed plant would be constructed near the DeCordova dam which now impounds Lake Grandbury and would discharge into the downstream leg of an oxbow in the Brazos River known as DeCordova Bend. Construction of such a project would require issuance of a license by the Commission. Any net diversion of water from Lake Granbury to Squaw Creek reservoir would not affect the generation (capacity and energy) by the Village Bend Pumped-Storage development and would decrease only the energy output of the DeCordova power plant.

The draft environmental statement reports that consumptive water losses due to cooling at the Comanche Peak plant would average about 38,300 acre-feet per year when both units are in operation. This loss would decrease power generation at potential hydroelectric facilities that could be developed at the existing DeCordova Bend Dam and at the potential Bee Mountain project downstream with a potential of about 60 megawatts of conventional capacity and about 80 megawatts of reversible capacity. This loss would also decrease the hydroelectric power generation at the Corps of Engineers' 30-megawatt Whitney Project located downstream on the Brazos River. The U. S. Study Commission, Texas, in its March 1962 report to the President, included hydroelectric power development at DeCordova Bend and Bee Mountain in its first-phase program.

The construction of the proposed Comanche Peak plant and its associated Squaw Creek Dam and Reservoir would require the relocation of two pipelines which traverse the site:

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Mr. Daniel R. Muller

(1) One 26-inch crude oil pipeline owned by the West Texas Gulf Company, a non-jurisdictional company;

(2) One 6-inch natural gas pipeline owned by the Lone Star Gas Company, a company subject to the jurisdiction of the Federal Power Commission.

One existing 36-inch natural gas pipeline and one new 36-inch line to be constructed, owned by the Texas Utilities Fuel Company, a non-jurisdictional company, would be anchored to remain submerged in their present location.

The Applicant's Environmental Report states that geological studies, test borings and other indicators reveal that no mineral resources underlay the site at economically recoverable depths.

The Bureau of Power staff concludes that additional capacity equivalent to that represented by the proposed Comanche Peak Units 1 and 2 is desirable to provide for the projected load growth of the affected systems and afford a reasonable level of reserve capacity with which to meet normally encountered contingencies on interconnected electric systems.

Very truly yours,

T. A. Phillips
Chief, Bureau of Power

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

10 MAY 1974

OFFICE OF THE ADMINISTRATOR

Mr. L. Manning Muntzing
Director of Regulation
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Muntzing:

The Environmental Protection Agency has reviewed the draft environmental impact statement issued in conjunction with the application of the Texas Utilities Generating Company for a construction permit for the proposed Comanche Peak Steam Electric Station Units 1 and 2. Our detailed comments are enclosed.

In our view, the proposed cooling system for the Comanche Peak facility constitutes a cooling lake design utilizing the planned Squaw Creek Reservoir. This system is acceptable to EPA provided the waters of the reservoir are not considered navigable as defined by the Federal Water Pollution Control Act Amendments of 1972 (FWPCA). In general, reservoir waters can be considered as navigable if they were formed by impounding an existing natural or man-made water body previously classified as navigable. In this specific case, the waters may not be so considered if the applicant can demonstrate that 1) pumping of water from Lake Granbury to provide flow for the Squaw Creek can be done in a manner which will not result in undue degradation of water quality or impact on aquatic biota in the creek and 2) that the possible multiple-use of reservoir waters for recreation will be limited. In this regard, should the State of Texas and the utility desire full recreational development, the FWPCA might apply to the reservoir. If it does, of importance is Section 301 (as interpreted by EPA's proposed guidelines for steam electric power plants) which calls for a closed-cycle system. However, it should be noted that, under Section 316(a) of the Act, the Administrator could allow the use of the proposed once-through system if the applicant can demonstrate that the guideline requirements are "...more stringent

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than necessary to assure the pro[t]ection and propagation of a balanced, indigenous, population of shellfish, fish, and wildlife in and on the body of water into which the discharge is made...."

Our major concern regarding the radiological aspects of the plant is that the evaluations of source terms and the resultant dose consequences performed by the AEC staff were based on the standard AEC models which apply to base-loaded nuclear plants. The Comanche Peak Station, however, is to be operated as a load-following facility. It is likely that this mode of operation will cause significant variations in the input to waste systems and, thus, may cause differences in the amounts of activity to be released. Although the plant will be expected to meet the design objectives of the proposed Appendix I, we believe that an evaluation of the influence of load-following source terms is justified and should be included in the final statement. If the mode of operation does result in larger volumes of waste to be processed, the proposed plant waste management systems should be evaluated in light of the expected source term.

In light of our review and in accordance with EPA procedures, we have classified the project as LO (Lack of Objections) and have rated the draft statement as Category 2 (Insufficient Information). If you or your staff have any questions concerning our classification or comments, we will be happy to discuss them with you.

Sincerely yours,

Sheldon Meyers

Sheldon Meyers
Director
Office of Federal Activities

Enclosure

EPA# D-AEC-06126-TX

ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, D.C. 20460

MAY 1974

ENVIRONMENTAL IMPACT STATEMENT COMMENTS

Comanche Peak Steam Electric Station

Units 1 and 2

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INTRODUCTION AND CONCLUSIONS

The Environmental Protection Agency has reviewed the draft environmental impact statement issued February 15, 1974, by the U.S. Atomic Energy Commission in conjunction with the application of Texas Utilities Generating Company for a permit to begin construction of the Comanche Peak Steam Electric Station Units 1 and 2. This plant is planned for a site located in Somervell County, Texas.

1. As described in the draft statement, the cooling system for the Comanche Peak facility constitutes a cooling lake design utilizing the proposed Squaw Creek Reservoir. This system is acceptable to EPA provided the reservoir waters are not considered navigable as defined in the Federal Water Pollution Control Act Amendments of 1972 (FWPCA). In general, reservoir waters can be considered as navigable if they were formed by impounding an existing natural or man-made water body previously classified as navigable. In this specific case, the waters may not be so considered if a) the applicant can demonstrate that the proposed pumping of water from Lake Granbury to the Squaw Creek can be done in a manner which will not result in undue degradation of water quality or impact on aquatic biota in the creek and b) that the possible multiple-use of the reservoir waters (particularly recreation) will be limited. Under such circumstances, two permits under the National Pollutant Discharge Elimination System (Section 402 of the FWPCA) will be required. One at the point where blowdown from the Squaw Creek Reservoir will be discharged to Lake Granbury and the second where water pumped from the lake will be discharged to Squaw Creek.

2. Should the applicant or the State of Texas desire that the reservoir be a full multiple-use water body, the waters therein might be considered navigable and thus under the jurisdiction of the FWPCA. In particular, this would mean that, in accordance with Section 301 of the Act, the cooling system of the plant must employ the "Best Practicable Control Technology Currently Available" by July 1, 1977, and the "Best Available Technology Economically Achievable" by July 1, 1983. These terms are defined in EPA's proposed effluent guidelines for steam electric power plants (issued March 4, 1974). These guidelines are directed to treatment of discharges to navigable water bodies. As a consequence, the applicant might be required to install a closed-cycle system. It should be noted, however, that Section 316(a) of the FWPCA can provide relief from the requirements of Section 301 if

the applicant can demonstrate to the satisfaction of the Administrator (of EPA) that the effluent limitations are "...more stringent than necessary to assure the pro[t]ection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is made...." If such a case can indeed be made, the Administrator could allow the use of the once-through system.

3. We anticipate that the station, as proposed, may not at all times comply with Texas Water Quality Standards for dissolved oxygen levels at the blowdown discharge to Lake Granbury. This would result in the requirement for provision of supplemental aeration during critical months of low dissolved oxygen discharge, to insure protection of aquatic biota.

4. While intake water volumes for makeup and blowdown requirements at the station will be low, we believe that velocities through the intake screens should be maintained at 0.15 m/s (0.5 fps) or less. In addition, we recommend that the final statement provide clarification on the maintenance of 0.042 m^3/s (1.5 cfs) flow in Squaw Creek below Squaw Creek Reservoir.

5. Radioactivity releases have been evaluated using parametric values appropriate to a base-loaded nuclear power station. In order to accurately assess the potential radiological impact of the Comanche Peak Steam Electric Station, the final statement should evaluate radioactivity releases appropriate to the proposed load-following operation in the context of the proposed Appendix I to 10 CFR Part 50.

RADIOLOGICAL ASPECTS

Radioactive Waste Management

The draft statement for the Comanche Peak Steam Electric Station (CPSES) has evaluated radioactivity releases for a base-loaded mode of operation. The applicant and the draft statement, however, have indicated that the CPSES will be operated on a load-following schedule. As a result, many of the principal parameters and conditions used in calculating releases of radioactive material (Table 3.51 of the draft statement) would assume different values under load-following operation. Although estimated radioactivity releases via certain pathways might be expected to decrease, appropriate values for other parameters might actually result in an overall increase in estimated radioactivity releases. For example, the thermal cycling concomitant with load-following operation would subject fuel rod cladding to greater thermal stresses, possibly resulting in poorer fuel cladding performance. The final statement should, therefore, evaluate radioactivity releases using source term parameters more appropriate to the proposed load-following operation of the CPSES.

Sixty percent of the radioiodine estimated to be released from the plant is calculated to be from the turbine building ventilation exhaust. This release pathway is not specifically treated for radioiodine removal, but could be reduced if the measured thyroid doses proved to be excessive, e.g., plugging steam generator tube leaks, replacing defective fuel, locating and reducing turbine building steam leakage, or increasing steam generator blow down rate. In any event, the facility should also have the capability for monitoring the release of radioiodine from the turbine building.

Although waste liquids collected by the turbine building floor drain system will contain radioactive materials resulting from secondary system leakage, the PSAR does not indicate any means of monitoring this liquid radioactivity release pathway. In order to determine that the liquid radioactivity releases from the CPSES are "as low as practicable," the applicant should sample and monitor this liquid radioactivity release pathway.

Dose Assessment

The draft statement has indicated that the proposed gaseous and liquid waste treatment systems are expected to be capable of limiting radionuclide releases and subsequently offsite doses to levels within those given in the Concluding Statement of the Regulatory Staff on Appendix I to 10 CFR 50. As indicated above, the final statement should determine radioactivity releases using source terms appropriate to the load-following schedule proposed by the applicant. In addition, an evaluation of the dosimetric consequences of these releases should also be made in the context of the proposed Appendix I to 10 CFR Part 50.

EPA expects that the results from current and planned joint EPA-AEC and industry cooperative field studies in the environs of operating nuclear power facilities will greatly increase knowledge of the processes and mechanisms involved in the exposure of man to radiation produced through the use of nuclear power. We believe that, overall, the cumulative assumptions utilized to estimate various human doses are conservative. As more information is developed, the models used to estimate human exposures will be modified to reflect the best data and most realistic situations possible. Based on the results of these cooperative studies, it is possible that the scope and extent of present environmental monitoring programs may be relaxed.

More information should be presented relative to pathways of exposure other than those detailed in the draft statement. For example, according to the applicant's environmental report and the draft statement, irrigation is used in the local agricultural production. In addition, the draft statement also notes the existence of important game birds (bobwhite quail and mourning dove). The final statement should consider these pathways of exposure in addition to those already discussed in the draft statement.

Transportation

EPA, in its earlier reviews of the environmental impact of transportation of radioactive material, agreed with the AEC that many aspects of this program could best be treated on a generic basis. The generic approach has reached the point where on February 5, 1973, the AEC published for comment in the Federal Register a rulemaking proposal concerning the "Environmental Effects of Transportation of Fuel and Waste from Nuclear Power Reactors." EPA commented on the proposed rulemaking by a letter to the AEC, dated March 22, 1973, and by an appearance at the public hearing on April 2, 1973.

Until such time as a generic rule is established, EPA is continuing to assess the adequacy of the quantitative estimates of environmental radiation impact resulting from transportation of radioactive materials provided in environmental statements. The estimates provided for this station are deemed adequate based on currently available information.

Reactor Accidents

EPA has examined the AEC analysis of accidents and their potential risks which the AEC has developed in the course of its engineering evaluation of reactor safety in the design of nuclear plants. Since these accident issues are common to all nuclear power plants of a given type, EPA concurs with the AEC's approach to evaluate the environmental risk for each accident class on a generic basis. The AEC has in the past and still continues to devote extensive efforts to assure safety through plant design and accident analyses in the licensing process on a case-by-case basis. EPA, however, favors the additional step now being undertaken by the AEC of a thorough analysis on a more quantitative basis of the risk of potential accidents in all ranges. We continue to encourage this effort and urge the AEC to press forward to its timely completion and publication. EPA believes this will result in a better understanding of the possible risks to the environment.

We are pleased to note in the draft statement the discussion of the Reactor Safety Study and the commitment for timely public presentation of its results. If the AEC's efforts indicate that unwarranted risks are being taken at the Comanche Peak Steam Electric Station, we are confident that the AEC will assure appropriate corrective action. Similarly, if EPA efforts related to the accident area uncover any environmentally unacceptable conditions related to the safety of the Comanche Peak Steam Electric Station, we will make our views known.

NON-RADIOLOGICAL ASPECTS

Plant Cooling System and FWPCA Requirements

As presently proposed by the applicant, condenser cooling at the Comanche Peak nuclear power plant will be accomplished by a once-through system with water taken from and discharged to the Squaw Creek Reservoir - an impoundment to be built on the bed of Squaw Creek. All make up water for this reservoir will be withdrawn from and blowdown discharged to Lake Granbury - a nearby existing impoundment on the Brazos River. In addition, the applicant proposes what amounts to providing a new source for the Squaw Creek by pumping water from Lake Granbury and discharging it to the creek at a point immediately below the Squaw Creek Reservoir dam site. In essense, therefore, the applicant is proposing a closed-cycle system utilizing a cooling lake.

Section 301 of the Federal Water Pollution Control Act Amendments of 1972 stipulates that cooling systems for steam electric plants must employ the "Best Practicable Control Technology Currently Available" by July 1, 1977, and the "Best Available Technology Economically Achievable" by July 1, 1983. Proposed effluent guidelines for this category of point-source were published by EPA on March 4, 1974. These guidelines call for "...evaporative external cooling to achieve essentially no discharge of heat, except for cold-side blowdown, in a closed, recirculating cooling system." This restriction on discharge applies to those water bodies, whether natural or man-made, deemed as falling under the jurisdiction of the FWPCA (i.e., deemed as "navigable").

Although it is clear that Lake Granbury is covered by the FWPCA, of immediate concern to the Comanche Peak station is whether the proposed Squaw Creek Reservoir would also be considered navigable. If it were, the effluent limitations mentioned above would apply not at the point where the reservoir would connect with Lake Granbury, but at the outflow from the nuclear plant. Reservoir waters can be considered as navigable if they were formed by impounding an existing natural or man-made water body previously classified as navigable. In some cases, however, it may be possible to successfully reroute or relocate all or part of a navigable water body (or provide a new source for that body) in a manner which protects its water quality and indigenous aquatic life. Subsequently, if a reservoir were constructed on the former site of the water body (e.g. on the dry stream bed), EPA would not, on that basis alone, classify the reservoir as navigable. In our opinion, the Squaw Creek Reservoir proposal satisfies this criterion. Obviously, however, a final determination must be based on the applicant's demonstration that the creation of the proposed new source for Squaw Creek and the subsequent operation of the pumping system will not result in undue degradation of water quality or impact on aquatic biota in the creek. Such additional data as are necessary to establish this point should be submitted as part of an application for a NPDES permit. EPA will require that permits be obtained for both the blowdown discharge from the reservoir to Lake Granbury and the discharge of Lake Granbury water pumped to the Squaw Creek (discharge point below the Squaw Creek dam).

The above assumes, however, that no other factor enters to put the Squaw Creek Reservoir in the navigable category. In this regard, it should be noted that EPA's interpretation of the definition of navigable under the FWPCA goes beyond the criterion discussed previously. For example, included are waters such as intrastate lakes, rivers, and streams which are utilized by interstate travelers for recreational or other purposes. Thus, either planned or possible future development of recreation could make the waters navigable. EPA is not opposed to limited multiple-use of such reservoir waters to the extent that we believe the public should be denied access. However, it is important to draw a distinction between purely process waters (i.e., designed solely for industrial cooling or other purposes) and navigable waters under the jurisdiction of the FWPCA.

If the applicant and the State of Texas wish to fully exploit the waters of the proposed Squaw Creek Reservoir for recreation and other public uses, then the waters might come under the FWPCA and the requirements of Section 301 may apply. In that event, it may be required to install another form of cooling system, such as evaporative towers or spray canals, or to apply for a variance under Section 316(a). Section 316(a) can offer relief to the applicant from the thermal effluent restrictions imposed by Section 301 if he can demonstrate to the satisfaction of the Administrator (of EPA) that the imposed restrictions are "...more stringent than necessary to assure the pro[t]ection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is made...." If the applicant can indeed make such a case for the Comanche Peak plant, the Administrator could allow the use of the cooling system as proposed.

Thermal and Chemical Effects

The following comments address the proposed plant as described in the draft statement and are based on the assumption that the cooling lake concept is approvable.

[Lake Granbury]

The draft statement does not adequately discuss the combined thermal effects of the proposed Comanche Peak plant and the De Cordova Bend steam electric station on Lake Granbury. The only reference to the De Cordova fossil plant is in Section 2.1, Station Location (page 2-1). Because we believe the synergistic effects could be significant, particularly with respect to long-term cumulative impacts on water quality in Lake Granbury and the Brazos River, such an expanded discussion should be included in the final statement. It should also be noted that the De Cordova Bend station will be subject to the NPDES permit requirements of the FWPCA. An application for a permit has recently been received by EPA and is now under consideration.

We believe the releases of blowdown water into Lake Granbury from the Squaw Creek Reservoir may result in degradation of water quality in that lake. After review of the draft statement, it appears the primary impacts will be on dissolved oxygen and total dissolved solids content. Although we believe that Texas water quality standards for total dissolved solids will probably not be violated in the lake as a result of blowdown discharge, we are not certain that dissolved oxygen levels during the summer months will meet State standards.

On page 5-42, of the draft, it is stated that, "From June through October the discharge will have a low dissolved oxygen level, with the concentration being 0.0 ppm from June through September." Also, it is stated, that "Fish will be able to move out of the affected area, but the total areas involved could not be predicted." Therefore, we believe it may become necessary to provide supplemental aeration (i.e., a mechanical aerator) during these critical months of low dissolved oxygen discharge to protect aquatic life in the affected area. We recommend that the applicant provide for the maintenance of a minimum instantaneous concentration of 2 ppm and an average concentration of 4 ppm of D.O. in the blowdown from Squaw Creek Reservoir. With respect to the latter, the NPDES permit will be conditioned accordingly.

[Squaw Creek Reservoir]

According to the draft statement, antifouling of the circulating water system will be accomplished by shock

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chlorination with chlorine to be diffuser-injected ahead of each traveling water screen (at anticipated dosage of two 30-minute periods per day). The estimated chlorine concentration at the discharge resulting from chlorination of one unit while both are in operation is 0.5 ppm. The AEC staff will require that at the point of discharge to Squaw Creek Reservoir, residual chlorine not exceed 0.1 ppm. We recognize the fact that residual chlorine levels at the blowdown discharge to Lake Granbury will be well within the requirements of the Texas water quality standards and the requirements of FWPCA. However, EPA concurs with the AEC in that, for the protection of the aquatic environment (such as anticipated by the applicant at Squaw Creek Reservoir), residual chlorine levels should be maintained at the levels required by the AEC.

The circulating water velocity through the intake screens is calculated by the AEC to range from 0.37 m/s to 0.73 m/s (1.20 to 2.40 fps), dependent upon the number of pumps in operation and reservoir level. In like manner, velocity through the screens for service water is calculated to range from 0.27 m/s to 1.83 m/s (0.89 to 5.94 fps), dependent upon operation under normal or emergency conditions and reservoir level. We recommend that, for the protection of aquatic biota, intake velocities be maintained at 0.15 m/s (0.5 fps) or lower.

[Makeup and Blowdown Systems]

The applicant proposes to divert makeup water for the Squaw Creek Reservoir from Lake Granbury. This will be accomplished by pumping up to 30.2 m^3/s (101 cfs) through a 1.22 m (4 ft) diameter pipe. The velocity through the screens at the makeup water pumps is calculated to be 0.20 m/s (0.64 fps). We recommend that the applicant explore means to limit velocity through the screens to 0.15 m/s (0.5 fps) or less. In addition, blowdown water will be pumped via a 0.91 m (3 ft) diameter return line to Lake Granbury. Velocity through the screens at the Squaw Creek Reservoir intake structure is calculated to be 0.28 m/s (0.91 fps). Here again, we recommend that the velocity through the screen be limited to 0.15 m/s (0.5 fps) or less.

The potential impact upon entrained organisms in the makeup water system, of sudden pressure reduction at the pumps, return to one atmosphere pressure at the outfall in Squaw Creek Reservoir, and reaeration (at discharge velocity of 2.1 m/s (7 fps) over 15.2 m (50 ft) of riprap) can not be evaluated with the data presented. Data to facilitate such an evaluation should be presented in the final statement.

[Squaw Creek]

Squaw Creek has not been gaged to determine flow rates. However, it is known that this creek is intermittent to the extent that it is frequently dry during drought years. As is mentioned in the draft statement, the applicant will maintain a minimum flow of 0.042 m /s (1.5 cfs) in Squaw Creek below the proposed Squaw Creek Reservoir, by pumping water from Lake Granbury to a point 30.5 meters (100 ft) downstream from the dam site.

It is recognized in the draft statement that this diversion will equal only 13% of the long-term average annual runoff and be less than the monthly average flow of 19.36 ha-m (157 acre-ft). However, the AEC staff concludes that, "...although this flow will probably not be sufficient to maintain the present character of the stream, the continuous, gradual releases will have a stabilizing effect by reducing the erosion and scouring associated with floods. A more stable substrate will result in higher production of periphyton and benthic invertebrates, which in turn will benefit the fish population." While we concur in this position, we are concerned by the statement (p. 5-42) that, "...the applicant will avoid makeup water withdrawals during periods of low levels in Lake Granbury." The rationale for avoiding withdrawal during periods of low water levels in Lake Granbury (that of avoidance of entrainment of aquatic organisms which are concentrated at these times) is, in our opinion, sound. However, it is not clear what provision will be made for the continuance of the water diversion to Squaw Creek, which is essential to the protection and propagation of the aquatic ecosystem established below Squaw Creek Reservoir. Thus, we recommend that the final statement clarify this point and evaluate the impact upon Squaw Creek of any variation from, or discontinuance of, the proposed flow of 0.042 m^3/s (1.5 cfs).

The draft statement indicates that adverse effects from low oxygen releases to Squaw Creek might occur during summer, but that it is likely that these releases will be re-oxygenated within a short distance from the discharge. The staff conclusion that "...the impact on the dissolved oxygen in Squaw Creek will not be significant" requires, in our opinion, additional clarification. We recommend, therefore, the inclusion in the final statement of data relative to the hydrological characteristics of Squaw Creek for re-oxygenation (turbulence).

ADDITIONAL COMMENTS

During the review, we noted in certain instances that the draft statement does not present sufficient information to substantiate the conclusions presented. We recognize that much of this information is not of major importance in evaluating the environmental impact of the Comanche Peak Steam Electric Station. The cumulative importance, however, could be significant. It would, therefore, be helpful in determining the impact of the plant if the following information were included in the final statement:

1. According to the draft statement, steam releases of radioactivity due to turbine trips and low power physics testing will have a negligible effect on the calculated source term. The AEC should present the bases for this conclusion, particularly with reference to radioiodine releases, in the final statement or reference an appropriate regulatory guide.

2. With respect to air quality, the final statement should discuss what methods will be used to control particulate emissions from the onsite concrete batch plant and what steps will be taken to reduce wind blown dust during site preparation and construction.

3. The draft does not provide information concerning noise level criteria. The final statement should contain a computation of anticipated levels for noise sensitive areas on the basis of the most adverse conditions expected to occur on the site. The analysis should include a model for relating parameters to estimated noise levels, as well as existing noise levels representing the no-project situation.

4. Section 1.2, Status of Reviews and Approvals (page 1-2), lists several Federal, State and local agencies that will require permits and licenses and other authorizations for the project. However, the list did not include EPA's permit involvement under the Federal Water Pollution Control Act Amendments of 1972 (FWPCA, P.L. 92-500).

5. The final statement should evidence any commitment by the applicant to limit construction

activities at the dam site during spawning periods in Squaw Creek.

6. There are three pipelines crossing the proposed reservoir site (p. 45). The draft statement indicates that one pipe, a 91.4 cm (36 in.) gas line, will be anchored in the reservoir. The final statement should consider the potential impact of rupture or leakage from this line, if such is considered significant.

7. In Section 10.1.1.2. Water (p. 10-1) it is stated that, "About 45,000 acre feet per year of water will evaporate from Squaw Creek Reservoir during CPSES operation. This will result in an increase in the average salt concentration in the Brazos River below the station of 2.3 percent." It is not clear whether the increase in salt concentration in the Brazos River is due to the projected salt concentrations in Lake Granbury or some other factor. In order for the salt concentration to increase by 2.3 percent in the river below Lake Granbury, total dissolved solids concentrations would have to exceed Texas Water Quality Standards for the lake by several fold. This, as pointed out in the draft statement, will not be the case. Therefore, we recommend that the basis for the above quote be presented in the final statement.

8. The hydraulic flows between the plant, lake, reservoir and creek are quite complicated. Therefore, we recommend that the final statement include a flow diagram, depicting the source and discharge points for all flows.

9. The statement thoroughly discusses the impact of the Comanche Peak Station on Hood and Somervell Counties. However, the impacts of the power that will be generated by the station were not assessed in detail. The statement should discuss to what extent the station will tend to stimulate growth, where the growth will occur, and what the general impacts of this growth will be. In accordance with Section 1500.8(a)(2) of the CEQ guidelines, the statement should discuss the relationship of the proposed action to land use plans, policies, and controls for the affected area.

10. In light of the recent success of energy conservation efforts, the statement shoud further discuss expected electrical demand for the future. If conservation efforts continue, the final statement should consider how they affect the forecast demand curve and the need for the Comanche Peak Station.

Texas Historical Commission
Box 12276, Capitol Station
Austin, Texas 78711
Truett Latimer
Executive Director

April 26, 1974

RECEIVED
APR 30 1974
TEXAS UTILITIES SERVICES INC.
NUCLEAR PLANTS

Texas Utilities Services, Inc.
Attn: Mr. Robert W. Caudle
1506 Commerce Street
Dallas, Texas 75201

RE: Comanche Peak Steam Electric Station: Cultural Resource Compliance

Dear Mr. Caudle:

In response to a request by Mr. B.E. Glenn of your company concerning the above-referenced project area, and cultural resources, we have examined our records and offer the following comments:

1. No sites on the National Register of Historic Places lie within the project area.

2. At present, there are no sites in the process of submission to the National Register of Historic Places, although the Texas Historical Commission survey has not been completed in this area.

3. Although the survey to locate, record, and appraise the cultural resources in the entire project area of the proposed facility has not been completed, the Texas Historical Commission has been assured by Texas Utilities Services, Inc. that substantive measures have been taken toward the completion of this necessary survey and that the recommendations concerning the findings of this survey will be followed in detail.

Sincerely,

Truett Latimer
State Historic Preservation Officer

TL:pc

ERRATA

Page in: App. C	Page in: FES-CP	Correction
C-3	iii	Paragraph 7.b., line 3. Add following sentence: The results of these monitoring programs shall be submitted as part of the applicant's Environmental Report - Operating License Stage.
C-3	iii	Paragraph 7.c., line 10. Add following sentence: The results of these evaluations shall be submitted as part of the applicant's Environmental Report - Operating License Stage.
C-4	iv	Paragraph 7.d., line 21. Add following sentence: The results of this study shall be submitted as part the applicant's Environmental Report - Operating License Stage.
C-16	2-1	First paragraph, lines 12 and 13. Change "latitude" to "longitude", and "longitude" to "latitude", in both lines.
C-45	3-10	Delete the second paragraph and add in its place: The warmed circulating water will be discharged as shown in ER Fig. 3.4-5A (ER, Amendment 3, Fig. 3.4-5A). A tunnel from each of the two units will discharge into an open channel formed from rock. The bottom of the channel is 750 ft above mean sea level and expands horizontally from a 60 ft width at the tunnels to a 200 ft width at the point of discharge to the reservoir in a 530 ft channel length. The sides of this open channel slope upward away from the bottom at an angle such that the reservoir end of the channel is 280 ft wide at the 770 ft water level. Assuming the maximum circulating water flow rate of 2,200,000 gpm and the 770 ft water level, the velocity at the reservoir end of the channel will be about 1 ft/sec. The staff evaluated this revised discharge structure and concludes that the thermal assessment discussed in Section 5.3 is not affected and is still applicable.
C-45	3-10	Third paragraph, fourth line. Change "16,000 gpm" to "17,000 gpm".
C-45	3-10	Third paragraph, last line. Change "Amendment 1" to "Amendment 3".
C-45	3-10	Last paragraph, third line. Change "1600 ft" to "1800 ft".
C-45	3-10	Last paragraph, fourth line. Change "(ER, Amendment 1, p. 3.4-2a)" to "(ER, Amendment 3, p. 3.4-3a)".

ERRATA

Page in: App. C	Page in: FES-CP	Correction
C-45	3-10	Last paragraph, sixth line. Change "32,000 gpm" to "34,000 gpm".
C-45	3-10	Last paragraph, next to last line. Change "7.7 ft/sec" to "8.2 ft/sec". Change "48,000 gpm" to "51,000 gpm".
C-45	3-10	Last paragraph, last line. Change "11.5 ft/sec" to "12.2 ft/sec".
C-45	3-11	Figure 3.4.3. Delete and replace with following note: The design of the circulating water discharge for CPSES is as depicted in Figure 3.4-5A of the applicant's Environmental Report, Amendment 3.
C-46	3-12	Table 3.4.3. Replace with revised Table 3.4.3 from this appendix page C-236.
C-60	3-41	Section 3.7.1.2, second sentence. Change to read as follows: The effluent will be chlorinated for disinfection and odor reduction prior to release into Squaw Creek Reservoir.
C-62	3-45	Figure 3.8.2. The highway shown leaving Granbury in a southwesterly direction is incorrectly designated as Highway 144. It should be designated as Highway 377, as indicated in Figure 2.1.2 on page 2-3.
C-63	3-47	Section 3.9.1, second paragraph, line 3. Change Road 50 to Road 51.
C-106	5-36	Seventh line. Delete "only".
C-106	5-36	Ninth line. Add to the end of the first paragraph: The velocity at the service water intake as indicated in Table 3.4.3 (as revised) may increase impingement losses during emergency operation or operation with only one screen. The staff believes that emergency operation will be so infrequent that impingement during such operation is acceptable. The staff further believes that operation with one screen will usually be less than 5 percent of the time during a given year. However, the applicant will be required to monitor impingement losses at the service water intake and take appropriate corrective action if monitoring indicates adverse impingement effects are occurring (refer to Section 11.6.2).

ERRATA

Page in: App. C	FES-CP	Correction
C-110	5-44	Section 5.6.1, second paragraph, line 4. Delete the phrase: "...in an evaporation pond...".
C-126	8-9	Table 8.2.2. Change table heading from "Average Kilowatt-Hours Per Customer (Billions)" to "Average Kilowatt-Hours Per Customer (Thousands)".
C-161	11-18	Section 11.6.7, Applicant Position, line 3. Change to read: "...mining of the Twin Mountain aquifer will not occur as a result of CPSES...".
C-162	11-20	Section 11.6.7, paragraph d., line 7. Change 35 gpm to 30 gpm.
C-162	11-21	Section 11.8.1(1). Change Sect. 11.5.3 to Sect. 11.5.4.
C-163	11-22	Section 11.8.2. Change Sect. 11.5.3 to Sect. 11.5.4.
C-165	11-27	Section 11.8.8(5), first line. Change Sect. 11.5.11 to Sect. 11.5.12.
C-165	11-27	Section 11.8.8(6), first line. Change Sect. 11.5.14 to Sect. 11.5.15.
C-168	11-33	Section 11.11.13, first line. Change Sect. 11.5.14 to Sect. 11.5.15.

ERRATA

Table 3.4.3. Water velocities in the service water intake structure calculated by the staff

A. Service water flow rates (E.R., Amendment 3, p.3.4-2a)

1. Normal operation
   Operating pumps: 2
   Flow rate: 34,000 gpm
2. Emergency operation
   Operating pumps: 3
   Flow rate: 51,000 gpm

B. Water velocities

	Water velocity (ft/sec) for reservoir water level of –					
	764 ft		770 ft		775 ft	
	Normal operation[a]	Emergency operation	Normal operation	Emergency operation	Normal operation	Emergency operation
1. Approach to trashrack						
a. Two operating screens		1.15	0.46	0.69	0.34	0.52
b. One operating screen		2.30	0.91	1.38	0.68	1.04
2. Through trashrack						
a. Two operating screens		1.72	0.69	1.03	0.52	0.78
b. One operating screen		3.44	1.38	2.06	1.04	1.55
3. Approach to traveling screens						
a. Two operating screens		1.58	0.63	0.95	0.48	0.71
b. One operating screen		3.16	1.26	1.90	0.96	1.42
4. Through traveling screens						
a. Two operating screens		3.16	1.26	1.90	0.96	1.42
b. One operating screen		6.31	2.52	3.79	1.92	2.84

[a]Only emergency operations will be allowed at this reservoir level.

Revised July 25, 1974

APPENDIX D

REBASELINING OF THE RSS RESULTS FOR PWRs

The results of the Reactor Safety Study (RSS) have been updated. The update was done largely to incorporate results of research and development conducted after the October 1975 publication of the RSS and to provide a baseline against which the risk associated with various LWRs could be consistently compared.

Primarily, the rebaselined RSS results reflect use of advanced modeling of the processes involved in meltdown accidents, i.e., the MARCH computer code modeling for transient and LOCA initiated sequences and the CORRAL code used for calculating magnitudes of release accompanying various accident sequences. These codes* have led to a capability to predict the transient and small LOCA initiated sequences that is considerably advanced beyond what existed at the time the Reactor Safety Study was completed. The advanced accident process models (MARCH and CORRAL) produced some changes in our estimates of the release magnitudes from various accident sequences in WASH-1400. These changes primarily involved release magnitudes for the iodine, cesium, and tellurium families of isotopes. In general, a decrease in the iodines was predicted for many of the dominant accident sequences while some increases in the release magnitudes for the cesium and tellurium isotopes were predicted.

Entailed in this rebaselining effort was the evaluation of individual dominant accident sequences as we understand them to evolve rather than the technique of grouping large numbers of accident sequences into encompassing, but synthetic, release categories as was done in WASH-1400. The rebaselining of the RSS also eliminated the "smoothing technique" that was criticized in the report by the Risk Assessment Review Group (sometimes known as the Lewis Report, NUREG/CR-0400).

In both of the RSS designs (PWR and BWR), the likelihood of an accident sequence leading to the occurrence of a steam explosion (a) in the reactor vessel was decreased. This was done to reflect both experimental and calculational indications that such explosions are unlikely to occur in those sequences involving small size LOCAs and transients because of the high pressures and temperatures expected to exist within the reactor coolant system during these scenarios. Furthermore, if such an explosion were to occur, there are indications that it would be unlikely to produce as much energy and the massive missile-caused breach of containment as was postulated in WASH-1400.

For rebaselining of the RSS-PWR design, the release magnitudes for the risk dominating sequences, e.g., Event V, TMLB' w, q, and S_2C-w (described later) were explicitly calculated and used in the consequence modeling rather than being lumped into release categories as was done in WASH-1400. The rebaselining led to a small decrease in the predicted risk to an individual of early fatality or latent cancer fatality relative to the original RSS-PWR predictions. This result is believed to be largely attributable to the decreased

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*It should be noted that the MARCH code was used on a number of scenarios in connection with the TMI-2 recovery efforts and for post-TMI-2 investigations to explore possible alternative scenarios that TMI-2 could have experienced.

likelihood of occurrence for sequences involving severe steam explosions (a) that breached containment. In WASH-1400, the sequences involving severe steam explosions (a) were artificially elevated in their risk significance (i.e., made more likely) by use of the "smoothing technique."

In summary, the rebaselining of the RSS results led to small overall differences from the predictions in WASH-1400. It should be recognized that these small differences due to the rebaselining efforts are likely to be far outweighed by the uncertainties associated with such analyses.

The accident sequences which are expected to dominate risk from the RSS-PWR design are described below. These sequences are assumed to represent the approximate accident risks from the Comanche Peak PWR design. Accident sequences are designated by strings of identification characters in the same manner as in the RSS. Each of the characters represents a failure in one or more of the important plant systems or features that ultimately would result in melting of the reactor core and a significant release of radioactive materials from containment.*

Event V (Interfacing System LOCA)

During the Reactor Safety Study a potentially large risk contributor was identified due to the configuration of the multiple check valve barriers used to separate the high pressure reactor coolant system from the low design pressure portions of the ECCS (i.e., the low pressure injection subsystem - LPIS). If these valve barriers were to fail in various modes, such as leak-rupture or rupture-rupture, and suddenly exposed the LPIS to high overpressures and dynamic loadings, the RSS judged that a high probability of LPIS rupture would exist. Since the LPIS is largely located outside of containment, the Event V scenario would be a LOCA that bypassed containment and those mitigating features (e.g., sprays) within containment. The RSS assumed that if the rupture of LPIS did not entirely fail the LPIS makeup function (which would ultimately be needed to prevent core damage), the LOCA environment (flooding, steam) would. Predictions of the release magnitude and consequences associated with Event V have indicated that this scenario represents one of the largest risk contributors from the RSS-PWR design. The NRC has recognized this RSS finding, and has taken steps to reduce the probability of occurrence of Event V scenarios in both existing and future LWR designs by requiring periodic surveillance testing of the interfacing valves to assure that these valves are properly functioning as pressure boundary isolation barriers during plant operations. Accordingly, Event V predictions for the RSS-PWR are likely to be conservative relative to the design and operation of the Comanche Peak PWR.

TMLB'-w, q

This sequence essentially considers the loss and nonrestoration of all AC power sources available to the plant along with an independent failure of the steam turbine driven auxiliary feedwater train which would be required to operate to remove shutdown heat from the reactor core. The transient event is initiated by loss of offsite AC power sources which would result in plant trip (scram) and the loss of the normal way that the plant removes heat from the reactor

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*For additional information detail see Appendix V of "Reactor Safety Study," WASH-1400, NUREG-75/014, October 1975.

core (i.e., via the power conversion system consisting of the turbine, condenser, the condenser cooling system, and the main feedwater and condensate delivery system that supplies water to the steam generators). This initiating event would then demand operation of the standby onsite emergency AC power supplies (2 diesel generators) and the standby auxiliary feedwater system, two trains of which are electrically driven by either onsite or offsite AC power. With failure and non-restoration of AC and the failure of the steam turbine driven auxiliary feedwater train to remove shutdown heat, the core would ultimately uncover and melt. If restoration of AC was not successful during (or following) melt, the containment heat removal and fission product mitigating systems would not be operational to prevent the ultimate overpressure (w, q) failure of containment and a rather large, energetic release of activity from the containment. Next to the Event V sequence, TMLB'w, q is predicted to dominate the overall accident risks in the RSS-PWR design.

S_2C-w (PWR 3)

In the RSS the S_2C-w sequence was placed into PWR release Category 3 and it actually dominated all other sequences in Category 3 in terms of probability and release magnitudes. The rebaselining entailed explicit calculations of the consequences from S_2C-w and the results indicated that it was next in overall risk importance following Event V and TMLB'w, q.

The S_2C-w sequence included a rather complex series of dependencies and interactions that are believed to be somewhat unique to the containment systems (subatmospheric) employed in the RSS-PWR design.

In essence, the S_2C-w sequence included a small LOCA occurring in a specific region of the plant (reactor vessel cavity); failure of the recirculating containment heat removal systems (CSRS-F) because of a dependence on water draining to the recirculation sump from the LOCA and a resulting dependence imposed on the quench spray injection system (CSIS-C) to provide water to the sump. The failure of the CSIS(C) resulted in eventual overpressure failure of containment (Δ) due to the loss of CSRS(F). Given the overpressure failure of containment the RSS assumed that the ECCS functions would be lost due either to the cavitation of ECCS pumps or from the rather severe mechanical loads that could result from the overpressure failure of containment. The core was then assumed to melt in a breached containment leading to a significant release of radioactive materials.

Approximately 20% of the iodines and 20% of the alkali metals present in the core at the time of release would be released to the atmosphere. Most of the release would occur over a period of about 1.5 hours. The release of radioactive material from containment would be caused by the sweeping action of gases generated by the reaction of the molten fuel with concrete. Since these gases would be initially heated by contact with the melt, the rate of sensible energy release to the atmosphere would be moderately high.

PWR 7

This is the same as the PWR release Category 7 of the original RSS which was made up of several sequences such as S_2D-ε (the dominant contributor to the risk in this category), S_1D-ε, S_2H-ε, S_1H-ε, AD-ε, AH-ε, TML-ε, and TKQ-ε. All of these sequences involved a containment basemat melt-through as the containment failure mode. With exception of TML-ε and TKQ-ε, all involve the potential failure of the emergency core cooling system following occurrence of a LOCA with the containment ESFs continuing to operate as designed until the base mat was penetrated. Containment sprays would operate to reduce the containment temperature and pressure as well as the amount of airborne radioactivity. The containment barrier would retain its integrity until the molten core proceeded to melt through the concrete containment basemat. The radioactive materials would be released into the ground, with some leakage to the atmosphere occurring upward through the ground. Most of the release would occur continuously over a period of about 10 hours. The release would include approximately 0.002% of the iodines and 0.001% of alkali metals present in the core at the time of release. Because leakage from containment to the atmosphere would be low and gases escaping through the ground would be cooled by contact with the soil, the energy release rate would be very low.

APPENDIX E

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT

United States
Environmental Protection
Agency

Region 6
1201 Elm Street
Dallas TX 75270

Arkansas, Louisiana,
Oklahoma, Texas,
New Mexico

EPA

RECEIVED
DEC 13 1978
R. J. GARY

NPDES DETERMINATION

After considering the facts and the requirements and policies expressed in PL 95-217 and implementing regulations, I have determined that proposed Permit No. TX0065854, Texas Utilities Generating Company - Glen Rose, shall be modified and issued as indicated in a Public Notice of modification, subject to timely certification (or waiver thereof) by the state certifying agency, provided however, that any condition(s) contested in a request for an Adjudicatory Hearing submitted within 10 days from receipt of this determination shall be stayed if the request for a Hearing is granted.

Dated: December 13, 1978

for Howard G. Bergman
Director
Enforcement Division (6AE)

U. S. ENVIRONMENTAL PROTECTION AGENCY/TEXAS

PUBLIC NOTICE

DECEMBER 16, 1978

The purpose of this notice is to indicate substantial changes to the proposed permit(s) identified on the attached list, under the authority of the Clean Water Act of 1977, Public Law 95-217.

It is the Agency's determination to issue the modified permit(s) unless the state certifying agency denies certification prior to the effective date of the permit.

Any person may submit a request for an adjudicatory hearing within 10 days from receipt of the Agency's determination to reconsider the permit(s). The contested provisions of the proposed permit(s) shall be stayed pending final action of the Agency pursuant to 40 CFR 125.36.

Requirements which must be satisfied prior to the granting of a request for an adjudicatory hearing or for request to be party at an adjudicatory hearing may be obtained from 40 CFR 125.36(b), or from available fact sheets. Further information may be obtained by writing:

Mrs. Linda E. Hunter
Environmental Protection Agency
Permits Branch (6AEPAP) Region VI
First Int'l Bldg., 1201 Elm Street
Dallas, Texas 75270

or by telephone (214) 767-2765, between 8:00 a.m. and 4:40 p.m. Monday through Friday.

1. Permit No. TX0065854 for NPDES Authorization to Discharge to waters of the United States, Public Notice of which was issued on June 24, 1978.

The applicant's mailing address is: Texas Utilities Generating Company
2001 Bryan Street
Dallas, Texas 75201

The discharge is made into Squaw Creek Reservoir, a water of the United States which is classified for contact and noncontact recreation and the propagation of fish and wildlife, and is located on that water 4 miles north of the City of Glen Rose, Somervell County, Texas. A fact sheet is not available. The applicant's activity under the standard industrial classificatoin (SIC) code 4911 which results in a new discharge, is the generation of steam electric power.

On February 17, 1977, the Regional Administrator made an initial determination that Texas Utilities Generating Company's Comanche Peak Steam Electric Station would be a new source as defined in Section 306, PL 92-500. This determination was not appealed and subsequently became the final determination that the proposed facility would be a new source. The National Environmental Policy Act (NEPA) is applicable to the issuance of new source permits. The Nuclear Regulatory Commission has assumed the role of lead agency for the purposes of compliance with NEPA. A final environmental impact statement was fled with the Council on Environmental Quality on June 7, 1974.

The substantial changes to the proposed permt are as follows:

Minor changes have been made to the chlorine study plan provisions of Part III.

Permit No. TX0065854
Application No TX0065854

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Water Pollution Control Act, as amended, (33 U.S.C. 1251 et. seq; the "Act"),

Texas Utilities Generating Company
2001 Bryan Street
Dallas, Texas 75201

is authorized to discharge from a facility located at

Glen Rose, Somervell County, Texas

to receiving waters named

Squaw Creek Reservoir

in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts I, II, and III hereof.

This permit shall become effective on January 16, 1979

This permit and the authorization to discharge shall expire at midnight, January 15, 1984

Signed this 21st day of June 1978

Howard G. Bergman
Director
Enforcement Division

EPA Form 3320-4 (10-73)

A- **EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS**

During the period beginning effective date and lasting through expiration date
the permittee is authorized to discharge from outfall(s) serial number(s) 001, reservoir blowdown

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify)			
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	N/A	N/A	(23.9)	(23.9)	Continuous***	Record
Temperature	N/A	N/A	33.9°C(93°F)	33.9°C(93°F)*	Continuous***	Record

* Instantaneous Maximum

*** When discharge occurs

The pH shall not be less than N/A standard units nor greater than N/A standard units and shall be monitored N/A

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s):
At outfall 001, where Squaw Creek Reservoir discharges into the 36 inch pipeline** prior to entry to Lake Granbury.

** Samples to be taken from a tap on the 36-inch return pipeline.

A. **EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS**

During the period beginning effective date and lasting through expiration date
the permittee is authorized to discharge from outfall(s) serial number(s) 002, reservoir overflow

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify) mg/l			
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow-m^3/Day (MGD)	N/A	N/A	(*)	N/A	Daily Average**	Estimate
Temperature	N/A	N/A	N/A	*°C(*°F)	1/day**	Record

* Report
** When discharge occurs

The pH shall not be less than N/A standard units nor greater than N/A standard units and shall be monitored N/A

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s):
At Outfall 002 where Squaw Creek Reservoir discharges from the spillway to Squaw Creek.

E-8

A- **EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS**

During the period beginning effective date and lasting through expiration date the permittee is authorized to discharge from outfall(s) serial number(s) 101, low-volume wastewater**

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify)			
	Daily Avg	Daily Max	mg/l Daily Avg	mg/l Daily Max	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	N/A	N/A	(*)	N/A	Daily Average ***	Estimate
Total Suspended Solids	N/A	N/A	30	100	1/week ***	Grab
Oil and Grease	N/A	N/A	15	20	1/week ***	Grab

* Report

** See Part III

*** When discharge occurs to Squaw Creek Reservoir (This waste stream normally is routed to an evaporative pond.)

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/week by grab sample

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): At outfall 101 where low-volume wastewater is discharged from the drainage system prior to mixing with any other waste stream.

A- **EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS**

During the period beginning effective date and lasting through expiration date the permittee is authorized to discharge from outfall(s) serial number(s) 201, condenser cooling water and previously monitored effluents.

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify)			
			mg/l	mg/l	Measurement	Sample
	Daily Avg	Daily Max	Daily Avg	Daily Max	Frequency	Type
Flow—m^3/Day (MGD)	N/A	N/A	(3168)	(3168)	Continuous[4]	Record
Temperature	N/A	N/A	40.6°C(105°F)[2]	43.3°C(110°F)[1]	Continuous	Record
Free Available Chlorine	N/A	N/A	.2	.5	1/week[3]	Grab
Total Residual Chlorine	N/A	N/A	(Report)	(Report)	1/week[3]	Grab

1 Instantaneous maximum
2 See Part III
3 Samples shall be representative of periods of chlorination
4 Flow rates shall be obtained from pump curve data

The pH shall not be less than N/A standard units nor greater than N/A standard units and shall be monitored N/A

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): At outfall 201 where condenser cooling water and previously monitored effluents are discharged from the discharge canal to Squaw Creek Reservoir.

E-10

A- EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning effective date and lasting through expiration date the permittee is authorized to discharge from outfall(s) serial number(s) 301, treated sanitary sewage effluent(s)

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify)			
	Daily Avg	Daily Max	mg/l Daily Avg	mg/l Daily Max	Measurement Frequency	Sample Type
Flow-m^3/Day (MGD)	N/A	N/A	(*)	N/A	Daily Average	Estimate
Biochemical Oxygen Demand	N/A	N/A	30	45	1/week	Grab
Total Suspended Solids	N/A	N/A	30	45	1/week	Grab

* Report
** See Part III

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/week by grab sample

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): At outfall 301 where treated sanitary sewage effluents are discharged from the sewage treatment plant prior to mixing with any other waste stream.

B. SCHEDULE OF COMPLIANCE

1. The permittee shall achieve compliance with the effluent limitations specified for discharges in accordance with the following schedule:

None

2. No later than 14 calendar days following a date identified in the above schedule of compliance, the permittee shall submit either a report of progress or, in the case of specific actions being required by identified dates, a written notice of compliance or noncompliance. In the latter case, the notice shall include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next scheduled requirement.

C. MONITORING AND REPORTING

1. *Representative Sampling*

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge.

2. *Reporting*

Monitoring results obtained during the previous 12 months shall be summarized for each month and reported on a Discharge Monitoring Report Form (EPA No. 3320-1), postmarked no later than the 28th day of the month following the completed reporting period. The first report is due on April 28, 1979 . Duplicate signed copies of these, and all other reports required herein, shall be submitted to the Regional Administrator and the State at the following addresses:

Howard G. Bergman, Director (6AE)
Enforcement Division, Region 6
U. S. Environmental Protection Agency
First International Bank Building
1201 Elm Street
Dallas, Texas 75270

Mr. Harvey D. Davis, Exec. Director
Texas Department of Water Resources
P. O. Box 13087, Capitol Station
Austin, Texas 78711

3. *Definitions*

a. ~~The "daily average" discharge means the total discharge by weight during a calendar month divided by the number of days in the month that the production or commercial facility was operating. Where less than daily sampling is required by this permit, the daily average discharge shall be determined by the summation of all the measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made.~~

b. The "daily maximum" discharge means the total discharge by weight during any calendar day.

4. *Test Procedures*

Test procedures for the analysis of pollutants shall conform to regulations published pursuant to Section 304(g) of the Act, under which such procedures may be required.

5. *Recording of Results*

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information:

a. The exact place, date, and time of sampling;

b. The dates the analyses were performed;

c. The person(s) who performed the analyses;

d. The analytical techniques or methods used; and

e. The results of all required analyses.

6. *Additional Monitoring by Permittee*

If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved analytical methods as specified above, the results of such monitoring shall be included in the calculation and reporting of the values required in the Discharge Monitoring Report Form (EPA No. 3320-1). Such increased frequency shall also be indicated.

7. *Records Retention*

All records and information resulting from the monitoring activities required by this permit including all records of analyses performed and calibration and maintenance of instrumentation and recordings from continuous monitoring instrumentation shall be retained for a minimum of three (3) years, or longer if requested by the Regional Administrator or the State water pollution control agency.

A. MANAGEMENT REQUIREMENTS

1. *Change in Discharge*

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit. Any anticipated facility expansions, production increases, or process modifications which will result in new, different, or increased discharges of pollutants must be reported by submission of a new NPDES application or, if such changes will not violate the effluent limitations specified in this permit, by notice to the permit issuing authority of such changes. Following such notice, the permit may be modified to specify and limit any pollutants not previously limited.

2. *Noncompliance Notification*

If, for any reason, the permittee does not comply with or will be unable to comply with any daily maximum effluent limitation specified in this permit, the permittee shall provide the Regional Administrator and the State with the following information, in writing, within five (5) days of becoming aware of such condition:

a. A description of the discharge and cause of noncompliance; and

b. The period of noncompliance, including exact dates and times; or, if not corrected, the anticipated time the noncompliance is expected to continue, and steps being taken to reduce, eliminate and prevent recurrence of the noncomplying discharge.

3. *Facilities Operation*

The permittee shall at all times maintain in good working order and operate as efficiently as possible all treatment or control facilities or systems installed or used by the permittee to achieve compliance with the terms and conditions of this permit.

4. *Adverse Impact*

The permittee shall take all reasonable steps to minimize any adverse impact to navigable waters resulting from noncompliance with any effluent limitations specified in this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

5. *Bypassing*

Any diversion from or bypass of facilities necessary to maintain compliance with the terms and conditions of this permit is prohibited, except (i) where unavoidable to prevent loss of life or severe property damage, or (ii) where excessive storm drainage or runoff would damage any facilities necessary for compliance with the effluent limitations and prohibitions of this permit. The permittee shall promptly notify the Regional Administrator and the State in writing of each such diversion or bypass.

6. *Removed Substances*

Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall be disposed of in a manner such as to prevent any pollutant from such materials from entering navigable waters.

7. *Power Failures*

In order to maintain compliance with the effluent limitations and prohibitions of this permit, the permittee shall either:

a. In accordance with the Schedule of Compliance contained in Part I, provide an alternative power source sufficient to operate the wastewater control facilities;

or, if such alternative power source is not in existence, and no date for its implementation appears in Part I,

b. Halt, reduce or otherwise control production and/or all discharges upon the reduction, loss, or failure of the primary source of power to the wastewater control facilities.

B. RESPONSIBILITIES

1. *Right of Entry*

The permittee shall allow the head of the State water pollution control agency, the Regional Administrator, and/or their authorized representatives, upon the presentation of credentials:

a. To enter upon the permittee's premises where an effluent source is located or in which any records are required to be kept under the terms and conditions of this permit; and

b. At reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit; to inspect any monitoring equipment or monitoring method required in this permit; and to sample any discharge of pollutants.

2. *Transfer of Ownership or Control*

In the event of any change in control or ownership of facilities from which the authorized discharges emanate, the permittee shall notify the succeeding owner or controller of the existence of this permit by letter, a copy of which shall be forwarded to the Regional Administrator and the State water pollution control agency.

3. *Availability of Reports*

Except for data determined to be confidential under Section 308 of the Act, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the State water pollution control agency and the Regional Administrator. As required by the Act, effluent data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalties as provided for in Section 309 of the Act.

4. *Permit Modification*

After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term for cause including, but not limited to, the following:

a. Violation of any terms or conditions of this permit;

b. Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts; or

c. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

5. *Toxic Pollutants*

Notwithstanding Part II, B-4 above, if a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the Act for a toxic pollutant which is present in the discharge and such standard or prohibition is more stringent than any limitation for such pollutant in this permit, this permit shall be revised or modified in accordance with the toxic effluent standard or prohibition and the permittee so notified.

6. *Civil and Criminal Liability*

Except as provided in permit conditions on "Bypassing" (Part II, A-5) and "Power Failures" (Part II, A-7), nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance.

7. *Oil and Hazardous Substance Liability*

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Section 311 of the Act.

8. *State Laws*

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or regulation under authority preserved by Section 510 of the Act.

9. *Property Rights*

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

10. *Severability*

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

PART III

OTHER REQUIREMENTS

There shall be no discharge of polychlorinated biphenyl transformer fluid.

The "daily average" concentration means the arithmetic average (weighted by flow value) of all the daily determinations of concentration made during a calender month. Daily determinations of concentration made using a composite sample shall be the concentration of the composite sample. When grab samples are used, the daily determination of concentration shall be the arithmetic average (weighted by flow value) of all the samples collected during that calendar day.

The "daily maximum" concentration means the daily determination of concentration for any calendar day.

The "daily average temperature" shall be computed and recorded on a daily basis as the daily flow weighted average temperature (DFWAT) averaged with the DFWAT for the preceeding 14 days.

The DFWAT is the 24 hour average of the flow weighted average temperature (FWAT) which shall be computed at equal time intervals not greater than two hours. FWAT is calculated as follows:

$$\text{FWAT} = \frac{\text{Summation (Instantaneous Flow X Instantaneous Temperature)}}{\text{Summation (Instantaneous Flow)}}$$

The term "free available chlorine" shall mean the value obtained using the amperometric titration method for free available chlorine described in "Standard methods for the Examination of Water and Wastewater", page 112 (13th edition).

Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than 30 minutes in any one day and not more than one unit in any plant may discharge free available or total residual chlorine at any one time unless 1) the permittee can demonstrate to the permitting Agency that the units in a particular location cannot operate at or below the limitations specified in this permit, or 2) such discharge is part of an approved chlorine minimization program.

The permittee shall submit, for EPA approval, a study plan to demonstrate the minimum level of chlorination required to prevent biofouling of the condenser tubes. This study shall consider seasonal temperature differences, variations in chlorine concentrations and time of chlorination, and predicted water quality changes. It shall be designed to be conducted for at least one calendar year following operation of each unit at greater than 5% of rated thermal power. The study plan shall be submitted within 90 days of the effective date of this permit. Results of the Unit 1 study shall be submitted within 18 months of the operation of Unit 1 at greater than 5% of rated thermal power. Chlorine concentrations determined by this study may be used for modification of chlorine limitations. Results of the Unit 2 study shall be submitted within 18 months of the operation of Unit 2 at greater than 5% of rated thermal power, and the chlorine limitations may be modified where appropriate.

The term "metal cleaning wastes" shall mean any cleaning compounds, rinse waters, or other waterborne residues derived from cleaning and metal process equipment including, but not limited to, boiler tube cleaning, boiler fireside cleaning and air preheater cleaning.

There shall be no discharge of "metal cleaning wastes".

The term "low-volume waste sources" means, wastewaters from, but not limited to: wet scrubber air pollution control systems, ion exchange water treatment system, water treatment, evaporator blowdown, laboratory and sampling streams, floor drainage, cooling tower basin cleaning wastes and blowdown from recirculating house service water systems.

The makeup water intake, located on Lake Granbury, is approved pursuant to Section 316(b) of the Clean Water Act. The applicant shall conduct a program to monitor the impingement and entrainment of organisms at the circulating water intake structure in Squaw Creek Reservoir.

This permit may be modified, or alternatively, revoked and reissued, to comply with any applicable effluent limitation issued pursuant to the order the United States District Court for the District of Columbia issued on June 8, 1976, in Natural Resources Defense Council, Inc. et. al. v. Russel E. Train, 8 ERC 2120 (D.D.C. 1976), if the effluent limitation so issued:

(1) is different in conditions or more stringent than any effluent limitation in the permit; or

(2) controls any pollutant not limited in the permit.

APPENDIX F

EVACUATION MODEL

"Evacuation," used in the context of offsite emergency response in the event of substantial amount of radioactivity release to the atmosphere in a reactor accident, denotes an early and expeditious movement of people to avoid exposure to the passing radioactive cloud and/or to acute ground contamination in the wake of the cloud passage. It should be distinguished from "relocation" which denotes a post-accident response to reduce exposure from long-term ground contamination. The Reactor Safety Study (RSS) (Ref. 1) consequence model contains provision for incorporating radiological consequence reduction benefits of public evacuation. Benefits of a properly planned and expeditiously carried out public evacuation would be well manifested in reduction of acute health effects associated with early exposure; namely, in number of cases of acute fatality and acute radiation sickness which would require hospitalization. The evacuation model originally used in the RSS consequence model is described in WASH-1400 (Ref. 1) as well as in NUREG-0340 (Ref. 2). However, the evacuation model used herein is a modified version (Ref. 3) of the RSS model and is, to a certain extent, site emergency planning oriented.

The model assumes that a plume exposure pathway Emergency Planning Zone (EPZ) is established which is a circular area with a specified radius (such as 10 miles), with the reactor at the center. It is assumed that people living within this area would evacuate if an accident should occur involving imminent or actual release of significant quantities of radioactivity to the atmosphere.

Significant atmospheric releases of radioactivity would in general be preceded by one or more hours of warning time (postulated as the time-interval between the awareness of impending core-melt and the beginning of the release of radioactivity from the containment building). For the purpose of calculation of radiological exposure, the model assumes that all people who live in a fan-shaped area (fanning out from the reactor), within the plume exposure pathway EPZ, with the downwind direction as its median - i.e., those people within the plume exposure pathway EPZ who would potentially be under the radioactive cloud that would develop following the release - would leave their residences after lapse of a specified amount of delay time and then evacuate. The delay time is reckoned from the beginning of the warning time and is the sum of the time required by the reactor operators to notify the responsible authorities, time required by the authorities to interpret the data, decide to evacuate, and direct the people to evacuate, and time required for the people to mobilize and commence evacuation.

While leaving the area, the model assumes that each evacuee would move radially out and in the downwind direction with an average effective speed* (obtained by dividing the plume exposure pathway EPZ radius by the average time taken to clear the EPZ after the delay time) over a fixed distance* from the evacuee's

*Assumed to be of a constant value which would be the same for all evacuees.

starting point which would be somewhat greater than the radius of the plume exposure pathway EPZ; e.g., this distance is selected to be 15 miles when the selected plume exposure pathway EPZ radius is 10 miles. After reaching the end of the travel distance, the evacuee is assumed to receive no further radiation exposure.

The model incorporates a finite length of the radioactive cloud in the downwind direction which would be determined by the product of the duration over which the atmospheric release would take place and the average wind speed during the release. It is assumed that the front and the back of the cloud formed would move with an equal speed which would be the same as the prevailing wind speed; therefore, its length would remain constant at its initial value. At any time after the release, the concentration of radioactivity is assumed to be uniform over the length of the cloud. If the delay time would be less than the warning time, then all evacuees would have a head start, i.e., the cloud would be trailing behind the evacuees initially. On the other hand, if the delay time would be more than the warning time, then depending on initial locations of the evacuees there are possibilities that (a) an evacuee will still have a head start, or (b) the cloud would be already overhead when an evacuee starts out to leave, or (c) an evacuee would be initially trailing behind the cloud. However, this initial picture of cloud people disposition would change as the evacuees travel depending on the relative speed and positions between the cloud and people. It may become possible that the cloud and an evacuee would overtake one another one or more times before the evacuee would reach his or her destination. In the model, the radial position of an evacuating person, while stationary or in transit, is compared to the front and the back of the cloud as a function of time to determine a realistic period of exposure to airborne radionuclides. The model calculates the time periods during which people are exposed to radionuclides on the ground while they are stationary and while they are evacuating. Because radionuclides would be deposited continually from the cloud as it passed a given location, a person while under the cloud would be exposed to ground contamination less concentrated than if the cloud had completely passed. To account for this, at least in part, the revised model assumes that persons are exposed to the total ground contamination concentration calculated to exist after complete passage of the cloud when completely passed by the cloud, to one half the calculated concentration when anywhere under the cloud, and to no concentration when in front of the cloud. The model provides for use of different values of the shielding protection factors for exposure from airborne radioactivity and contaminated ground, and the breathing rates for stationary and moving evacuees during delay and transit periods.

The model has the same provision for calculation of the economic cost associated with implementation of evacuation as in the original RSS model. For this purpose, the model assumes that for atmospheric releases of durations three hours or less, all people living within a circular area of five-mile radius centered at the reactor plus all people within a 45° angular sector within the plume exposure pathway EPZ and centered on the downwind direction will be evacuated and temporarily relocated. However, if the duration of release would exceed three hours the cost of evacuation is based on the assumption that all people within the entire plume exposure pathway EPZ would be evacuated and temporarily relocated. For either of these situations, the cost of evacuation and relocation is assumed to be $125 (1980 dollars) per person which includes cost of food and temporary sheltering for a period of one week.

References

1. "Reactor Safety Study." U.S. Nuclear Regulatory Commission, WASH-1400, NUREG-75/014, October 1975.*

2. "Overview of the Reactor Safety Study Consequences Model." U.S. Nuclear Regulatory Commission, NUREG-0340, October 1977.**

3. "A Model of Public Evacuation for Atmospheric Radiological Releases." SAND 78-0092, June 1978.

*Available free upon written request to the Division of Technical Information and Document Control, U.S. Nuclear Regulatory Commission, Washington, DC 20555.
**Available for purchase from the National Technical Information Service, Springfield, VA 22161.

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16. ABSTRACT (200 words or less)
A Draft Environmental Statement has been prepared that contains the second assessment of the environmental impact associated with operation of the Comanche Peak Steam Electric Station pursuant to the guidelines of the National Environmental Policy Act of 1969 (NEPA) and 10 CFR Part 51 of the Commission's Regulations. The station would be operated by the Texas Utilities Generating Company at a site on Squaw Creek Reservoir in Somervell County, Texas. The facility will employ two pressurized water reactors to produce 3411 megawatts thermal per unit. A steam turbine generator will use this heat to provide 1159 megawatts electric per unit. The staff assessed the terrestrial, aquatic, radiological, social, and economic benefits and costs associated with station operation, considered station accidents, their likelihood of occurrence, and their consequences; and also updated the discussion of need for power based on information available in 1980. The staff concludes that the station's engineered safety features provide for protection of the environment; that operation of the station will be less expensive than any other generation alternative; that the benefits of increased availability of electric power, contributed as an increase in other than gas- or oil-fired baseload capacity, outweigh the environmental and economic costs created by the station; and that the action called for is the issuance of operating licenses for Units 1 and 2.

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