DIRECT TESTIMONY OF

EDWIN E. SCHOENBERGER

ON BEHALF OF HOUSTON LIGHTING & POWER COMPANY

RE HINDERSTEIN CONTENTION 5/COASTAL SITE

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RE COASTAL SITE

Q. Please state your name and position.

A. My name is Edwin E. Schoenberger. I am a Vice President of TERA, a company specializing in energy and environmental engineering.

Q. Please describe your educational background.

A. I have a B.S. degree from the U.S. Naval Academy and an M.S. degree from The Ohio State University in Nuclear Engineering.

Q. Please describe your employment experience.

A. Following my graduation from the U.S. Naval Academy in 1964, I served in the U.S. Navy's nuclear submarine program for five years. During this period I performed duties as Engineering Officer of the Watch on the SIC nuclear submarine reactor prototype and the S5W nuclear submarine reactor. Following my graduation from Ohio State in 1970, I went to work for Bechtel Power Corporation, a leading architectural and engineering firm engaged in power plant design. While at Bechtel I worked on the engineering and licensing of the Hope Creek and Limerick nuclear plants. With respect to the Limerick plant I was the supervisor in charge of both environmental and safety licensing matters. In 1973 I went to work for TERA and during my employment with TERA I have participated in and directed numerous power plant siting studies. I have conducted siting studies for

Houston Lighting & Power Company, Central Power & Light Company, West Texas Utilities Company, City Public Service Board of San Antonio, Public Service Company of Oklahoma, Southwestern Public Service Company, Lower Colorado River Authority and Texas Municipal Power Agency.

Q. Are you a Registered Professional Engineer?

A. Yes, I am a registered Mechanical Engineer and a registered Nuclear Engineer.

Q. What is the purpose of your testimony?

A. I have been asked by HL&P to testify in connection with Hinderstein Contention 5, which is basically as follows:

> "Petitioner alleges that, in light of the increasing demands upon fresh water, the possibility of an alternative site on the Texas Coast to utilize sea water as a coolant should be explored."

Q. Have you conducted an evaluation of potential coastal sites in or near HL&P's service area?

A. Yes. In 1974 TERA was retained by HL&P, for reasons unrelated to the present case, to undertake an extensive study of potential future sites for the location of new power plants. The study results were published in 1975. In the study we identified approximately 200 potential sites.

Q. How does this study relate to the contention in question?

A. When I was asked to address the contention, I reexamined our 1975 study to determine if there were any coastal sites suitable as alternatives to the Allens Creek site. The 1975 TERA study area included not only the totality of Houston Lighting & Power Company's service area, but also included a significant land area outside of the HL&P service area. The area which was screened for sites covered an area of approximately 24,000 square miles in and around the HL&P service area. The regional screening phase of the study allowed us to screen out the areas where we knew that there could not be a potential site due to factors such as inadequate water supply, undesirable aquifer characteristics, geologic hazards, or high population densities and/or conflicting land uses. Therefore, by definition, sites identified in the remaining region (Candidate Area) can be assumed to be viable sites, with further, more detailed evaluation being required to determine any ranking among the sites. Out of the sites catalogued in the study, there were seven coastal sites that could be considered for comparison with Allens Creek. I have undertaken an analysis of each of those sites and compared them with the Allens Creek site. The factors used in the comparative analysis are described later in my testimony.

Q. Did you prepare a separate coastal siting study summarizing your analysis?

A. Yes. The study is presented here as Applicant Exhibit ___ (EES 1).

Q. What conclusion did you reach in your coastal siting study?

A. It was concluded that none of the coastal sites are superior to the Allens Creek site for purposes of siting a nuclear plant.

Q. Was the Allens Creek site covered in the 1975 study?

A. At the time of our 1975 study the Allens Creek site was treated as an existing two unit site at which two additional units might be added. In order to prepare the analysis in Exhibit EES 1, I had to reevaluate the Allens Creek site as though it were a new site thereby treating it in the same manner as the other sites in our 1975 study. The Allens Creek site was rated on the same rating scale as the seven coastal sites to insure that there was no bias in comparing the Allens Creek site to these sites. The information in Exhibit EES 1 is consistent with, but not a substitute for, the more detailed information in Applicant's environmental and safety reports.

Q. Was the Brazoria County site in the 1975 study?

A. The Bz-1 site in Brazoria County, which is 25 miles southwest of Galveston, was evaluated in January, 1979, in response to questions from the NRC Staff in connection with the Staff's updated alternative sites evaluation. Both HL&P and the Staff had previously rejected the San Jacinto Basin on the basis of water availability. However, under the NRC's practice, it was determined that it was necessary to identify a specific site in this region. TERA was retained to make this evaluation and the Brazoria County site was selected for purposes of the evaluation sought by the NRC staff. Coincidentally, the Brazoria County site is a coastal site so I included it in the comparison provided in Exhibit EES 1.

Q. Would you please list the sites that were considered in EES 1?

A. They are as follows:

Site	County	Nearest Communities	Type of Heat Dissipation System
Au-1 (Allens Creek)	Austin	4 mi. NW of Wallis; 8 mi. SE of Sealy; 45 mi. W of Houston	Cooling Pond (Freshwater)
Bz-1	Brazoria	15 mi. NE of Freeport; 25 mi. SW of Galveston; 50 mi. SSE of Houston	Once Through (Saltwater)
Ch-1	Chambers	5 mi. NW of Winnie; 10 mi. S of Nome; 57 mi. E of Houston	Cooling Pond (Saltwater)

Site	County	Nearest Communities	Type of Heat Dissipation System
Je-2	Jefferson	27 mi. SW of Port Arthur; 9 mi. NE of High Island; 67 mi. E of Houston	Cooling Pond (Saltwater)
Je-3	Jefferson & Chambers	5 mi. N of High Island; 13 mi. S of Winnie; 60 mi. E of Houston	Cooling Pond (Saltwater)
Ma-1	Matagorda	2 mi. SE of Sargeant; 13 mi. S of Sweeney; 65 mi. SW of Houston	Cooling Pond (Saltwater)
Ma-2	Matagorda	7 mi. W of Sargeant; 15 mi. SW of Bay City; 70 mi. SW of Houston	Cooling Pond (Saltwater)
Ma-3	Matagorda	9 mi. NE of Matagorda; 13 mi. S of Bay City; 73 mi. SW of Houston	Cooling Pond (Saltwater)

The location of each of these sites is shown on Figure 3.2-1 of Exhibit EES 1.

Q. Please describe the factors you used in comparing these sites.

A. Each of these sites were evaluated on the basis of several site selection factors, including (1) geology and seismology, (2) meteorology, (3) hydrology, (4) ecology, (5) demography, (6) land use, (7) aesthetics, (8) transportation, and (9) economics. Exhibit EES 1 contains an analysis of each of the sites based on each of these factors. The final rating is shown on the Candidate Site Evaluation Matrix, Figure 3.5-1 of Exhibit EES 1. As can be seen, the

Allens Creek site had the highest overall ranking on the Matrix.

Q. How was the Matrix developed?

A. The Matrix was developed by using both quantitative and qualitative evaluation methods to rate each candidate site based upon the factors I described earlier. The qualitative assessment provides a means for rating the intangible or non-quantifiable features of each site. The quantitative assessment is primarily a numerical evaluation of economic, environmental and licensing evaluation factors. The method involves rating each factor using a zero-to-five scale, where zero is least desirable and five is most desirable. For each of the factors, an evaluation is made of relevant characteristics to establish the appropriate numerical rating. Appendix A of Exhibit EES 1 provides the definitions for the rating system.

Q. Why did you use the combination of qualitative and quantitative analyses?

A. Either approach alone is a legitimate basis for this type of evaluation process. When the two are combined they complement and serve as a check on each other.

Q. Was each rating factor in the quantitative assessment given equal weight?

A. No. The factors were weighted in order to account for the relative importance of each of the factors. The weights given to each factor are described in Exhibit EES-1. The numerical rating given to each category for each site is multiplied by the appropriate weighting factor. The overall site rating number is obtained by totaling the various categories for each site. The sites with the highest total would naturally be the most desirable.

Q. Did you conduct any sensitivity analysis in order to make certain that the rankings were not biased by the weighting scale or other factors?

A. Yes. Sensitivity analyses were conducted on both the site rankings presented on the Matrix and the economic evaluation discussed in Section 3.3 of Exhibit EES 1 to determine the significance of parameter variation on site evaluation. The sensitivity analysis results demonstrate that the Allens Creek site remains the highest ranked site and is insensitive to 40% changes in economic, environmental and licensing weighting factors.

Q. What was the result of your qualitative analysis?

A. As can be seen from an examination of the Matrix, every site but Bz-1 was considered acceptable from the standpoint of environmental and licensing considerations, which is in keeping with the definition of Candidate Area. Thus, it is obvious that the sites selected were viable sites for consideration as alternatives to the Allens Creek site. Indeed, the six sites selected were the top six coastal sites in our 1975 study.

Q. Taking into account both quantitative and qualitative evaluations, what was your conclusion regarding the acceptability of the sites you examined?

A. None of the sites rated higher than the Allens Creek site in terms of overall ranking. More importantly, none of the sites rated as environmentally superior to Allens Creek.

Q. Would you please provide a brief summary on each site?

A. The Brazoria County (Bz-1) site is comparable to the Allens Creek only on the factors of meteorology, hydrology and demography. However, the site rated unacceptable on the factors of geology and ecology. With respect to geology, this site is located in an area of salt dome influence which raises a potential for subsurface fault activity. Moreover, the site is in a potential hurricane washover channel. With respect to the ecological factors, this site is located in a coastal region considered to be of particular environmental concern. Construction and operation activities such as dredging, spoil placement and operation of a cooling water intake system and thermal discharge system could affect the biota of Saint Louis Pass, Cold Pass, Churchill

Bayou, Christmas Bay and the near-shore Gulf, and possibly cause significant negative ecological impacts.

The Chambers County (Ch-1) site is comparable to the Allens Creek site in terms of meteorology, ecology and demography; however, this site rated undesirable in terms of land use considerations. The land on this site is very valuable agricultural land because it is presently used for rice farming.

The first Jefferson County (Je-2) site rated comparably to the Allens Creek site in terms of meteorology, demography and land use, but was rated low on the basis of ecology. This site is almost completely marshland and thus provides an extensive habitat area for waterfowl. The marsh may serve as a nursery ground for marine species such as shrimp, crab and various fishes.

The second Jefferson County (Je-3) site is comparable to the Allens Creek site in the areas of meteorology and demography. In no instance did any of the factors compare more favorably with respect to this site than at the Allens Creek site and in at least two instances, ecology and aesthetics, the Allens Creek site was superior.

The first Matagorda County (Ma-1) site rated comparably with the Allens Creek site in terms of meteorology and demography; however, it received a lower rating on all other factors, and in at least two instances, ecology and aesthetics, was ranked as marginally acceptable.

The second Matagorda County (Ma-2) site is comparable with the Allens Creek site only in terms of meteorology and demography. The site rated less favorably than Allens Creek on every other factor, and again was considered marginally acceptable on the factors of ecology and aesthetics for the same reasons as the Ma-1 site.

The third Matagorda County (Ma-3) site is comparable with Allens Creek in terms of meteorology and demography. It had a lower rating than Allens Creek in every other category, and was considered marginally acceptable in aesthetics. Like sites Ma-1 and Ma-2, the topography of the site area is very flat and the reactor building complex and transmission lines would be visible from the town of Matagorda, the Intercoastal Waterway, Matagorda Bay and the highways near the area.

Q. As a general matter, is it likely that any coastal site would be superior to the Allens Creek site from an environmental standpoint?

A. No. Coastal sites are often located in or adjacent to marshland areas. Construction in these marshland areas can impact the productivity of the marshland, and thus the productivity of the Gulf Coast offshore areas. While such an affect is not necessarily significant, no such complication exists at Allens Creek. Moreover, the use of salt water requires construction of intake and discharge facilities that are more likely to be an ecological threat than the intake and discharge facilities to be located in the Brazos River at the Allens Creek site. The portion of the Brazos River passing near the Allens Creek site is not a highly productive area from the standpoint of aquatic organisms. By contrast, where you are dealing with the intake and discharge structures for the use of saltwater cooling, there is necessarily a greater potential for impingement and entrainment losses than would be associated with operation of intake and discharge facilities for the Allens Creek project. Therefore, in this case, I do not believe a coastal site is likely to be more ecologically desirable than the Allens Creek site.

Q. Would your answer be different if you were to assume the use of salt water cooling towers on those sites where you assumed the use of a cooling pond for purposes of your evaluation?

A. No, it would not. When all of the environmental/licensing site evaluation factors are considered together, the relative rankings of the coastal sites would not change relative to the Allens Creek site. The major environmental factor considered in analyzing the use of salt water towers in utility service is that of salt water drift and its resultant deposition. Drift damage will affect local vegetation, switch yard equipment, parked automobiles, housing and other structures in the site vicinity. There are also problems with blowdown from the tower basin, fogging and icing, noise and aesthetics. In my opinion local ecological impacts would be approximately equal for both salt water cooling lakes and towers since the additional land preempted by a cooling lake is essentially offset by losses caused by salt deposition associated with cooling towers.

Q. Does that conclude your testimony?

A. Yes.

Applicant Exhibit No. ____ (EES-1)

COASTAL SITE COMPARISON REPORT

TERA CORPORATION

COASTAL SITE COMPARISON REPORT

Submitted to:

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P.O. Box 1700
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November, 1980

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1.0 INTRODUCTION

1.1 BACKGROUND

In 1974 TERA was retained by Houston Lighting & Power Company (HL&P) to undertake an extensive study of potential future sites for the location of new power plants. The study results were published in 1975. In the 1975 study, TERA identified 16 new power plant sites, and catalogued a total of approximately 200 potential sites.

In 1979 Houston Lighting & Power Company retained TERA Corporation to prepare testimony related to Hinderstein Contention 5:

> "Petitioner alleges that, in light of the increasing demands upon fresh water, the possibility of an alternative site on the Texas coast to utilize seawater as a coolant should be explored."

TERA reexamined its 1975 study to determine if there were any coastal sites suitable for consideration as alternatives for the Allens Creek site. In this regard, the 1975 study area included not only the totality of Houston Lighting & Power Company's service area, but also included a significant land area outside of the HL&P service area. The area which was screened for sites is an area bounded to the west by longitude 96° 30', to the north by latitude 30° 45', to the east by the Neches River and to the south by the Gulf of Mexico, an area including approximately 24,000 square miles. The regional screening phase of the 1975 study allowed us to screen out the areas where we knew that there could not be a potential site due to factors such as inadequate water supply, undesirable aquifer characteristics, geologic hazards, or high population densities and/or conflicting land uses. Therefore, by definition, sites identified in the remaining region (candidate area) can be assumed to be viable sites, with further, more detailed evaluation being required to determine the more desirable sites. Out of the sites catalogued in the 1975 study, TERA determined that seven coastal sites were proper for comparison with Allens Creek.

1.2 OBJECTIVE

The primary objective of this coastal site comparison is to compare the seven coastal sites identified in the 1975 study with the Allens Creek site, and determine if any of these coastal sites are superior to the Allens Creek site for purposes of siting a nuclear power plant.

1.3 PLAN OF APPROACH

The overall plan of approach was developed to meet known regulatory requirements and, in addition, to take into account engineering, economic, environmental and current licensing practice.

The siting study was performed in three phases:

I. Regional Screening

II. Selection of Candidate Site Alternatives

III. Site Selection

PHASE I: REGIONAL SCREENING

In the Regional Screening Phase, the 1975 site study region was established, and a detailed review of existing siting reports and other published information was conducted.

The regional screening phase of the study was conducted. This phase delineated those areas within the study region which contained areas of such serious concern that it appeared unproductive to seek sites in those regions. The regional screening criteria excluded areas with inadequate water supplies; areas with undesirable aquifer characteristics; areas with geologic hazards; areas with high population densities and areas with conflicting land use planning objectives; and identified the presence of other regional screening attributes.

After finalizing the site selection criteria, the regional screening was performed. A series of regional screening maps was developed and utilized to conduct the regional screening. The various screening maps included:

- Geologic Map
- Surface Linears and Faults Map
- Subsurface Faults Map
- Mineral Resources Map
- Geologic Hazards Map
- Land-Use Map
- Construction Suitability Map
- Flood-Prone Areas Map
- Aquifer Map
- Inland Water Availability Map
- Normal-Flow Water Quality Map
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- Demography Map
- Environmentally Sensitive Areas Map - Fauna
- Environmentally Sensitive Areas Map - Flora
- Meteorology Map
- Transportation Map
- Aircraft Flight Zones Map
- Generating Stations and Transmission Lines Map
- Previously Studied Power Plant Sites Map

Areas of the study region within which licensable cost-effective candidate sites could be selected were identified by considering certain of the regional screening criteria described above to be exclusionary. A composite map was thus prepared which eliminated certain areas based upon those criteria. The remaining non-excluded areas were designated as candidate areas. As a result of this level of screening, areas unlikely to contain acceptable power plant sites are effectively removed from further consideration. Thus, candidate sites selected in candidate areas are likely to be economically and environmentally acceptable and licensable.

PHASE II: SELECTION OF CANDIDATE SITE ALTERNATIVES

The data and information collected during Phase I concerning the candidate areas were reviewed and, where appropriate, additional information was collected to further refine the evaluations. Within the favorable candidate areas, a set of candidate site alternatives was identified. The factors used in selecting these alternatives were essentially those factors shown on regional screening maps, except that they were analyzed in greater depth.

A cost effectiveness comparison of the candidate site alternatives was conducted using the appropriate factors from NRC Regulatory Guide 4.2, "Preparation of Environmental Reports for Nuclear Power Stations."

PHASE III: SITE SELECTION

The evaluations conducted in Phase II were reviewed and modified or revised as required to further characterize the areas. This process became necessary as additional detailed information was acquired as the site selection became more specific. An overall economic ranking of sites was established and a comparison of values for site selection evaluation factors was prepared.

2.0 REGIONAL SCREENING

2.1 INTRODUCTION

After establishment of the 1975 site study region and a detailed review of existing literature, the regional screening phase of the study was conducted. This phase delineated those areas within the study region which contained areas of such serious concern that it appeared unproductive to seek sites in those regions. The regional screening criteria excluded areas of high population density; areas with inadequate water supplies; areas with undesirable aquifer characteristics; and areas with conflicting land use planning objectives.

As a result of this screening, the various licensable areas were identified and designated as candidate areas.

2.2 METHODOLOGY

Regional screening was accomplished by performing the following tasks:

ESTABLISHMENT OF THE SITE STUDY REGION

The 1975 site study region was established using logical geographical and licensing considerations. The study area included not only all of the Houston Lighting & Power Company service area, but also significant land area outside of the normal Houston Lighting & Power boundaries. It is bounded to the west by longitude 96° 30'; to the north by latitude 30° 45'; to the east by the Neches River and to the south by the Texas territorial boundary in the Gulf of Mexico.

The western boundary was established based on three criteria: power load center location, transmission line distance, and safety. The Houston Lighting & Power Company load center is located south of Houston which then provided an economic western boundary based on transmission losses and load flow. Concentrated student jet training areas are located on Matagorda Island and directly north of Matagorda Island. These areas were excluded due to safety considerations.

The northern boundary was established based on three criteria: power load center location, transmission line distance, and land use. The Houston Lighting & Power Company load center location establishes an economic northern boundary based on transmission losses and load flow. The Sam Houston National Forest is directly north of Houston and was considered excluded by land use. The area within the forest was excluded from being a candidate area.

The eastern boundary was established based on the natural geographic delineation formed by the Texas-Louisiana state border on the Gulf Coast and the Neches River. Sites east of the river were considered to be outside of the economically feasible boundaries.

The southern boundary was formed by the Texas State territorial limits into the Gulf of Mexico. These limits extend 3 marine leagues (10-1/3 miles) into the Gulf from the coast.

REVIEW OF EXISTING REPORTS

Existing siting reports, the Allens Creek Environmental Report, and South Texas Project Environmental Report were reviewed in order to compile existing data and thereby avoid duplication of data collection.

COLLECTION OF INFORMATION

The information requirements were reviewed and data not already held was collected. This new data included information from relevant unpublished investigations and reports. The information sources utilized are provided in the list of references (Section 4.0).

COMPARISON OF INFORMATON SOURCES

For the 1975 study, collected information was correlated and contradictions were investigated. Where differences could not be readily clarified, the more conservative information was utilized.

PERFORMANCE OF REGIONAL SCREENING

The collected information and approved evaluation criteria were used to characterize the region by developing a set of regional screening maps.

2.2.1 SCREENING FACTORS

2.2.1.1 GEOLOGY AND SEISMOLOGY

EVALUATION CRITERIA

The NRC has promulgated guidance concerning the criteria by which a proposed nuclear power plant should be evaluated with respect to seismic, geologic, and topographic information (References 2-1 and 2-2). Basically, the worst areas of geologic hazard should be avoided. Any site where a geologic event has either induced a disaster in the past, or might induce one in the future, should be avoided. The most restrictive safety-related site characteristics considered in determining the suitability of a site are surface faulting, potential ground motion and foundation conditions (including liquification, subsidence and landside potential, Reference 2-3).

Areas preferred for nuclear power plants have good soil stability, limited topographic relief and adequate drainage. Although in most cases unstable natural surface slopes can be dealt with through good engineering, areas where the problem does not exist are preferred.

Investigative criteria to evaluate subsidence and its effects are presented in 10 CFR 100 Appendix A (Reference 2-1). In the regional study, areas of potential surface disruption from activities such as heavy petroleum or groundwater withdrawal mining, and underground solution cavities were avoided.

REGIONAL GEOLOGY

The geologic surface of the study region is composed entirely of sedimentary strata deposited since the Eocene, that is, within the last 60 million years. The sediments are unconsolidated or poorly consolidated gravels, sands, silts and clays brought to the coast by rivers during Gulfward progradation of successive delta systems. The sediments of the region are differentiated in two time intervals, the Tertiary-Pleistocene and the Modern-Holocene.

- Tertiary-Pleistocene systems are composed of fluvial (river), fluvial-deltaic (river-delta — delta-marine) and strandplain sediments. The fluvial system is composed of coarse-grained sediments deposited in braided streams, coarse- and fine-grained meanderbelts and alluvial fans. These sediments are the most consolidated of the sediments in the area and are locally cemented. The fluvial -deltaic system contains fine- to very fine-grained meanderbelts, abandoned channels, and deltas. The delta facies include distributary sands, interdistributary muds, and deltafront sands. The strandplain facies, deposited along ancient coasts by long-shore currents, are well-sorted, medium-grained sand bodies.

- Modern-Holocene systems include fluvial-deltaic, barrier-strandplain, and marsh facies. The fluvial-deltaic system includes levees, overbank muds, entrenched-valley fill, meanderbelt sands, interdistributary silts and muds, and mud-filled channels. Modern barrier island and coastal beach sands make up the barrier-strandplain system. The marsh system includes mud, silt, and organic material of fresh water swamps, and fresh and salt water marshes in estuaries, lagoons and tidal flats.

Genetic or geologic process maps more accurately delineate sediment character than the strict formational maps of the Geologic Atlas of Texas.

Regional geology provides the foundation for understanding the nature of surface materials and is the data base for derivative maps. Construction suitability and aquifer maps are examples of derivative maps used in the regional screening or cost comparison processes.

The regional geology map was compiled using maps by Proctor (Reference 2-4), Fisher and others (Reference 2-5) and Achalabhuti (Reference 2-6). Proctor's map was the geologic base for the area east of Matagorda, Wharton and Colorado

Counties. From the coast to 50 miles inland, Proctor's map was itself based on earlier work by Fisher and others (Reference 2-7). Proctor mapped the rest of his area on large-scale aerial photographs. Data for the area west of the boundaries of Proctor's map, from the coast to 50 miles inland, was obtained from Fisher and others (Reference 2-5). The small remaining area was covered by Achalabhuti. All map units are consistent with the terminology of Proctor.

SURFACE LINEARS AND FAULTS

Surface faults, photo-linears and sections of photo-linears coincident with the surface traces of subsurface faults were mapped.

Also mapped were segments of projected subsurface faults that coincide with a photo-linear. Linears were plotted for the area from the coast to 50 miles inland; however, these linears are not considered to be of any geological significance unless they correlate with faults.

Subsurface fault projections were made for the entire study area except for a large circular area centered on Houston which was excluded from site consideration by demography. Definitons of surface faults, growth faults (fault subject to creep), subsurface faults and photo-lineations as used in the regional screening process are listed in Table 2.2-1.

Movement along faults in the Houston area occurs as slow fault creep rather than catastrophic movement. For this reason, earthquakes are not expected to be associated with fracturing along these faults. Furthermore, earthquake foci are known to occur where faults juxtapose crystalline rocks. The faults along the Texas Coastal Plain are included entirely within the sedimentary rock section that overlies the crystalline basement rocks.

Although ground shaking and other problems associated with fault seismicity are improbable in the Houston area, ground surface displacements are common on many of the identified surface faults. Total scarp heights range up to as much as 40 feet at the Hockley scarp northwest of Houston (Reference 2-8). Rates of

TABLE 2.2-1

FAULT AND PHOTO-LINEATION DEFINITIONS

1. Surface Fault:

   A fault recognized on the land surface by: (1) disruption of man-made objects, for example, breaks in street pavements, foundations, highways and airport runways; (2) topographic scarps defined by an abrupt steepening of land surface either in flat areas or areas of gentle slope; (3) sharp breaks in rates of subsidence as determined from cumulative topographic profiles; and (4) anomalies in natural patterns such as drainage or vegetation. (Reference 2-7).

2. Capable Fault:

   A surface fault that has experienced movement in the last 35,000 years.

3. Subsurface Fault:

   A fault identified by various subsurface geologic and geophysical evidence such as lithologic well-logs, subsurface maps, cross sections, trenches, reflection and refraction seismology and geophysical well logs.

4. Photo-Lineation:

   A visual lineation on air photo maps which suggests closer inspection for the possibility of a possible fault.

5. Growth Fault:

   A fault subject to creep. The creep surface was formed contemporaneously with sediment deposition such that strata are typically thicker on the downthrown side and the magnitude of displacement increases with depth.

movement along faults in the Houston-Galveston area range from 0.8 inches per year to 4.7 inches per year with an average of 1.3 inches per year (Reference 2-9). These faults are capable of causing structural damage, as evidenced by damage to airport runways, highways, railroad tracks and buildings.

Surface faults and the surface trace of subsurface faults show strong parallelism and in some cases are coincident. Many subsurface faults die out before reaching the surface. Brown and others (Reference 2-8) state:

> "The similarity in trend of surface and subsurface faults indicates that most surface faults are probably genetically related either to long-trending coastwise fault systems extending upward from several thousand feet below surface and/or to faults associated with the numerous salt domes of the area. Faults radiating from salt domes may explain why some surface faults trend perpendicular to the common coastwise trend. Where verified, the association between surface and subsurface faults indicate that some surface faults are products of natural geologic processes."

Surface faults in the northwestern part of the study region were taken from Barnes (References 2-12 and 2-13). The linears and surface faults near Houston are from Fisher and others (Reference 2-7) and a prepublication map by Fisher and others (Reference 2-5). The coincident parts of the photo-linears and subsurface fault projections were determined by overlaying one map on the other and designating the coincident sections. Where there is no correlation between photo linears and subsurface fault projections the linear may be disregarded for geologic purposes.

The projection of subsurface faults to the surface was made by using a standard cross-section profile for Gulf Coast growth faults and determining the horizontal offset between the subsurface and surface traces. The fault was then replotted in the offset position, parallel to its subsurface trace.

MINERAL RESOURCES

Locations of known, probable and possible oil and gas, sulfur, and coal or lignite deposits were mapped. Five hundred forty-six (546) oil and gas fields cover approximately 2200 square miles. Thirteen sulfur deposits may cover as much as 42 square miles of the study region. Three identifiable zones containing coal or lignite underlie 12,000 square miles. Coal or lignite occurs at the surface outcrop to depths greater than 8,000 feet which are far below current and projected mining depths. The quality of this coal and lignite ranges from moderate to poor. Therefore, coal and lignite deposits of every quality and depth were identified separately. Contour lines were used to indicate the formation, the number of coal and lignite beds within the formation and their elevations.

The location of mineral resource deposits is needed in regional screening for power plant sites to:

- Indicate areas that may be susceptible to subsidence because of subsurface mineral extraction; substantial ground surface subsidence may accompany mineral extraction. More than three feet of land surface subsidence is attributed to oil and gas extraction in the Goose Creek oil field (Pratt & Johnson, 1926). Poor production practices in early history of the field are believed to have been the primary cause of this subsidence. Surface subsidence has accompanied extraction of sulfur by the Frasch process at Hoskins Mound, Brazoria County, Texas, and at Boling Dome, Wharton County, Texas.

- Minimize interference with extraction of mineral resources. Because spot shortages of many minerals occur with increasing frequency and the cost of these commodities continues to increase as richer and more convenient deposits are exhausted, government regulatory agencies are instituting policies to insure that land-use patterns do not preclude ultimate extraction of valuable mineral resources.

- Assess the susceptability of a site to potential accidents at nearby mineral production. Such accidents include oil or gas well blow-outs, mine explosions and explosions or fires in a mineral processing plant.

To reduce possib'e si*:ıg problems associated with mineral resources, potential sites impinging on known mineral extraction were, in general, eliminated from considerations. A Mineral Resources Map was developed using the following sources:

- The outlines of the oil and gas fields on the regional maps were taken from the Texas Highway Department's county highway maps, which are published at a scale of 1/4 inch = 1 mile. One or two maps cover an entire county, showing roads, pipelines, individual oil and gas wells, oil and gas field outlines, electrical transmission lines, buildings, windmills, and other cultural features. The oldest cultural base map used for the compilation of the mineral resources map was published in 1962; the majority were published in 1968 or later. Where individual oil and gas wells were shown on the county maps, the field boundary was defined by drawing a line around the outermost wells of a group. When the fields were delineated on the county highway maps, the boundary was used without modification. The oil and gas fields shown on the highway maps were checked against the Transcontinental Gas Pipeline Corporation map of the Texas Gulf Coast. This map, published in 1973 at a scale of approximately 1/8 inch = 1 mile, shows oil and gas fields and major petroleum transmission pipelines. Any discrepancies between the two sources were resolved by using the larger of the field areas shown on either map.

- Sulfur production on the upper Texas Gulf Coast comes from the gypsum, anhydrite, limestone and dolomite caprock on the top of shallow piercement salt domes. The names of sulfur-productive domes are listed by Ellison (Reference 2-14). The location of these domes and their areal extent were obtained from the Tectonic Map of Gulf Coast Region U.S.A. (Gulf Coast Association of Geological Societies and American Association of Petroleum Geologists, 1972, scale 1:1,000,000). The areas of sulfur production were increased to coincide with the dome area.

- The distribution of lignite and coal deposits was taken from open-file maps by Fisher and others at the Texas Bureau of Economic Geology. The elevation of the various lignite-bearing formation tops were derived from subsurface structural contour maps (Scale 1:48,000) of the Geomap Company (Dallas), a petroleum industry service company.

GEOLOGIC HAZARDS

A Geologic Hazards Map was prepared showing the location of: zones of influence surrounding salt domes and shale diapirs; hurricane washover channels; and zones of shoreline erosion or accretion. Another geologic hazard of the Texas Coastal zone is subsidence. These geologic features and processes require careful evaluation in determining the suitability of a site located on the Texas coastal plain because of the following:

- Salt domes and shale diapirs could cause possible large-scale differential ground movement due to:
  - direct uplift by the dome
  - subsidence of the rim syncline
  - discrete motion along trapdoor faults or crestal stretch faults
  - subsidence or fault activity resulting from the extraction of oil, gas, sulfur, water or sand from the dome or the sediments peripheral to it.
- Hurricane washover channels are storm-created passes activated as storm surge waters cross barrier islands. The hurricane surge waters cause erosion, deep floods and tidal flows of high velocity which would cause severe damage to structures.
- Shoreline erosion can occur at very high rates. This could cause a site initially protected by a barrier island to have portions of its structures become offshore during the life of the plant. Such a site would have to be bordered by a sea wall and elevated or diked to provide hurricane surge tide protection.

  Subsidence when occurring locally can cause foundation problems. These problems are commonly associated with differential ground movement across growth faults and the resulting changes in slope gradients.

Other geologic hazards of the Texas coastal zone include flooding and ground surface displacement across faults. The latter two subjects are sufficiently important to have been treated separately.

SALT DOMES AND SHALE DIAPIRS

Salt domes are tall spires of salt 1/2 to 10 miles in diameter extending upward from deeply buried "mother" salt beds. Uneven sediment loading of the mother salt bed causes the salt to be squeezed from beneath the sediments into salt spires or domes. This causes the dome to grow upwards, uplifting and arching the sediments overlying the dome, which in turn are broken and fractured in the process. The withdrawal of salt from the area peripheral to the dome results in the formation of a rim syncline or subsidence moat around the dome. Shale diapirs are thought to have identical origins. The area of influence around both salt domes and shale diapirs is affected by growth of the feature.

Uplift of the ground surface is evidenced on many domes along the Texas and Louisiana coastal plain (for example, Weeks Island and Avery Island in Louisiana and High Island, Barbers Hill, Spindletop and Hoskins Mount on the upper Texas coast). Across each of these domes, the ground surface is elevated as much as 50 feet above the surrounding coastal plain. At Barbers Hill, a late Pleistocene alluvial channel (less than 10,000 years old) has been uplifted a minimum of 36 feet since its deposition. Uplift over the other domes cited likely occurs at even greater rates, but the evidence is not as definitive.

Subsidence of the rim syncline is not obvious at the surface because the resulting topographic depression is continuously filled with sediment. However, subsurface exploration demonstrates that this activity is continuous with dome growth.

Ground surface disruption is also a hazard in these influence zones. The geologic record proves a direct cause-effect relationship between dome growth and both trapdoor faults and crestal stretch faults. Growth faults of both types have been observed at Mykawa Dome in southeast Houston. Movement along these faults has broken street pavements and runways at Hobby Airport and has disrupted the foundation of many structures in the area.

Salt domes are commonly the hosts for many valuable mineral deposits. The extraction of these minerals has commonly led to ground surface subsidence and rupture within a relatively small zone of influence. For example, over two feet of subsidence and 16 inches of differential vertical fault movement is associated with oil, gas, and water production at Goose Creek Oilfield (Harris County), 15 feet of subsidence has been recorded at Hoskins Mound (Brazoria County) as a result of sulfur mining and natural collapse over the crest of many Gulf Coast domes can be traced to leaching of the salt by percolating ground water.

The salt domes and shale diapirs were identified on subsurface structural contour maps (scale 1:48,000) published by the Geomap Company in July, 1974. A mapped structure was designated a salt dome or mud diapir if the feature exhibited more than 1,000 feet of closed structural relief within a distance of 4,000 feet and the structure possessed a radial fracture system. The boundary of the relatively small zone of influence was defined by a line connecting the axis of all the synclines immediately adjacent to and surrounding the structure.

HURRICANE WASHOVER CHANNELS

Washover channels usually develop through blowouts on poorly developed fore-island dunes and beach ridges. Before hurricane landfall, water flows inland through these low places scouring a channel and depositing sediment in washover fans in the adjacent bay or lagoon. After the hurricane passes, the elevated waters behind the islands return to the Gulf through the channel leaving an open pass across the island. These channels are active only during hurricanes. Generally they are filled with sediment on the Gulfward side within a few days after the hurricane passes. Behind the beach, an open channel may remain for many months (Reference 2-8). Importantly, the same channels are opened each time a hurricane makes landfall in the area and, to date, most structures built astride hurricane channels have been destroyed by washover.

The locations of hurricane washover channels were taken from Fisher and others (Reference 2-7). These channels were identified on topographic maps and aerial photographs as elongated topographic expressions and were verified by historical monitoring.

SHORE EROSION AND ACCRETION

Shorelines throughout the study region are continuously changing because of natural processes.

The barrier islands of the Texas Coast are enormous sand bars, 1/2 to 1 mile wide, which lie parallel to the coastline about 3 to 5 miles seaward from it. These islands are the products of coastal marine processes and are continuously being shaped by these processes first building the beach and the dunes behind it and then destroying them.

Segments of the Texas shoreline are being eroded at high rates. Measurements of shoreline loss in excess of 10 feet per year are common. Where reliable data are present, rates of up to 23 feet per year have been documented. (For example, Morton (Reference 2-15) recorded 900 feet of shoreline loss in 40 years.) Because the barrier islands are narrow, a plant sited on one would likely extend across the entire breadth of the island. Such a site would have to be bordered by a seawall for protection. At least a portion of any such site would become "offshore" during the life of the plant, regardless of protection afforded it. This problem is compounded by the fact that the site would have to be elevated or diked to protect against hurricane surge tides which commonly exceed 12 feet.

Shoreline processes were identified from maps by Fisher and others (Reference 2-7), W. L. Leeper (personal communication, 1974) and J. T. Woodman (personal communication, 1974). Processes maps were prepared by comparing shoreline positions as shown on current maps or modern aerial photos. In a few locales, rates of erosion were actually measured by surveying coastline profiles and bench marks periodically.

SUBSIDENCE

Two types, regional and local, affect the study area.

- Regional subsidence affects approximately 75% of the coastal plain. It appears to arise from both natural and man-made causes. Subsidence has occurred nearly continuously along the coastal zone for at least the last 60 million years. Regional subsidence results in extremely small slope gradient changes producing very slow subsidence rates and is not thought to trigger fault activity.

  The cumulative subsidence over this time span (60 million years) is 60,000 feet, or about one foot per 1,000 years. This natural subsidence probably continues today but it is clearly not significant in planning a power plant site.

- Local subsidence, in the majority of cases, is caused by pumpage of large quantities of ground water, which lowers the potentiometric surface in aquifers and causes dewatering of clays surrounding the aquifer sands. The volume of the clays is thus reduced and the land surface subsides.

  At the present time, nearly 230 square miles in the study area have experienced subsidence in excess of five feet. The maximum subsidence recorded in the area is 8.5 feet (Reference 2-8). Subsidence increases the probability that both flood and tidal waters will inundate a site area. Brown and others (Reference 2-8) cite the following " . . . if storm tides with the same surge height as those generated by Hurricane Carla in 1961 were to strike upper Galveston Bay today (1974), an additional 70 square miles of subsiding lands . . . would be flooded by hurricane-surge water."

  Local subsidence also results in changes in the land surface gradient and slope reversals are common. Gravity-flow systems are typically rendered useless by such elevation changes and pump-flow systems are also affected adversely.

In the past areas subject to local subsidence are believed to have been eliminated as potential plant sites for the following reasons:

- Regions of oil fields or salt domes have been excluded, thereby eliminating local subsidence areas associated with these regions.

- Urban and suburban regions have been excluded because of demographic considerations, thereby eliminating local subsidence areas associated with these regions. Brown and others (Reference 2-8), in a comprehensive study of subsidence, showed that areas of significant subsidence were confined to urban and suburban areas.

CONSTRUCTION SUITABILITY

A Construction Suitability Map was prepared using geologic units judged to have similar soils engineering characteristics that were combined into four basic suitability groups: clay and mud; sand; clayey sand and silt; and marshland. The surface distribution of these construction suitability units reflect the depositional patterns of modern or ancient rivers, with their associated channel, floodplain, delta and marsh environments. The clays and muds are deposited on delta plains along the borders of river systems in abandoned channels and locally in bays, lagoons and coastal lakes. Sands are deposited in point bars by meandering rivers, in channels by braided rivers and in barrier islands by near-shore marine processes. Clayey sands and silts are associated with river systems, alluvial fans and the fronts of deltas. These three units are defined for both modern and ancient systems. However, only modern marshlands were identified. They are located inland of the current barrier islands and along some river systems.

The construction suitability map affords a simple, reasonably accurate method for judging the construction problems and costs associated with locating a facility at any particular location.

Kier and Bell (Reference 2-16) have demonstrated that various depositionally related sediment assemblages characteristically have identifable soils engineering test characteristics. In their study the mean, standard deviation and the number of soil test samples were calculated in order to relate these parameters to both the depth below the surface and the geologic unit. The engineering properties were found to be precisely defined in end-member units (that is, for dominantly mud or dominantly sand units) but showed a wider variation in composite units (that is, in sandy silt or silty mud units). This means that for certain types of geologic units engineering properties may be predicted accurately even though no test data are available, and reasonable estimates can be made for all mapped ur. ts.

The surface geology units assigned to each of the construction suitability groups are given in Table 2.2-2. These groups are basically the same as used by Fisher and others (Reference 2-7) with the exceptions that all marsh, swamp, and tidal flats were mapped as one group and Fisher's "made land or spoil" category was eliminated. The construction suitability map, because it is a derivative geologic map, covered the same part of the study region as the geologic map.

The construction suitability units were not used to eliminate potential plant sites. Rather, knowledge of construction properties of each site were used to assess relative economic penalties for construction at each site. Factors included in the analysis were excavation difficulities, foundation stability, ground-water drainage and protection, stability in the presence of ground vibrations, availability of barrow material and leakage protection in the cooling pond.

The methods of Kier and Bell (Reference 2-16) were employed in this study. Because of a lack of published engineering test data on surficial units in the Houston area, the test values obtained by Kier and Bell for similar geologic units in the Corpus Christi area were used in this study.

The variations in engineering properties between the construction suitability groups were used to determine the relative construction costs at various sites. By comparing these variations, different construction costs were calculated for the specific sites selected in the screening process.

TABLE 2.2-2

SURFACE GEOLOGY UNITS ASSIGNED TO CONSTRUCTION SUITABILITY GROUPS

Construction Suitability Group Nomenclature	Surface Geology Nomenclature
I. Dominantly Clay and Mud	1. Floodplain, overbank mud and silt
	2. Floodbasin, overbank mud and silt, prairie
	3. Floodbasin, mud veneer over meanderbelt sand, grass-covered
	4. Interdistributary mud, including bay, floodbasin, and local abandoned channel facies
	5. Floodbasin, overbank mud
	6. Interdistributary silt and mud, includes locally bay, lacustrine, and crevasse splay facies
II. Dominantly Sand	1. Braided, coarse-grain meanderbelt sand and gravel
	2. Strandplain sand with prominent accretion ridges
	3. Beach, beach ridge, and barrier flat, sand and shell
III. Dominantly Clayey Sand and Silt	1. Fine-grained meanderbelt sand with prominent grain
	2. Meanderbelt sand and fine gravel
	3. Alluvial fan, sand, along southern margin of upland fluvial deposits
	4. Meanderbelt sand, with prominent grain, grass-covered
	5. Meanderbelt sand, heavily tree-covered
	6. Distributary and fluvial sands and silts, including levee and crevasse splay deposits
	7. Marine deltaic sand, delta front and reworked delta facies
	8. Levee and locally crevasse splay deposits, silt, mud and sand
	9. Meanderbelt sand, inactive, composes, primary sediment within filled (nonentrenched) valley, including levee, crevasse splay, and locally floodbasin mud dsposits
	10. Fluvial sand and floodbasin mud, undifferentiated, inactive, with an entrenched valley
	11. Meanderbelt sand with prominent grain, inactive (terrace deposits)
IV. Marshes and Swamps	1. Coastal marsh, salt, brackish and fresh-water

2.2.1.2 HYDROLOGY

EVALUATION CRITERIA

FLOODING

The NRC has promulgated guidance concerning the criteria by which a proposed nuclear power plant site should be evaluated with respect to flooding information (Reference 2-1, 2-3, and 2-19). Basically these describe methods of determining design basis and probable maximum floods along streams or rivers and discuss comparable floods for coastal and estuary sites. Flooding in general does not exclude possible sites, but becomes an economic penalty as increased flood protection is required.

WATER QUALITY

The basic water quality requirements that were considered when conducting the study were that the design and operation of the facility would comply with the intent of the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977 (commonly referred to as the Clean Water Act Reference 2-20) and the Texas Water Quality Act.

Effluent limitations for discharges from steam electric power plants (40CFR423) were first promulgated by the Federal Environmental Protection Agency (EPA) in October 1974 and have subsequently been revised on several occasions (Reference 2-21). These regulations specify quality levels which must be met by the various waste streams which may be discharged from steam electric power plants.

The EPA approved the water quality standards developed under the Texas Water Quality Act for use when developing discharge specific federal waste discharge permit conditions on February 9, 1976 (Reference 2-22). The purpose of these standards is to maintain the quality of the surface waters within the state's jurisdiction consistent with public health and enjoyment, the propagation and protection of terrestrial and aquatic life, the operation of existing industries, and the economic development of the state.

Steam electric power plants can, and indeed have, been designed so that their liquid waste discharges comply with Texas and Federal waste discharge permit requirements. Therefore, surface water quality is generally not an environmental regional screening consideration. Surface water quality, however, can have a significant impact on plant construction, operations and maintenance costs. Generally, the most significant cost impacts of surface water quality are those associated with the main condenser cooling system.

40CFR423 requires that new steam electric power plants be designed with recirculating main condenser cooling systems using either cooling towers or ponds. However, Section 316(a) of the Clean Water Act states that:

> ". . . whenever [it] . . . can be demonstrated . . . that any effluent limitation proposed for the control of the thermal component of [a]. . . . discharge . . . will require effluent limitations more stringent than necessary to assure the protection and propagation of a balanced, indigenous population of shell fish, fish, and wildlife in and on the body of water into which the discharge is to be made the [EPA may issue less stringent effluent limitations.]"

As a consequence of 40CFR423, Section 316(a) of the Clean Water Act, EPA interpretations of what is required to maintain "balanced indigenous population . . .", (see 40CFR125), and their definition of a "cooling pond"; it is generally considered that new steam electric power plants cannot be designed using fresh or brackish water nonrecirculating (once-through) main condenser cooling systems. The length of time required and costs incurred in developing the information necessary for a Section 316(a) "demonstration" for "cooling lakes" and/or once-through cooling systems using seawater are extensive and the results of the EPA review of the information developed are uncertain. Therefore, designs including "cooling lakes" or once-through cooling systems using seawater must be approached on a site-by-site basis with extreme caution.

The requirements of Section 316(b) of the Clean Water Act can also have a significant impact on cooling system design. This Section of the Act requires that:

> ". . . the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts."

The EPA guidelines which have been published to assist designers in interpreting the requirements of Section 316(b) of the Act present descriptive material on state-of-the-art cooling water intake structure designs. The guidelines present information on how to minimize damage to aquatic organisms.

In summary, although water quality is not a significant environmental regional screening factor it can have a significant impact on plant costs and can result in the rejection of candidate sites.

GROUNDWATER PROTECTION

Protection of groundwater supplies is a requirement for the qualification of a site as suitable for a nuclear power plant. For groundwater used by the plant, the sustained yield of the groundwater system should not be exceeded, i.e., groundwater mining will require special evaluation.

The location and uses of groundwater at the potential site must be considered in the selection process if any discharge water to the groundwater system, planned or inadvertent, may occur. The criteria listed in Table 2.2-3 are used for groundwater protection.

TABLE 2.2-3

GROUNDWATER CRITERIA FOR SITE SELECTION

Category	Rating	Characteristics
Most Acceptable	3	Areas underlain to a great depth (of at least 1,000 feet) by a dense aquiclude of geographically broad extent; there is no significant underlying groundwater; or, alternatively, groundwater of unusable quality underlies site below impermeable section noted above, with no aquifer discharge outlet or development potential with aquifer travel-distance necessary for decay of possible radioactive contaminants.
Acceptable	2	1. Areas underlain by aquifer containing groundwater of poor quality, with no significant natural barrier to downward seepage from the ground surface; the water table is no shallower than approximately 50 feet below the ground surface; there are no aquifer discharge outlets, or development potential within aquifer travel-distance necessary for decay of possible radioactive contaminants. (Key portions of plant area would be undersealed with a minimum layer of 10 feet of impervious compacted clay to prevent downward seepage of operational or other casual pollutants). 2. Areas underlain by a thick aquiclude of substantial thickness (at least several hundreds of feet) of geographically broad extent; an aquifer containing groundwater of usable quality underlies impermeable section; there are no faults, joints, fissures, or obscure well bores within site area which could transmit surface contaminants downward.
Conditionally Acceptable	1	1. Areas overlying lowermost portion of artesian aquifer system in which piezometric head is substantially above the land surface or there is existing or impending means of enhancing aquifer recharge and controlling area well usage, which, consistent with historical piezometric head fluctuations, assures that the head can be continuously maintained above the land surface during critical dry periods. (Existing water quality is not critical to this condition; however, site acceptability would be enhanced if underlying artesian groundwater is of poor and/or unusable quality.) 2. Areas underlain by a sequence 200 feet or more thick of interbedded clay, silt and sand strata that are not of aquifer quality or that have very limited potential use and that also either a) overlay an aquifer containing groundwater of usable quality that can be demonstrated by onsite tests and monitoring to not be hydraulically connected to the surface sequence or b) are the updip time stratigraphic equivalents to a downdip aquifer containing groundwater of usable quality; the two sequences can be shown to not be hydraulically connected by on-site tests or; downdip seepage of groundwater can be totally halted by the construction of suitable hydrologic barriers on the site.
Unacceptable	0	1. Areas directly overlying usable aquifers, with no significant natural barrier to downward seepage from the ground surface. 2. Areas directly upstream of the recharge intake area aquifer systems.

AVAILABILITY OF COOLING WATER

The water supply for Allens Creek is guaranteed by contract with the Brazos River Authority. It is assumed that salt water is freely available for the coastal sites.

FLOOD PRONE AREAS

Lands subject to flooding by either fresh or marine waters were mapped. Three areas having different flooding characteristics are identified: uplands, coastal plain and coast.

- Uplands

  Areas designated as flood prone in the uplands encompass the so-called 100-year floodplain. Although flooding is not as likely in areas not designated as flood prone, there is still some possibility for flooding in these areas.

  Flood waters recede rapidly in upland areas and flood protection outside of designated flood prone areas is commonly simple and inexpensive. This simple protection is possible because in the uplc s, relatively steep hill-slopes and channels quickly trunsport rainfall out of the area. In the upland drainage basins, flooding is associated with excessive rainfall. Boundaries of inundated areas and depths of flood waters vary considerably from year to year.

- Coastal Plain

  On the coastal plain, slopes are very flat, channels are less efficient than in uplands, channel depths are modest in view of discharge requirements, and topography between drainages is typically low and easily flooded. These conditions lead to ponding and flooding. Because of the shallow gradients, flood waters recede slowly. Plants built on the coastal plain generally will incur economic penalties for flood protection.

- Coast

  The coast is subject to flooding by both fresh water and marine water. Runoff from inland storms periodically floods all segments of the coast, but the greatest flood hazards are associated with hurricanes. When a hurricane approaches land, the intense winds push marine waters across the coast, flooding areas as much as 15 to 20 miles inland. Salt water flood depths commonly exceed 10 feet and surge heights of over 16 feet were experienced at all places along the coast at least once during the last 100 years. Inland, the flood heights do not diminish according to elevation because the surface of the surge tide is not horizontal, but is subparallel to the ground surface. For instance, flood depths 10 miles inland, where the elevation is 15 to 20 feet, may be only 2 to 5 feet less than along the coast where the elevation is 1 to 4 feet.

Using mathematical models, Bodine (Reference 2-18) estimated surge heights on the Gulf Coast. The surge height likely to be exceeded once every 100 years is 11 feet on beaches near Freeport and 13 feet near Galveston.

Fresh water flood depths along the coast are abnormally great following hurricanes because large rainfall totals accumulate over extensive inland areas and the surge tide elevation reduces coastal stream gradients, retarding the drainage of runoff. Current data assemblage is insufficient to present an accurate picture of expected freshwater flood depths, which are likely governed by the difference between site elevation and nearby channel bank elevations.

Plants built on or near the coast will definitely incur economic penalties with regard to protection from flooding. Identification of flood prone areas in the uplands, on the coastal plain and on the coast itself during the regional screening provides information by which the economic penalties associated with flood hazard protection for specific site areas can be estimated.

The information utilized to map the flood prone areas was derived from these sources: the United States Geological Survey's flood prone area maps, Fisher and others (References 2-7), and the Texas Bureau of Economic Geology's Hurricane Flooding - Bay City and Port Lavaca area maps. The Geological Survey's flood-prone area maps cover approximately 30% of the study region. These large-scale maps (1:24,000 scale) have been prepared as part of a federal flood insurance program and cover most urban areas. The maps show the approximate boundaries of flood-prone areas, stating that "There is, on the average, about 1 chance in 100 that the designated areas will be inundated in any year."

The United States Geological Survey bases their calculations of flood levels on: regional discharge frequency studies of historical flood records, measures of drainage area, channel cross-sectional area, and channel shape as determined from topographic base maps. From regional discharge frequency studies, flood formulas are developed which allow calculation of flood discharges from any watershed in the study area based on physical characteristics of the basin.

After an estimate has been made of the peak discharge expected on several tributaries, the floods are routed along streamlines by computer to determine their cumulative downstream effect. With the peak discharge established, the extent of inundation along any channel can be calculated by measuring channel characteristics from the base map.

The flood prone areas determined by the Geological Survey were transferred to Flood Prone Areas Map. For the 70% of the study area not covered by Geological Survey maps, the flood prone areas were extended upstream or downstream by linear interpolation between mapped areas. For instance, if the distance between flood prone areas on a stream was 10,000 feet and the difference in the elevation of the floodplain in the two mapped areas is 50 feet, it was assumed that the elevation of the 100-year floodplain changed 10 feet every 200 feet.

Areas subject to flooding from hurricane surge and hurricane rainfall were added to the previously described flood prone areas of the uplands and coastal plain. Active processes and hurricane flooding maps prepared by the Texas Bureau of Economic Geology were used to define these additional flood prone areas along the coast. The areal extent of inundation due to hurricanes included areas flooded either by Hurricane Beulah or Hurricane Carla.

AQUIFER

The ground water protection classification criteria was used in developing an Aquifer Map. This map essentially differentiates surface areas considered to be in direct communication with important artesian and water-table aquifers and areas where the degree of hydraulic communication between ground and surface waters is undetermined.

An aquifer is in hydraulic communication with the surface water if surface water infiltrates into the subsurface.

Areas identified as being in direct hydraulic communication with aquifers containing signficant quantities of usable quality water are classified as unacceptable for a plant location. These unacceptable areas occur where no natural barriers to downward seepage of surface fluids occur and where artificial protection of underlying aquifers is considered impractical. Depositional units mapped as unacceptable because of their high permeabilities (greater than 10^{-3} cm/sec), are:

- Meanderbelt sands paralleling present rivers
- Recent and ancient barrier island sands
- Very coarse-grained fluvial deposits thought to be the outcrops of major aquifers.

In the conditionally acceptable areas the hydraulic communication of surface and ground waters is highly variable and cannot be determined from existing geologic maps. Much of this area is underlain by aquitards that impede downward migration of surface water. Some of the area is in limited hydraulic communication with the subsurface, and locally the hydraulic communication is direct. In all areas except those in direct hydraulic communication with the subsurface, aquifer protection requirements for nuclear power siting probably can be economically satisfied.

The Aquifer Map was constructed by designating geologic units containing little or no silt and clay with their high permeabilities (greater than 10^{-3} cm/sec) as unacceptable siting areas. The designated geologic units were:

- Braided stream and coarse-grained meanderbelt sand and gravel

- Meanderbelt sand and fine gravel
- Alluvial-fan sand
- Strandplain sand with prominent accretion ridges
- Fluvial sand and floodbasin mud, undifferentiated, inactive within an entrenched valley
- Beach, beach ridge, and barrier flat, sand and shell

To classify those areas not covered by the Geologic Map, the Beaumont and Austin Sheets of the Geologic Atlas of Texas (Reference 2-12 and 2-13) were used. Quaternary alluvium and fluvial terrace units shown on these sheets were classified as unacceptable units. All other formations or depositional units were classified as conditionally acceptable.

WATER QUALITY

Water quality in terms of total dissolved solids for low-flow and normal-flow conditions was mapped to show the water quality in the study region.

Although the management of the quality of surface water is important, water quality per se is not a major consideration in assessing the suitability of a site because adequate design alternatives can generally be developed to meet the requirements of State Water Quality Standards, the Federal Water Pollution Control Act and the NRC's regulations implementing NEPA (Reference 2-3).

2.2.1.3 ECOLOGY

EVALUATION CRITERIA

The basic criteria is to avoid areas of important species, their habitats, migration routes and areas of unique vegetation.

A species, whether plant or animal, is considered important: (Reference 2-3)

- If it is commercially or recreationally valuable
- If it is endangered or threatened
- If the species or specific population has important or unique aesthetic or scientific value
- If it affects the well-being of some important species within criteria above, or if it is critical to the structure and function of a valuable ecological system.

If important species are known to live in the vicinity of a site, long-term, on-site studies may be required to assess potential displacement, habitat and behavioral impacts, the results of which will likely be subject to controversy.

Special consideration is given to any of these ecological considerations in the vicinity of a potential power plant site which would be susceptible to environmental alterations brought about by the construction and operation of a particular type of power plant at the site. Design options employed at a favorable site could conceivably allow the use of the site for electric generation without impairing these ecological items. These considerations will have to be evaluated in detail on a site-specific basis after the prime site is selected and detailed environmental investigations are begun.

ENVIRONMENTALLY SENSITIVE AREA - FAUNA

TERRESTRIAL FAUNA

An Environmentally Sensitive Area Map - Fauna, was prepared showing those areas of important species and ecological systems which are ecologically sensitive.

The study region contains two of the six biotic provinces delimited by Blair (Reference 2-23) based on the distribution of terrestrial vertebrates. In the study region, these provinces correspond closely to Gould's vegetational areas (Reference 2-24) as follows:

- Austroriparian province includes the piney woods and the northeastern portion of the Gulf Prairies and Marshes; the Austroriparian fauna is typical of the moist forest of the southeastern U.S.

- Texas province includes most of the Gulf Prairies and Marshes, the Blackland Prairies, and the Post Oak Savannah. The Texas province supports a fauna transitional between forest species to the east and grassland species to the west.

ENDANGERED TERRESTRIAL FAUNA

The area under consideration supports several species of terrestrial vertebrates listed as endangered by the United States Department of Interior (Reference 2-25) and/or the Texas Parks and Wildlife Department (Reference 2-26). When the 1975 study was conducted, the species, discussed below, appear on both lists unless otherwise indicated.

- American alligator (Alligator mississippiensis). Alligators range throughout the area under consideration. Although officially listed as endangered, they are quite common in appropriate habitats in southeastern Texas. Unofficial estimates of over 40,000 alligators in Jefferson and Chambers Counties have been made. Alligators prefer river swamps, lakes, bayous and marshes.

- Artic peregrine falcon (Falcon peregrinus tundrius). This species migrates throughout Texas and winters in the eastern half of the state. Fall migrants move along the Texas coast with the heaviest concentrations along the mid and lower coast (Matagorda Island and south) (Reference 2-30). They prefer open country. The decline of this species, like that of the brown pelican and bald eagle, has been linked to the accumulation of pesticide residues (Reference 2-31).

- Atlantic ridley turtle (Lepidochelys kemysi). This species is not listed by the USDI (Reference 2-25). It may appear irregularly along the Texas coast and has been recorded breeding south of the study area (Reference 2-32).

- Attwater's prairie chicken (Tumpanuchus cupido attwateri). Attwater's prairie chicken, once widespread over the Texas coastal prairie, are now largely restricted to disjunct, remnant stands of native grasslands along the upper and mid Texas coasts. The distribution was constructed mainly from maps and discussions in Lehmann (Reference 2-34) and Lehmann and Mauermann (Reference 2-35). The largest colonies in the study area occur in Galveston and Harris Counties (250 birds), and Wharton Counties (450 birds). The decline of the prairie chicken has been attributed to habitat deterioration caused by rice farming, grazing and other man related activities.

- Brown pelican (Pelecanus occidentalis). Once a common resident along the Gulf Coast, this species now breeds only in certain areas along the southern Texas coast. The northernmost nesting occurs around Port O'Conner, which is in the southeastern corner of the study area. Wintering birds occur along the full extent of the upper Texas coast. The decline in this species is reportedly due to eggshell thinning caused by DDT residues (Reference 2-33).

- Eskimo curlew (Numenius borealis). This rare species, now near extinction, once migrated through the prairies of eastern and central Texas. It is now rarely seen along the Texas coast (Reference 2-36). The cause of its demise is not known.

- Florida manatee (Trichelus manatus). This species has been recorded in Texas in Cow Bayou, near Sabine Lake, Copano Bay, Laguna Madre, and the mouth of the Rio Grande (Reference 2-37). However, these records are based on occasional sightings; the presence of breeding populations in Texas has not been established. Although manatees are found chiefly in large rivers and brackish water bays, they can tolerate salt-water and move from place to place along the coast. Their threatened status is due in part to hunting pressure and low reproductive potential.

- Houston toad (Bufo houstonensis). This species, which currently maintains its largest populations in Bastrop County, is known in few localities in five southeastern Texas counties (Reference 2-27 and 2-28) where it occurs as small populations on sandy soils often in or near pine forests. It is probably extinct over much of the range (Reference 2-29) depicted in the faunal distribution maps. The species seems to be losing ground due to interspecies hybridization apparently caused by habitat destruction.

- Ivory-billed woodpecker (Campehilus principales). The present distribution and status of this rare species is poorly known with few recent authenticated records (Reference 2-25). It requires "overmature" hardwood forests with dead and dying trees which support its principal food, wood boring beetle larvae. Such habitat in southeastern Texas occurs sparingly in river bottoms, especially in the Big Thicket area. The near extinction of this species is due to habitat reduction.

- Red cockaded woodpecker (Dendrocopos borealis). Red cockaded woodpeckers occur in old age pine woodlands throughout the southeastern United States and into eastern Texas and Southeastern Oklahoma (Reference 2-38). In Texas, it is known from isolated populations in 17 counties. It is restricted to pine forests having old, living trees infected with red-heart disease (Reference 2-25). Its endangered status is largely a result of the forestry practice of removing such trees.

- Red Wolf (Canis rufus). Although once common throughout the southeastern United States from Florida to central Texas and north to southern Indiana, this species is now restricted to the upper Texas coast and adjacent Louisiana (Reference 2-40). It occurs in coastal prairie and marsh areas. Riley and McBride (Reference 2-40) estimate that in the primary portion of the remaining red wolf range in Chambers, Jefferson, and southern Liberty Counties (an area of about 1,260,000) acres) approximately 300 wolves remain. Much of the red wolf's former range in Texas and eastern Louisiana is now apparently occupied by a hybrid (red wolf x coyote) swarm (Reference 2-41). Habitat destruction and competition and hybridization with the coyote, and possibly the domestic dog, has been largely responsible for the demise of the red wolf.

- Southern bald eagle (Haliaietus leucocephalus leucocephalus). This rare species nests during the winter in Texas, primarily in estuarine areas. Probably fewer than 50 birds inhabit the state (Reference 2-42). Bald eagles frequent the edges of rivers, lakes, and the coast, feeding primarily on fish or carrion and nesting in tall trees near the waters' edge. Bald eagle sightings in 1971-1973 were reported throughout the study area with concentrations around waterbodies (Reference 2-42). The highest concentrations in the state occur along the upper Texas coast from Calhoun through Galveston Counties.

Since the 1975 siting study was done, the status of some threatened and endangered species has changed. The American Alligator was reclassified from endangered to threatened within certain parts of its range (Federal Register 42:(6)2071-2077). The American Alligator is classified as a threatened species within the Texas coastal zone counties east of Corpus Christi. This includes most of the study region. The American Alligator is classified as an endangered species throughout the rest of its range in Texas.

The Atlantic Ridley turtle is now officially classified as an endangered species. In addition to the Atlantic Ridley, three other sea turtles are endangered (green sea turtle, hawksbill, and leatherback), and one is threatened (loggerhead). All of these species may occur along the Texas Coast.

Attwater's prairie chicken is still an endangered species, but its range and population size continue to decrease. For all practical purposes, the species presently is restricted to Harris, Galveston, Fort Bend, Brazoria, Austin and Colorado counties in the study region, and only a few prairie chickens presently occur in Harris and Brazoria counties.

AQUATIC/ESTAURINE FAUNA

The study region contains two of the eight wildlife areas used by Hubbs (1972) to define fish distributions within the state. The fauna reside in the drainages, estuaries and offshore areas of seven Texas river systems. These are the lower Sabine, Neches, Trinity, San Jacinto, Brazos, San Bernard and Colorado river systems.

Three relatively large reservoirs (Houston, Livingston, and Conroe) occur within the study region. These reservoirs do support a commercial fishery. However, the intensity of fishing varies with the year and/or reservoir. The freshwater commerical fishery within the study region is not considered significant.

Examination of available distributional patterns and species lists reveals that no rare or endangered freshwater fish species, as defined by United States

Department of Interior (Reference 2-25) and Texas Organization for Endangered Species (Reference 2-44) are known to inhabit the study area.

The bays and estuaries of the region under consideration support a great diversity of life. The state and federal regulatory agencies are continuing to show considerable concern for the ecological integrity of these habitats.

The commercial fisheries along the Texas coast is an important industry. Commercial fish and shellfish landings during 1972 were 114.7 million pounds having a recorded dockside value of $85 million (Reference 2-45); this value is $15.2 million above the 1971 value.

The location of the significant commercial catch areas varies with the species. Finfish and white shrimp are taken primarily from the shoreline to approximately 10 to 50 fathoms, depending on the season. Commercial crab fishing occurs principally within the bay areas. The oyster fishery is restricted to oyster reefs.

There are no known rare or endangered species which inhabit the estuarine environs within the study region.

SENSITIVE FAUNAL AREAS

The following areas are considered ecologically sensitive due to their faunal component:

- Waterfowl Wintering Areas - The study area lies at the southern end of the central flyway for migrating waterfowl. The coastal waters of the Gulf of Mexico and the coastal marshes and adjacent ri ·ands of Texas accommodate up to 45% of the migrating ducks in the flyway and 90% of the geese (Reference 2-46). The deep marsh-rice belt, east of Galveston Bay supports up to 750,000 ducks and geese in mid winter. Fresh and brackish marshes offer better support than saline marshes. Good wetland habitat extends northward from this area into east Texas, especially along the Neches and Trinity River systems. From Galveston Bay through Matagorda Bay, the shallow marsh-rice belt provides good waterfowl habitat. The offshore islands of Galveston and Matagorda are leading waterfowl resting areas.

- Rookeries - Many known bird rookeries occur in the study region, especially along the coast. The known sites were compiled from information obtained from the U. S. Bureau of Sport Fisheries and Wildlife and the Texas Parks and Wildlife Department.

- Wildlife Refuges and Game Management Areas - Three federal wildlife refuges (Anahuac, San Bernard, and Brazoria) and two state game management areas (Sheldon and J. D. Murphree) occur in the study region. Since the 1975 study two additional National Wildlife Refuges have been established along the Texas coast in the study area. These include the McFaddin and Sea Rim National Wildlife Refuges in Jefferson County.

- Passes - All passes which connect bay areas with the open Gulf are judged environmentally sensitive. These areas provide access for all marine fauna using the bays and estuaries as breeding and nursery grounds.

ENVIRONMENTALLY SENSITIVE AREA - FLORA

An Environmentally Sensitive Area Map - Flora, was prepared showing those areas of important species and ecological systems which are ecologically sensitive.

The region under consideration contains four of the ten ecologically distinct vegetation areas of Texas described by Gould (1969). These areas are:

- Piney Woods - This gently rolling to hilly forested land supports predominantly commercial timber species (loblolly, shortleaf, longleaf and slash pines) along with various hardwoods (e.g., oaks, hickory, maple). The pine represents a subclimax or fire disclimax currently being extensively exploited by the lumber industry. Pasture and farm lands are interspersed in the forests.

- Gulf Prairies and Marshes - The Coast Marsh is limited to narrow belts of low, wet marsh immediately adjacent to the coast. The climax vegetation of the Coastal Prairie is a tall grass prairie or post oak savannah. The area is mostly rangeland interspersed with farms.

- Post Oak Savannah - This is a gently rolling savannah of blackjack and post oak over tall grasses. Most of the area is native or improved pastures with occasional small farms.

- Blackland Prairies - This is a climax grassland on gently rolling to level surfaces. Mesquite, post oak, and blackjack oak occur in some areas. The high fertility of the calcareous clays and gray acid sandy loams has resulted in most of the area being cultivated.

RARE AND ENDANGERED FLORA

Plants in the study region that are considered scarce and endangered to very rare and acutely endangered in Texas are listed by the Rare Plant Study Center (Reference 2-47). Comprehensive range and locality information is not available for many of these species. Their presence or absence in particular areas must be determined by on-site surveys. There are no Federally listed threatened or endangered plant species in the study area.

SENSITIVE FLORA AREAS

The following are ecologically sensitive due to their vegetation:

- Big Thicket - This is an extensive mixed mesic woodland sufficiently homogeneous in species composition to be ecologically distinct from adjacent woodlands. The extent of the Big Thicket forest type has been discussed by McLeod (Reference 2-48).

  The ecological importance of the Big Thicket lies in its ecological diversity. Eight major plant associations have been identified within the Thicket (Reference 2-49). Some of these are unique and very sensitive harboring species of plants with specialized, narrow habitat requirements. Especially sensitive are wetland savannahs, bogs and swamps which support rare and unusual plants such as sundews, pitcher plants and a variety of orchids. Virgin forest still exists in a few areas inaccessible to lumbering. In these areas cypress, hickories, sweetgum and various oaks have grown to immense sizes.

- Sam Houston National Forest - Part of the Sam Houston National Forest (which includes a portion of the Big Thicket) occurs in the study region.

- Coastal Prairie - The Coastal Prairie consists of two distinct types of prairie:

  - Lissie Prairie - This is a large stretch of prime coastal prairie adjoining a beautiful wooded valley along the San Bernard River. Due to the increasing development of the few remaining tracts of virgin prairie and the concomitant destruction of their distinctive communities, such areas are considered ecologically sensitive.

  - Sea Oats Prairie - The stretch of prairie along Matagorda Peninsula is one of few remaining examples of extensive, virgin stands of sea oats (Uniola paniculata). This species, not listed as endangered by the Rare Plant Study Center (Reference 2-47), is considered rare by the Texas Organization for Endangered Species (Reference 2-44). Sea oats grow only in a few areas along the mature dune ridges of the coast and at the present time, these dunes are being rapidly exploited for commercial and/or recreational use; therefore, the habitat for this species is being destroyed.

- Mangroves - Black mangroves (Auicennia germinans) are found only along the coast in moist woods, along streams or lagoons, in seepage areas or marshes, and along tidal shores. This species is most demanding in its habitat and has become established and can only survive in certain areas of coastal Texas. Like sea oats, it is listed as rare in Texas by the Texas Organization for Endangered Species (Reference 2-44).

- Salt-water Marshes - Salt-water marshes, while they contain no unique vegetation assembleges, are considered important and sensitive due to the fact they provide nursery grounds and habitat for many commercially and recreationally valuable aquatic fish and shellfish.

2.2.1.4 LAND USE

EVALUATION CRITERIA

There are no widely accepted standards for land use. Although there are nationwide patterns of use that may be employed for screening sites, local preferences and values are the prime determinants of the "proper" pattern. Table 2.2-4 provides criteria for the following land use factors:

TABLE 2.2-4

LAND USE EVALUATION CRITERIA

Land Use Factors	Areas to Avoid	Areas to Select
1. Relation to existing or proposed land use plans and policies.	Areas where utility would conflict with existing or proposed plans, open space plans, transportation plan, airport plan, regional housing plan.	Compliance with existing plan.
2. Pre-emption of land uses existing on site or planned for site.	Areas of existing or potential public recreation (particularly areas with exceptional qualities). Areas of historic or important archaeological sites. Areas where significant costs to relocate pre-empted land use would be required. In particular, regional screening should exclude areas of existing public land.	Areas where compatible land use could enhance the area.
3. Industrial, Military and Transportation Facilities.	Areas nearby industrial, military and transportation facilities which may have potential accidents which could affect the safety of a nuclear power plant. In particular, regional screening should exclude: (1) Areas near aircraft prohibited, restricted, warning and alert areas (e.g., intensive student jet training areas). (2) Areas near airports having control zones extending upwards from the surface. (3) Areas of shipping safety fairways and fairway anchorages.	Areas where potential accidents from nearby facilities are at an acceptable level as determined by NRC Regulatory Guide 4.7 (Reference 2-3).

- Land Use Plans or Policies

  Proposed alternative uses of some lands may render a site unsuitable for a nuclear power station. One general class of such lands is that land specified by a community as planned for other uses or as restricted to compatible uses vis-a-vis other lands (Reference 2-3).

- Pre-emption of Land Use

  Pre-emption of existing land use at the site itself may cause significant impact if, for example, the land was being used for specialty crops or contains a small town. Sites adjacent to some lands devoted to public use may be considered unsuitable. Such cases are most apt to arise in areas adjacent to natural resource oriented areas as opposed to recreational oriented areas (Reference 2-3).

- Industrial, Military and Transportation Facilities

  Potential accidents at present or projected nearby industrial, military and transportation facilities may render a site unsuitable (Reference 2-3). Certain types of transportation movement areas and transportation facilities should be avoided; these are listed in Table 2.2-4.

LAND USE PATTERNS

A land use map was prepared showing the land use patterns throughout the study region. The land use was classified into the following categories:

- Recreational or Park Areas

  Existing and planned public and private recreational or park areas were mapped. These areas were located using references 2-50 to 2-58.

- Historic Sites

  Historic sites were mapped. These areas were located using references 2-50 to 2-53 and 2-59.

- Public Lands

  Existing and proposed public lands were mapped. Public lands include city, county, special authority, state and federally owned lands which are not classified in another category. For example, existing State Parks are state owned lands but are classified as "Recreational or Park Areas". These areas were located using references 2-50, 2-51, 2-56 and 2-57.

- Texas Travel Trails

  The Texas Brazos, Forest and Independence Trails were mapped. The trails were located using references 2-60 to 2-62.

- Lakes

  Existing and proposed lakes were mapped. The lakes were located using references 2-50 to 2-55 and 2-63 to 2-65.

- Shipping Safety Fairway and Anchorages

  Shipping safety fairways and fairway anchorages were mapped. These were located using references 2-66 to 2-68.

To define areas where sites would conform to land use patterns, the following land use classifications were not designated acceptable candidate areas:

- Existing Areas of Recreational or Park Areas
- Existing Public Lands
- Shipping Safety Fairways
- Fairway Anchorages

AIRCRAFT FLIGHT ZONES

In addition to the land use patterns map, an aircraft flight zone map was prepared. This map included the following items:

- Airports

  Active civil and military airports were mapped.

- Restricted Areas and Air Control Zones

  Areas which are designated prohibited, restricted, warning, danger, alert or intensive student jet training areas were mapped. Areas around airports which are designated control zones extending upwards from the surface were mapped.

- Air Corridors

  Low altitude "Victor" airways were mapped and identified.

References 2-69 to 2-71 were used to locate the preceding areas.

In order to comply with NRC Regulatory Guide 4.7 (Reference 2-3) the areas classified as Restricted Areas and Air Control Zones were excluded from acceptable candidate areas.

2.2.1.5 DEMOGRAPHY

EVALUATION CRITERIA

A major consideration in the selection of a nuclear power plant site is the potential risk to the public associated with locating such a facility near heavily populated areas. NRC regulations and guidelines do not provide specific criteria for site selection for population distribution. According to the regulations, areas of low population density are preferred for nuclear power station sites and a minimum exclusion distance of 0.4 mile and a distance of 3 miles to the outer boundary of the low population zone is usually adequate (Reference 2-3).

At the time of our 1975 study there were no official regulations or guidelines which specify detailed procedures for site suitability analysis with respect to population distribution characteristics. Consequently, we developed our own criteria, shown in Table 2.2-5, based on the following:

TABLE 2.2-5

POPULATION CRITERIA FOR USE IN SITE SELECTION

1. Cumulative population versus distance from the reactor should not exceed:

0- 5 miles	≤	30,000 persons
0-20 miles	≤	500,000 persons
0-40 miles	≤	2,000,000 persons

2. Local population densities should not exceed 220 persons per square mile within 2 miles of the reactors.

3. The "exclusion zone" distance should be greater than 0.5 miles.

- NRC Regulations 10 CFR 20, 50, 51 and 100 and proposed Appendix I to Part 50 (References 2-72 to 2-76).
- Current practice for licensing nuclear power plants.
- Pending NRC proposals.

The sites selected have subsequently been reviewed against NUREG-0625 based on reconnisance level information used in this evaluation, and each of the sites selected complies with the population density limits of NUREG-0625.

DEMOGRAPHIC SCREENING

A Demography Map was prepared showing the areas which were excluded from being candidate areas. The criteria used in this determination are listed in Table 2.2-5. Population data was obtained from references 2-77 to 2-85. These data were converted to population densities for the following: year of most recent census, time of proposed plant start up and end of life of plant, year 2025. The highest population projections including specific densities for town and cities were mapped on an overlay consisting of 1 x 1 mile grid squares. These population projections were then used to produce exclusion areas based on the criteria shown in Table 2.2-5. These areas were then used to produce a Demography Map, which provides the acceptable and not acceptable areas based on the demographic criteria.

This methodology provides a conservative approach for determining areas of low population distribution and minimizes site suitability licensing problems with respect to demography.

2.2.1.6 METEOROLOGY

EVALUATION CRITERIA

Site meteorology is a site suitability characteristic principally important to the calculation of radiation doses resulting from the release of fission products as a consequence of a postulated accident and the establishment of exclusion area boundaries, low population zone boundaries, and distance to a population center (Reference 2-3). Accordingly, this characteristic is screened for in the demography section. Other meteorology characteristics which should be considered are described below:

- Atmospheric Dispersion

  Forecasted air pollution stagnation regions and areas where low wind speeds and low mixing heights occur should be avoided.

  Meteorologic data should be compared with the NRC criteria. In most cases, it is possible to use the NRC criteria as worst case criteria, but this possibility must be confirmed.

- Atmospheric Extremes

  The potential effects of atmospheric extremes (for example, tornadoes and exceptional icing conditions) on the safety-related structures of a nuclear station must be considered; however, the atmospheric extremes that may occur at a site are not critical in determining the suitability of a site because safety-related structures, systems and components can be designed to withstand atmospheric extremes (Reference 2-3). The NRC now requires nuclear power plants in Texas to be designed for a tornado of 290 mph rotational speed and 70 mph translational velocity (Reference 2-86). Because all of Texas is in Tornado Region I, this criteria remains constant for all areas that were considered during the regional screening.

- Fogging and Icing

  Areas where the prevailing atmospheric conditions are less favorable for the dissipation of visible water droplet plumes (temperatore low and/or relative humidity high) and where the plume may result in fog formation over transportation corridors should be carefully investigated during the site selection process.

METEOROLOGY SCREENING

A Meteorology Map was prepared showing regional meteorological characteristics of ventilation and diffusion.

Atmospheric diffusion factors are used in determining the effects of radioactive effluents both for postulated accidents and from routine releases in gaseous effluents. Ventilation is one of the two basic parameters used to define diffusion climatology. Ventilation in the study region is generally characterized as good. The Meteorology map showed ventilation in terms of:

- Direction of prevailing wind
- Mean wind speed
- Areas where local winds are modified by topography

The second basic parameter in evaluating diffusion is atmospheric stability. The frequency of temperature inversions is a measure of this effect. The study region has a relative low frequency of temperature inversions indicating good diffusion characteristics. Meteorological data were obtained from references 2-87 to 2-89. On the map the two parameters, ventilation and stability, were combined to determine diffusion areas. These areas are classified as areas where:

- Diffusion is good on ridges and poor in valleys
- Diffusion is adequate
- Diffusion is good

In general, throughout the whole study region the meteorology is better than that required to meet the NRC requirements of references 2-90 and 2-91.

2.2.1.7 TRANSPORTATION

EVALUATION CRITERIA

The nuclear power plant is a heavy construction operation involving the installation of several particularly massive components. Moreover, the plant is likely to be situated at a remote location where transport facilities are generally lacking. With respect to the delivery of the large components, care should be taken to minimize environmental damage. While the major impact of providing new transportation facilities may be economic, careful consideration of the envionmental impact of delivery of the construction materials, equipment and major reactor components must be considered. The site area should preferably be convenient to either bodies of water or rail or road corridors of sufficient width and load-carrying capacity to handle the equipment.

TRANSPORTATION SCREENING

A transportation map was prepared showing the following:

- United States, Interstate and Texas State Highways
- Railroads
- Navigable Waterways and Barge Canals

Transportation information was obtained from references 2-50, 2-52, 2-54, 2-56, 2-58 and 2-92. Transportation considerations identified during the regional screening process were utilized during the candidate areas evaluation to develop the economic and associated environmental impact of siting a nuclear power plant at a particular location.

2.2.1.8 GENERATION STATION AND TRANSMISSION LINES

A Generating Stations and Transmission Lines Map was prepared showing the following:

- Houston Lighting & Power Company generating stations
- Other generating stations
- Houston Lighting & Power Company proposed generating stations
- Substations
- Existing 345 kV, 135 kV and 69 kV transmission lines
- Proposed 345 kV, 135 kV and 69 kV transmission lines

The information above was obtained from references 2-93 to 2-95.

This information was considered during the regional screening processing with the advance knowledge that both economic and environmental impact of transmission line routes can be reduced by locating the power plant close to the load center and near existing transmission line corridors.

2.2.1.9 PREVIOUSLY STUDIED POWER PLANT SITES

A map was prepared showing the power plant sites previously studied by Houston Lighting & Power. This map showed:

- Previously studied nuclear power sites
- Previously studied nuclear plant sites rejected on initial screening
- Previously studied lignite plant sites.

Where appropriate, information on these previously studied sites was utilized in the regional screening process.

2.3 CANDIDATE AREA DESIGNATION

The Regional Screening portion of the 1975 Siting Study was accomplished by performing the following tasks:

- Establish Site Study Region
- Review Existing Reports
- Collect Published Information
- Correlate and Verify Information Sources
- Conduct the Regional Screening

As a result of this screening, various licensable areas were identified and designated as candidate areas.

The candidate areas, which are envelopes of licensable areas, were identified by the application of primarily the following screening criteria:

- Demography

  Areas were excluded if:

  (1) Cumulative population versus distance exceeded:

  0 - 5 miles ≥ 30,000 persons

  0 - 20 ≥ 500,000 persons

  0 - 40 ≥ 2,000,000 persons

  (2) Local population densities exceed 220 persons per square mile within 2 miles of the reactor.

- Land Use

  Areas were excluded if they were within:

  (1) Areas of existing public lands (e.g., National Parks, State Parks, etc.)

  (2) Areas of aircraft prohibited, restricted, warning and alert areas (e.g., intensive student jet training areas)

  (3) Areas of airports having control zones extending upwards from the surface

  (4) Areas of shipping safety fairways and fairway anchorages

- Hydrology - Aquifer

  Areas were excluded if they were classified as unacceptable because:

  (1) The area directly overlaid a usable aquifer, with no significant natural barrier to downward seepage from the ground surface.

  (2) The area was directly upstream of the recharge intake area aquifer systems

  (3) The area was subject to flooding which cannot be protected by practical flood protection methods

- Hydrology - Water Availability

  Areas were excluded if they were classified as unacceptable because the area was within a water basin where the inland water available was less than 36,000 acre-feet per year.

A Candidate Area Map was prepared to show the candidate area resulting from the Phase I Regional Screening process. Out of the initial 24,000 square mile study region, a candidate area of approximately 4,500 square miles remained after regional screening.

3.0 CANDIDATE SITE EVALUATION

3.1 INTRODUCTION

After completion of the regional screening and selection of candidate areas within which potential sites are to be located, a search was performed to select candidate sites which were judged to be potentially licensable and capable of development as a site for a nuclear power plant. In this search, the following site selection evaluation factors were considered:

- Geology and Seismology
- Meteorology
- Hydrology
- Ecology
- Demography
- Land Use
- Aesthetics
- Transportation
- Economics

This report identifies seven salt-water cooling sites and one inland fresh-water site.

Each of the identified sites was then reviewed with respect to the engineering and economic evaluations, environmental factors and licensing considerations listed above. Site economic rankings were developed and sensitivity analyses on various factors were performed. The site data and results of these analyses are discussed in this section.

3.2 METHODOLOGY

Candidate site evaluation was accomplished by performing the following tasks:

COLLECTION OF SITE SPECIFIC CANDIDATE AREA INFORMATION

Data and information collected during the regional screening phase which described the candidate areas were reviewed and, where appropriate, additional information was collected to further refine the evaluation.

CANDIDATE AREA EVALUATION AND IDENTIFICATION OF CANDIDATE SITES

The candidate areas were evaluated to identify potential candidate sites. The candidate site identification was initiated by a preliminary search of U.S.G.S. Quadrangle maps for sites within selected candidate areas. The following criteria were used in selecting the candidate sites:

- Geology and Seismology
- Meteorology
- Hydrology
- Ecology
- Demography
- Land Use
- Aesthetics
- Transportation
- Economics

These criteria are essentially the same as those used to evaluate and select the candidate areas, except that they were researched in greater detail.

A summary of the eight sites evaluated in this report is provided in Table 3.2-1 and their location is shown in Figure 3.2-1. Each of the eight sites is described in Section 3.4.

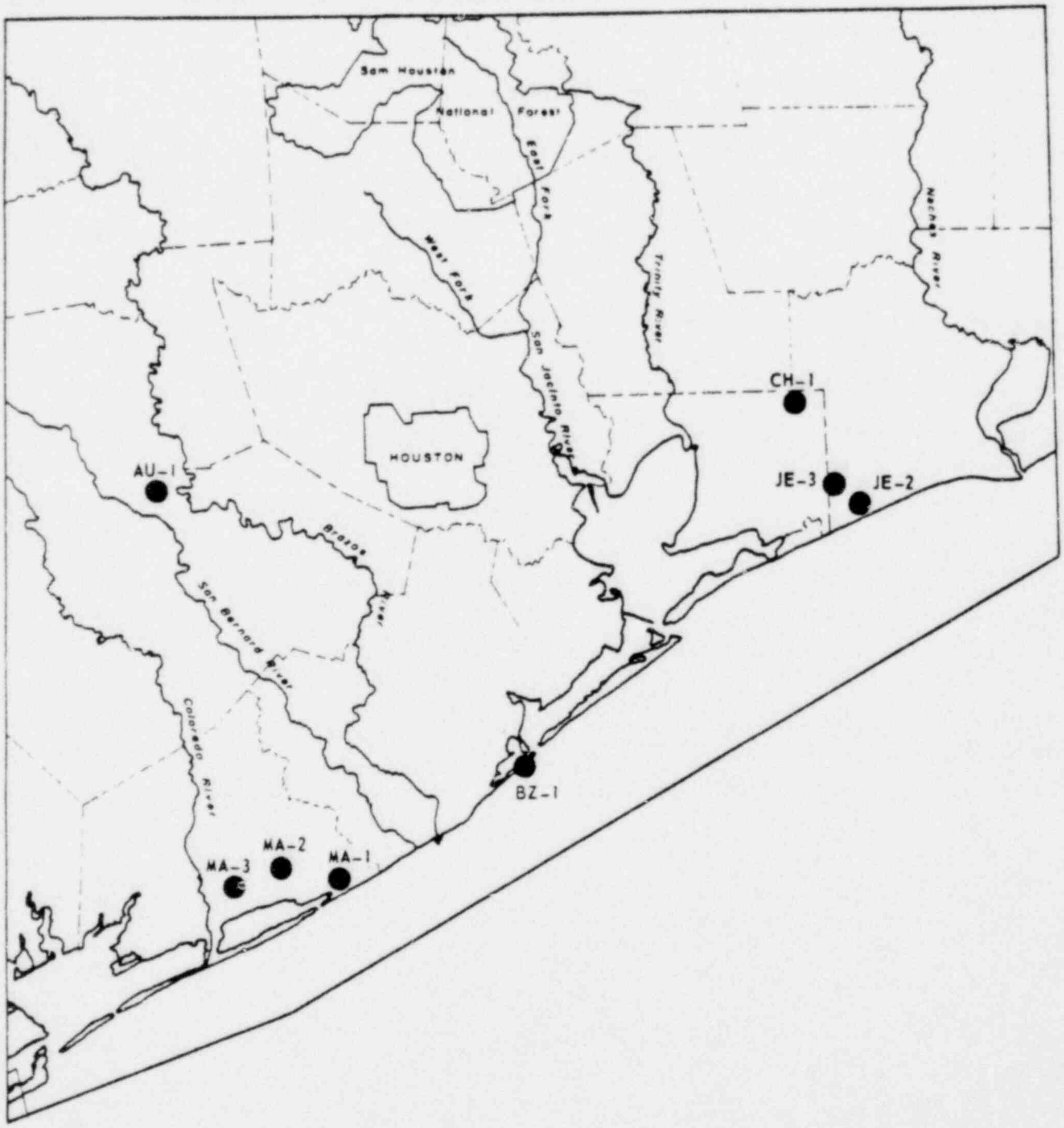
PERFORMANCE OF A COST EFFECTIVENESS COMPARISON OF CANDIDATE SITES

A cost effectiveness comparison of candidate sites was conducted. This comparison included engineering and economic evaluations, environmental factors and licensing considerations. The appropriate factors from the NRC

TABLE 3.2-1

SUMMARY SITE DESCRIPTIONS

Site	County	Nearest Communities	Type of Heat Dissipation System
Au-1	Austin	Four mi. NW of Wallis; Eight mi. SE of Sealy; Forty-five mi. W of Houston	Cooling Pond
Bz-1	Brazoria	Fifteen mi. NE of Freeport; Twenty-five mi. SW of Galveston; Fifty mi. SSE of Houston	Once Through
Ch-1	Chambers	Five mi. NW of Winnie; Ten mi. S of Nome; Fifty-seven mi. E. of Houston	Cooling Pond
Je-2	Jefferson	Twenty-seven mi. SW of Port Arthur; Nine mi. NE of High Island; Sixty-seven mi. E of Houston	Cooling Pond
Je-3	Jefferson and Chambers	Five mi. N of High Island, Thirteen mi. S of Winnie; Sixty mi. E. of Houston	Cooling Pond
Ma-1	Matagorda	Two mi. SE of Sargeant; Thirteen mi. S of Sweeney; Sixty-five mi. SW of Houston	Cooling Pond
Ma-2	Matagorda	Seven mi. W of Sargeant; Fifteen mi. Sw of Bay City; Seventy mi. SW of Houston	Cooling Pond
Ma-3	Matagorda	Nine mi. NE of Matagorda; Thirteen S of Bay City; Seventy-three mi. SW of Houston	Cooling Pond



NUCLEAR POWER PLANT SITING STUDY

Figure 3.2-1

Location Map of Candidate Sites

Regulatory Guide 4.2 (Reference 3-1) cost effectiveness check lists were incorporated into the comparison. The engineering and economic comparison was conducted utilizing TERA's computerized Economic Comparison Model. The model determines monetary cost differences for installation and operation of generating units at the potential sites. The economic comparison is described in Section 3.3.1 and the economic ranking is provided in Section 3.4.2. The economic, environmental and licensing factors are tabulated and compared in Section 3.5.

3.3 CANDIDATE SITE EVALUATION FACTORS

The primary factors used in the evaluation of candidate sites were engineering and economic evaluations, environmental factors and licensing considerations. A description of each of these factors and the assumptions that were used are presented below.

3.3.1 ENGINEERING AND ECONOMIC EVALUATION

Candidate sites were compared by determining the difference in the differential unit cost (per kilowatt hour) of energy delivered to the existing grid for specified plant output. The major cost differences between candidate sites can be determined by combining the cost elements for the heat dissipation system, transmission system, water transport systems (make-up and blowdown), transportation facilities and the site development in a single present value as of the date of operation. By annualizing this sum in a stream of payments proportional to the delivered output, it is possible to determine the necessary cost recovery rate. Costs considered include acquisition, construction and operating outlays for those plant site elements considered.

Cost categories included in the evaluation were:

- Capital Investments
- Fixed Rate Annual Costs
- Annual Costs of Generation
- Electrical Losses

The cost sources included:

- Basic Plant Parameters
- Heat Dissipation System
- Water Transport System
- Transmission System
- Transportation Facilities and Site Development

3.3.2 ENVIRONMENTAL FACTORS

Each of the candidate sites was reviewed from an environmental standpoint. This review was conducted using a combination of aerial reconnaissance, preliminary field surveys and literature reviews. The criteria used for each of the environmental factors were essentially the same as those used for the regional screening except more detail was sought.

These factors included uniqueness, sensitivity, successional status and biotic diversity of the sites and presence of breeding or feeding grounds for important migrating species. Any environmental problems identified are described as part of the environmental considerations presented in the site descriptions in Section 3.4.

3.3.3 LICENSING CONSIDERATIONS

In addition to the economic and the environmental screening, the potential sites were reviewed with respect to current licensing regulations and trends. The criteria used is consistent with the requirements of 10 CFR 50, 10 CFR 51, 10 CFR 100, NRC Regulatory Guide 4.2 and 4.7 (References 3-2, 3-3, 3-4, 3-1, and 3-5 respectively).

To minimize possible licensing problems the following procedure was used in locating the plant area.

PROXIMITY TO TRANSPORTATION FACILITIES

To determine the acceptable distance from a nuclear power plant to a transportation route over which explosive material (not including gases) may be carried, the criteria presented in Table 3.3-1 were employed. The criteria correlates the ability to withstand the possible effects of explosions occurring on nearby transportation routes relative to the effects of the design basis tornado (Reference 3-6). To comply with these criteria the plant areas were located at distances greater than those listed in Table 3.3-1.

PROXIMITY TO GEOLOGY FEATURES

Site maps were made for each of the potential sites using U.S.G.S. Quadrangle maps. The site maps show the following geology features:

- Oil or gas wells

  Oil and gas field locations were obtained from subsurface structural contour maps of the Geomap Company, a petroleum industry service company. These maps show the locations of proposed, producing and abandoned oil and gas wells.

- Surface linears and faults

  Surface fault locations for sites in the northwestern part of the study area were taken from Barnes (References 3-7 and 3-8). The locations of linears and surface faults near Houston are from Fisher and others (Reference 3-9) and a prepublication map by Fisher and others (Reference 3-10).

- Surface projections of subsurface faults

  The projection of subsurface faults to the surface was made by using a standard cross-section profile for Gulf Coast growth faults and determining the horizontal offset between the subsurface and surface traces. The fault was then replotted in the offset position parallel to its subsurface trace. The delineation of subsurface faults is based on subsurface structural contour maps of the Texas Coastal Plain published by the Geomap Company. These subsurface maps are constructed on two subsurface datums which differ from place to place.

To determine the acceptable distance from a power plant area to the above geologic features the following criteria were employed:

TABLE 3.3-1

MINIMUM DISTANCE FROM PLANT AREA TO TRANSPORTATION ROUTES (REFERENCE 3-5)

Highway[1]	1,500 feet
Railroad[2]	3,000 feet
Navigable Waterway[3]	9,000 feet

[1] Based on a 43,000 lb truckload shipment of TNT

[2] Based on a 396,000 lb three box car shipment of TNT

[3] Based on a 10,000,000 lb shipload of TNT

- Oil and gas wells

  No active oil or gas wells were allowed within the plant area. Where possible cooling ponds were not located over active oil or or gas wells.

- Surface linears, faults and projections of subsurface faults

  A minimum distance of 1100 feet was employed to separate the power plant area from surface linears, faults or projections of subsurface faults. The 1100 ft. separation is twice the possible error inherent in the subsurface projection technique. Cooling pond and pond embankment locations and alignment were based on literature information and on-site investigations would be required to verify or modify cooling pond embankment alignment.

3.4 PRESENTATION OF SITE DATA

3.4.1 SUMMARY DESCRIPTION

After selection of the candidate regions and identification of potential candidate sites were completed, a combination of overflights, preliminary field investigations, literature reviews and economic analyses were used to develop the information presented in this section. The sites and heat dissipation systems used in the evaluations were as follows:

Site Number	Type of Heat Dissipation System
Au-1 (Allens Creek)	Cooling Pond using fresh water
Bz-1	Once Through using salt water
Ch-1	Cooling Pond using salt water
Je-2	Cooling Pond using salt water
Je-3	Cooling Pond using salt water
Ma-1	Cooling Pond using salt water

Site Number	Type of Heat Dissipation System
Ma-2	Cooling Pond using salt water
Ma-3	Cooling Pond using salt water

The Au-I site (Allens Creek) was considered an existing two unit site at the time TERA did the 1975 study; therefore, it was considered as an existing site at which two additional units could be added. For the coastal site comparison report, TERA re-evaluated the Allens Creek site as a new site which did not contain two existing units. Thus, the Allens Creek site was rated on the same rating scale as the seven coastal sites to ensure that there was no bias in comparing the Allens Creek site to these sites. This format was necessarily more limited than the extensive information provided in the environmental report and safety evaluation report for the Allens Creek project. Therefore, this comparison is consistent with but not a substitute for the more detailed information developed in the prime site investigational phase and presented in the applicant's environmental and safety reports.

The BZ-I site in Brazoria County, which is 25 miles southwest of Galveston, was evaluated in January 1979, (Reference I-2) in response to questions from the NRC Staff in connection with the Staff's updated alternative sites evaluation. Both HL&P and the Staff had previously rejected the San Jacinto Basin on the basis of a regional screening. However, under the NRC's revised criteria, it was determined that it was necessary to identify a specific site in this region. The Brazoria County site was identified from the sites catalogued in the 1975 study, and was as good as could be identified under our criteria.

3.4.2 SITE ECONOMIC RANKING

The candidate sites were evaluated using the engineering and economic factors discussed in the previous sections. The site dependent variables associated with the heat dissipation system, transmission system, water transport system, transportation facilities and site development were developed for each of the candidate sites. These factors were utilized in the computerized economic model and an economic ranking developed. The results of the site economic ranking are presented in Table 3.4-1. The mills/kwhr presented are the differential cost from the base or lowest cost site.

3.4.3 SITE DATA

Each of the candidate sites was investigated in detail through use of the regional screening and site selection factors. Site summaries describing these factors and their significance to each site are provided in this section. The summaries include the following information:

- Type, size and location of site
- Geology and seismology
- Meteorology
- Hydrology
- Ecology
- Demography
- Land Use
- Aesthetics
- Transportation

All significant considerations are identified and discussed in the appropriate section.

TABLE 3.4-1

ECONOMIC RANKING

Order	Site Number	Differential Cost (mills/kwhr)
1	Au-1	Base
2	Ma-3	.104
3	Bz-1	.138
4	Ma-1	.145
5	Ch-1	.160
6	Je-3	.213
7	Ma-2	.217
8	Je-2	.257

SITE AU-1

(ALLENS CREEK)

Type: Cooling Pond Site Using Fresh Water

Size: The cooling pond will inundate approximately 5120 acres. The site consists of 11,152 acres of land and includes those areas to be occupied by the station, the restricted area, the cooling pond, and adjacent areas owned by Houston Lighting & Power Company.

Location: The Au-1 site is located in Austin county approximately 4 miles northwest of Wallis, 7 miles south-southeast of Sealy, and 45 miles west of the center of Houston.

Factors: The summary findings from application of the regional environmental protection considerations listed below are discussed on the following pages.

Regional Environmental Protection Considerations

Geology and Seismology

Meteorology

Hydrology

Ecology

Demography

Land Use

Aesthetics

Transportation

Geology and Seismology

- Geologic Setting

Age: Pleistocene

Surficial Sediment Assemblage: Fluvial-deltaic System

- Surface Material Types

The site is predominately covered by river alluvium, floodplain and backswamp deposits, and exposed sands, silty sands or silts. Near the Brazos River the alluvium is 120 feet thick and thins moving across the site location. Floodplain and backswamp deposits occur within the cooling pond location consisting of red, brown, and gray clay and clayey silts with occasional lenti-cular sand beds. The upper clay sequence is underlain by fine to coarse gravelly sand.

- Underlying Deposits

Pleistocene: Beaumont Clay Formation

The Beaumont Clay Formation consists primarily of Pleistocene age delta plain deposits; principally calareous red, brown or yellow clay that weathers bluish-gray or black; with logs, peat, fossil plants and some shells; represents interdistributary muds, abandoned channel-fill muds, fluvial overbank muds, and locally, bay, marsh, lagoon and backswamp muds. These deposits are characterized by low permeability, high water-holding capacity, high compressibility, high to very high shrink-swell potential, poor drainage, low shear strength and high plasticity. The clays are interbedded with highly lenticular beds of gray to bluish-gray sandy clay, silt, and very find-grained to medium grained sand representing levee, crevasse splay, distributary and locally, meanderbelt sand. These deposits exhibit low to moderate permeability, high to moderate water-holding capacity, moderate compressibility, moderate to low shrink-swell potential, moderate drainage, moderate to high shear strength and low plasticity. Meanderbelt sand may be under-consolidated and subject to liquification.

Pleistocene: Montogomery Formation

Immediately underlying the Beaumont Formation is the Montgomery Formation consisting primarily of a light brown sand. The sand is fine- to medium-grained near the top of the formation and grades coarser with depth; intervals of coarse sand and gravelly sands are common in the lower half of the formation. Interbedded with the sands are occasional red-brown and gray clay and silt beds. Several water-bearing and sand units exist within the Montgomery Formation. The formation is 70 to 100 feet thick at the plant site and the sands are generally dense to very dense.

Plioceneo: Goliad Formation

These aforementioned Pleistocene formations unconformably overlie the Pliocene Goliad Formation. The Goliad Formation consist of interbedded light gray to light brown sandstone, mudstone, fine to coarse sands and sandy clays. The sandstones occur as poorly- to well-cemented, thin-bedded, calcareous, fine- to coarse-grained deposits, with thin sand and clay seams. Some sand beds are water-bearing. The Goliad Formation is 70 to 100 feet thick in the site area. The clays are stiff to hard and the sands are dense to very dense.

Miocene: Fleming Formation

The Fleming Formation is present below the Goliad Formation. The upper portions of this unit consist of dark red-brown silty clay, red-brown and gray clay, and interbedded sandstone and sand. The clays and sands are hard and dense to very dense, respectively.

- Geologic Hazards

Salt Domes

The areas of potential salt dome activity closest to the site are the San Felipe Dome, approximately eight miles northwest, and Orchard Dome, approximately 12 miles southeast.

Seismicity

The closest reported earthquake epicenters to the site in historic time was:

Date	Lat. (N)	Long. (W)	Intensity (MM)	Location	Distance (Mi.)
1/7/56	29.300	94.800	MM IV	Galveston Island	76

Note that three earthquakes of intensity I, reported at Hobby Airport in Houston, Texas, in June 1969, have been recorded as possible sonic booms.

The unnamed events in 1910 north of Sealy, Texas, and the Anderson event in 1914 near Sealy, Texas, have not been substantiated by literature survey.

Surface Faults, Linears and Subsurface "Fault" Projections

Several literature linears are in the vicinity of the Au-I site area with the closest linear passing .6 miles south of the plant. Chapter 2 of the Allens Creek PSAR demonstrates that these linears have no correlation to subsurface faults and are of no geologicol significance.

- <u>Topography, Soil Stability and Construction Suitability</u>

  The plant site is flat topographically and bounded on the east by the Brazos River. The area consists primarily of floodplain and alluvium deposits. The soil generally has low permeability, high shrink-swell potential and low to moderate bearing capacity.

- <u>Subsidence</u>

  There has been some regional land subsidence attributed to extraction of fluids by pumping near the coast; however, the influence of pumping has been limited to that general area and measurable surface subsidence has not been reported within 10 miles of the plant site. Chapter 2 of the Allens Creek PSAR shows that there is no potential for subsidence which would affect the plant.

- <u>Aquifers</u>

  This site is located on a "acceptable" aquifer zone.

<u>Meteorology</u>

- <u>Atmospheric Dispersion</u>

  Evaluation of preliminary information including wind speed, atmospheric stability and topography indicates that the short-term diffusion characteristics of the site are adequate, and that the good annual average diffusion characteristics exist. There are no significant topographic restrictions to dispersion in the site vicinity. Overall, diffusion characteristics are such that additional engineering features designed to limit fission product release should not be required.

- <u>Tornado and Extreme Winds</u>

  All of the sites under consideration lie within Design Basis Tornado Region I.

  > General Design Criteria 2, "Design Basis for Protection Against Natural Phenomena" of Appendix A to 10 CFR 50, "Licensing of Production Facility", requires that structure, systems and components important to safety be designed to withstand the effects of natural phenomena such as tornadoes without loss of capability of their safety functions. A design basis tornado, acceptable to the Regulatory Staff, has been specified in Regulatory Guide 1.76. The requirements are shown in Table I on the following page.

TABLE I

DESIGN BASIS TORNADO CHARACTERISTICS

(from Regulatory Guide 1.76)

	Region		
	I	II	III
Maximum Wind Speed (mph)[a]	360	300	240
Rotational Speed (mph)	290	240	190
Translational Speed (mph)			
Maximum	70	60	50
Minimum[b]	5	5	5
Radius of Maximum Rotational Speed (ft)	150	150	150
Pressure Drop (psi)	3.0	2.25	1.5
Rate of Pressure Drop (psi/sec)	2.0	1.2	0.6

[a] The maximum wind speed is the sum of the rotational speed component and the maximum translational speed component.

[b] The minimum translational speed, which allows maximum transit time of the tornado across exposed plant features, is to be used whenever low travel speeds (maximum transit time) are a limiting factor in design of the ultimate heat sink. The ultimate heat sink is that complex of water sources, including associated retaining structures, and any canals or conduits connecting the sources with, but not including, the intake structures of nuclear reactor units. Regulatory Guide 1.27 (Safety Guide 27), "Ultimate Heat Sink," describes a basis that may be used to implement General Design Criterion 44 of Appendix A to 10 CFR Part 50 with regard to the ultimate heat sink.

- Fogging and Icing

  Cooling system fogging and icing generally occurs with cold, moist air under light to moderate wind conditions. Little icing is anticipated at the site since winters are generally quite mild. On the very conservative assumption that ground level cooling system-related fogs may occur up to 10 miles from the system, some occasional fog could affect local roads (FM 1093 and 1458), Texas Highways 60 and 36, Interstate 10, and the towns of Sealy, Wallis, Orchard, Chesterville and Simonton.

- Wind Characteristics

  Surface wind directions at Houston (Hobby Airport) predominately are from the south-southeast, which is generally true also for the individual months. The wind directions at the site are likely to have a slightly more south-southeast to southerly orientation, since they are further inland from the Gulf of Mexico. No major population center is within 30 miles downwind of the site under the prevailing wind directions. The town of Sealy is about 7 miles north-northwest of the site on the streamline of the prevailing wind. The annual average wind speed is 11.6 miles per hour at Houston Hobby and is estimated to be about 11 mph at the site.

Hydrology

- Availability of Cooling Water

  Water necessary to meet the makeup requirements for a 2,600 MWe nuclear station (LWR) would be purchased from the Brazos River Authority.

  For the Au-1 site, the required freshwater for use as cooling pond makeup and blowdown will be pumped 4,000 feet to and from the Brazos River.

- Water Quality

  The quality of the cooling water available at the Au-1 site should be acceptable. The cooling system will use freshwater from, and discharge to, the Brazos River.

- Flood Protection

  The safety-related features of the plant and in fact the entire plant, will be protected against the probable maximum flood and against the failure of upstream dams by siting above the flood plain.

Ecology

- Environmentally Sensitive Considerations

Flora

The site lies in the transitional zone between the Post Oak Savannah and the Gulf Prairie at the upper end of the coastal plain. Due to present land use, much of the flora has been disturbed or eliminated. Vegetation within the area is highly diverse and is no longer representative of the former climax vegetation. No environmentally sensitive species are expected to occur on site.

Fauna

The site area is characteristic of the region supporting several mammal and bird species. Aquatic habitats exist in the Brazos River and surrounding tributaries. The river is considered a poor producer by the Texas Parks and Wildlife Department. Although it is unlikely that any known threatened or endangered animal species reside on the site, it is possible that several sensitive species recognized by the U.S. Fish and Wildlife Service, the Texas Parks and Wildlife Department or the Texas Organization for Endangered Species may frequent the site area. Chapter 2 of the Allens Creek environmental report demonstrates that there are no sensitive species on the site.

Demography

The plant site falls outside of the exclusion areas defined by the demographic criteria provided below.

- Cumulative population versus distance from the reactor will not exceed:

  0 - 5 miles $\leq$ 30,000 persons

  0 - 20 miles $\leq$ 500,000 persons

  0 - 40 miles $\leq$ 2,000,000 persons

- Local population densities should not exceed 220 persons per square miles within two miles of the reactor.

- The exclusion zone distance from the reactor to the site boundary should be greater than or equal to that calculated for the specific reactor type and size an in any event should be greater than 0.5 miles.

Land Use

- Existing Land Use

  Most of the site area consists of cropland and improved pasture and is expected to remain predominantly agricultural in the future. A few residences are located within the proposed site boundaries.

- Airspace

  The site lies outside of aircraft, prohibited, restricted, warning and alert areas, and airport control zones.

- Mineral Reserves

  No known mineral reserves are believed to exist within the plant site area.

- Oil and Gas Fields

  No known or developed oil and gas fields are believed to exist within the plant site area. One underground natural gas pipeline located in the cooling pond area will have to be relocated.

- Archeological & Historical Sites

  No archeological or historical sites as listed in or considered for the National Register of Historic Places or the National Register of Natural Landmarks exist within the projected site boundaries.

- Recreational Sites

  No recreation areas are located within the site area. Several small parks are located in Sealy and Wallis and the Stephen F. Austin State Park is located approximately 10 miles north.

- Proposed Land Use Plans

  The proposed site area does not conflict with any known land use plans.

Aesthetics

Local vegetation would partially screen the plant complex, but because of the topography of the site area, portions of the reactor building complex and transmission lines will be visible from Texas Highway 36, FM 1093 and 1458, and the community of Wallis.

- Noise

  The noise created by construction and operation of the facility is not expected to cause undue impact in the site area.

Transportation

- Motor Carrier Service and Access

  The Au-I could be served by carriers operating over Texas Highway 36, which is located one mile west of the site.

- Railroad Service and Access

  The Au-I site could be served by a railroad spur extending from a Atchison, Topeka and Santa Fe Railroad I mile west of the site.

- Roads and Highways

  The site is located I mile east of Texas Highway 36, which provides good north-south access and connects with Interstate 10 seven miles north and with U.S. Highway 90A approximately 20 miles southeast of the site.

- Waterways

  The Au-I site is land-locked. The Brazo's River is not navigable due to inadequate channel depths, seasonal nature of flow and impaired vertical bridge clearances and other stream obstructions.

SITE BZ-1

Type: Once Through Cooling Site Using Salt Water

Size: The total land area for the site will be somewhat dependent on the parcel size but should be about 640 acres.

Location: The Bz-1 site is located on Follets Island in Brazoria County, approximately 2½ miles southwest of the near abutment of the San Luis Pass bridge, 50 miles south-southeast of the center of Houston, 25 miles southwest of Galveston and 15 miles northeast of Freeport, Texas.

Factors: The summary findings from application of the regional environmental protection considerations listed below are discussed on the following pages.

Regional Environmental Protection Considerations

- Geology and Seismology
- Meteorology
- Hydrology
- Ecology
- Demography
- Land Use
- Aesthetics
- Transportation

-

Geology and Seismology

- Geologic Setting

  Age: Modern Holocene

  Surficial Sediment Assemblage: Barrier-Strandplain-Chenier System

- Surface Material Types

  The site is predominantly coastal marsh located on the back side of a barrier island. During northers some shells may be washed into the marsh and narrow, discontinuous beaches develope. Except for these beaches, sediments underlying the marshes become coarser or sandier from the bay margin to the higher parts of the marsh. Underlying sediments of low marshes are generally dark gray mud or muddy sand, intensely burrowed by worms, crustaceans, and mollusks, and mottled by penetration of roots. Sediments underlying higher marshes are mud, muddy sand, or locally may be dominantly sand. Sediments of high marsh are reworked by plant roots and fiddler crabs. Surface coverings generally include the Mustang-Galveston association characterized by coastal flat and coastal terrace soils with gray, neutral, sandy surfaces with white to gray, neutral to alkaline, sandy subsoils that are rapidly to very slowly permeable.

- Underlying Deposits

  Pleistocene: Beaumont Clay Formation

  Pleistocene age delta plain deposits; principally calcareous red, brown, or yellow clay that weathers bluish-gray or black; with logs, peat, fossil plants and some shells; represents interdistributary muds, abandoned channel-fill muds, fluvial overbank muds, and locally, bay, marsh, lagoon and backswamp muds. These deposits are characterized by low permeability, high water-holding capacity, high compressibility, high to very high shrink-swell potential, poor drainage, low shear strength and high plasticity. The clays are interbedded with highly lenticular beds of gray to bluish-gray sandy clay, silt, and very fine-grained to medium-grained sand representing levee, crevasse splay, distributary and, locally, meanderbelt sand. These deposits exhibit low to moderate permeability, high to moderate water-holding capacity, moderate compressibility, moderate to low shrink-swell potential, moderate drainage, moderate to high shear strength and low plasticity. Meanderbelt sand may be under-consolidated and subject to liquification.

  Pleistocene: Lissie Formation

  Alternating beds of fine to coarse gray sand and thin lenses of fine gravel interbedded with gray, brown, blue and red clayey sand and sandy clay representing fine-grained meanderbelt sands, levee, crevasse splay, and distributary sands, and floodbasin mud over meanderbelt sand. Units are typically lenticular, but a few thicker clay strata may be traced over county-sized areas. These sands exhibit moderate to high permeability, moderate to good drainage, low shrink-swell potential, high shear strength and low plasticity. Some sands may be under-compacted and subject to liquification. The sandy clays exhibit moderate permeability, moderate drainage, moderate to high shear strength, and moderate to low shrink-swell potential. A few thicker clays have high water-holding capacity, high compressibility, high to very high shrink-swell potential, poor drainage, low shear strength and high plasticity.

- Geologic Hazards

Salt Domes

The site is located in an area of salt dome influence in the subsurface and is therefore located outside the acceptable candidate area. The center of the nearest identified salt done is Hoskins Mound, located approximately eight miles to the northwest.

Seismicity

The closest reported earthquake epicenters to the site in historic time was:

Date	Lat. (N)	Long. (W)	Intensity (MM)	Location	Distance (Mi.)
1/7/56	29.300	94.800	MM IV	Galveston island	76

Erosion Potential

The bay shorline in the site area is depositional, with accretion and eolian processes. Some portions are in depositional-erosional equilibrium.

Hurricane Washover

The site is a potential hurricane washover channel.

Surface Faults, Linears and Subsurface "Fault" Projections

The nearest linears reported in the literature trend northwest-southeast, at approximately one mile distance each, on either side of the site. Two possible projections of subsurface faults reported in the literature are located near the site area. One projection trends northeast-southwest approximately one mile northeast of the site. The linear to the northeast is concurrent with the subsurface fault projection in the same area.

Confirmation of surface and subsurface geology, especially the surface location of subsurface faults and the correlation with photolinears, should be accomplished through a detailed exploration program, using various investigative techniques shown effective in similar studies. This should include both remote and on-site investigative methods.

- Topography, Soil Stability and Construction Suitability

The site is basically flat, ranging from sea level to five feet throughout. The area is dominantly coastal marsh with some sand flats, subject to frequent inundations, with a permanently high water table, very low permeability, high water-holding capacity, very poor drainage, very poor load bearing strength and high organic content.

- Subsidence

Total recorded subsidence in this area is between 0.2 feet and 1.0 feet. The site area is believed to be affected by natural regional coastal subsidence. Local groundwater withdrawal is thought to have little effect on subsidence in this region, although a major increase in groundwater withdrawal in the site area would likely be accompanied by ground surface subsidence.

- Aquifers

This site is located on a "conditionally acceptable" aquifer zone. A - detailed on-site hydrogeologic investigation is needed to establish the conformance of this site to current requirements.

Meteorology

- Atmospheric Dispersion

Evaluation of preliminary information including wind speed, atmospheric stability and topography indicates that the short-term diffusion characteristics of the site are adequate and that the good annual average diffusion characteristics exist. There are no significant topographic restrictions to dispersion in the site vicinity. Overall diffusion characteristics are such that additional engineering features designed to limit fission product release should not be required.

- Tornado and Extreme Winds

  All of the sites under consideration lie within Design Basis Tornado Region I.

  General Design Criteria 2, "Design Basis for Protection Against Natural Phenomena" of Appendix A to 10 CFR 50, "Licensing of Production Facility", requires that structure, systems and components important to safety be designed to withstand the effects of natural phenomena such as tornadoes without loss of capability of their safety functions. A design basis tornado, acceptable to the Regulatory Staff, has been specified in Regulatory Guide 1.76. The requirements are shown in Table I on the following page.

- Fogging and Icing

  Since the plant will employ once-through cooling at this site, and a submerged offshore discharge in the Gulf of Mexico is planned, no fogging or icing effects will occur.

- Wind Characteristics

  The mean wind speed for the site is about 12 mph. The prevailing wind direction is from the south-southeast, which places Houston 35-40 miles distant on the streamline of prevailing winds for gaseous effluent releases.

TABLE I

DESIGN BASIS TORNADO CHARACTERISTICS
(from Regulatory Guide 1.76)

	Region		
	I	II	III
Maximum Wind Speed (mph)[a]	360	300	240
Rotational Speed (mph)	290	240	190
Translational Speed (mph)			
Maximum	70	60	50
Minimum[b]	5	5	5
Radius of Maximum Rotational Speed (ft)	150	150	150
Pressure Drop (psi)	3.0	2.25	1.5
Rate of Pressure Drop (psi/sec)	2.0	1.2	0.6

[a] The maximum wind speed is the sum of the rotational speed component and the maximum translational speed component.

[b] The minimum translational speed, which allows maximum transi. time of the tornado across exposed plant features, is to be used whene er low travel speeds (maximum transit time) are a limiting factor in design of the ultimate heat sink. The ultimate heat sink is that complex of water sources, including associated retaining structures, and any canals or conduits connecting the sources with, but not including, the intake structures of nuclear reactor units. Regulatory Guide 1.27 (Safety Guide 27), "Ultimate Heat Sink," describes a basis that may be used to implement General Design Criterion 44 of Appendix A to 10 CFR Part 50 with regard to the ultimate heat sink.

Hydrology

- **Availability of Cooling Water**

  Water necessary to meet the cooling requirements for a 2,600 MWe nuclear station (LWR) would be supplied via a once-through system from the Gulf of Mexico. The intake pipeline would be approximately 4,400 feet long and the discharge pipeline would be approximately 6,800 feet long.

- **Water Quality**

  The quality of the cooling water available at the site should be acceptable. The cooling system would use seawater intake from, and discharge to, the Gulf of Mexico.

- **Flood Protection**

  The site is subjected to flooding during storm surge and wave run-up from Gulf of Mexico hurricanes. The plant grade should be raised to prevent flooding and slope protection should be provided below this level.

- **Oceanography**

  Located on-land, the site is somewhat protected from waves and littoral drift caused impacts. Beach erosion may be significant.

Ecology

- **Environmentally Sensitive Considerations**

  ### Flora

  Three ecological habitat types occur on the Bz-1 site: (1) barrier flats; (2) tidal marshes; and (3) coastal ponds. Barrier flats or sand flats are found on the bay side of Follets Island behind the beach ridge north of the beachfront road (Brazoria County Road 257). On and near the site the barrier flats consist of sand vegetated with salt-tolerant grasses. Most of the site is tidal marshland with vegetation, such as cordgrass (*Spartina* sp.). The vegetation on the site and surrounding areas is important for biological processes and for erosion stabilization.

  ### Fauna

  Site fauna of sediment dwellers, such as nematodes, polychaetes and clams, as well as grass shrimp, crabs, shore birds and waterfowl. Although it is unlikely that any known threatened or endangered animal species reside on the site, it is possible that several sensitive species recognized by the U.S. Fish and Wildlife Service, the Texas Parks and Wildlife Department or the Texas Organization for Endangered Species may frequent the site area. These species include the brown pelican, olivaceous cormorant, reddish egret, wood ibis, American oystercatcher, white faced ibis, and roseate spoonbill. Bird rookeries are located near San Luis Pass, southeast of the site and on Mud Island, north of the site.

The site is located in a coastal region considered to be of particular environmental concern as described in the Texas Coastal Management Plan. Facility construction and operation activities, such as dredging, spoil placement and operation of a cooling water intake system and thermal discharge system, that would affect the biota of San Luis Pass, Cold Pass, Churchill Bayou, Christmas Bay, or the nearshore Gulf may cause significant negative ecological impact.

There is a high probability of significant licensing difficulities because of the ecological impact of utilizing this site for power plant development.

Demography

The plant site falls outside of the exclusion areas defined by the demographic criteria provided below.

- Cumulative population versus distance from the reactor will not exceed:

  0 - 5 miles ≤ 30,000 persons

  0 - 20 miles ≤ 500,000 persons

  0 - 40 miles ≤ 2,000,000 persons

- Local population densities should not exceed 220 persons per square miles within two miles of the reactor.
- The exclusion zone distance from the reactor to the site boundary should be greater than or equal to that calculated for the specific reactor type and size an in any event should be greater than 0.5 miles.

Land Use

- Existing Land Use

  The site consists of sand flats, coastal marshland and coastal ponds. Existing land use consists of coastal wildlife habitat (especially birds) and limited recreational use (e.g. bird watching). The Brazoria National Wildlife refuge is located approximately five miles west of the site. Land use of the intake and discharge pipeline routes consists of a county road and undeveloped beach available to the general public.

- Airspace

  The site lies outside of aircraft, prohibited, restricted, warning and alert areas. A private small craft landing strip lies within 1,000 feet of the site to the east.

- Mineral Reserves

  No known mineral reserves are believed to exist within the plant site area.

- Oil and Gas Fields

  No known or developed oil and gas fields are believed to exist within the plant site area. No known underground petroleum or petroleum product pipelines are located in the site area.

- Archeological & Historical Sites

  No known archeological or historical sites are believed to exist within the projected site boundaries. Detailed archeological and historical investigations would be necessary to confirm the initial investigations.

- Recreational Sites

  No recreation areas are located within the site area. The site and surrounding environs are available for recreational activities, such as hiking and bird watching. The 1,075-acre Mud Island State Recreational Park lies across Cold Pass from the site to the north. The beach shoreline south of the site is available to the public for swimming and fishing.

- Proposed Land Use Plans

  The proposed site area does not conflict with any known land use plans; however, the site is within an area of particular state concern expressed in the Texas Coastal Management Program. State concerns in the area include the designations of Christmas, Bastrop, and Drum bays and bayous, Mud Island, and San Luis Pass as critical habitats for marine and coastal ecosystems and associated biota. Follets Island and the surrounding area also are designated by the state as an important natural area for waterfowl. Bird rookeries are located near San Luis Pass southeast of the site and on Mud Island north of the site. Licensing difficulties associated with conflicts in land use could be major licensing issues.

Aesthetics

Because of the flat topography of the site area the plant facilities and transmission lines would be visible for considerable distances and would be visible from the Brazoria National Wildlife Refuge, farm-to-market roads 523 and 2004, the San Luis Pass tollbridge and Brazoria County Road 257, as well as the Intracoastal Waterway and the Gulf of Mexico. The plant complex and transmission towers would be the dominant features on the landscape.

- Noise

Construction noise would impact bird populations in the areas surrounding the site. Noise from construction and operation of the facility and from traffic would be noticeable in the relatively isolated site and nearby areas.

Transportation

- Motor Carrier Service and Access

The site could be served by carriers operating over Texas Highway 332, which connects with the medium duty Brazoria County Road 257.

- Railroad Service and Access

The Bz-1 site could be served by a railroad spur extending from a barge facility located north of the site on Christmas Bay. Barge access from the facility to the Intracoastal Waterway would require dredging or channel construction.

- Roads and Highways

The site is located within 2,000 feet from a medium duty beachfront road which is Brazoria County Road 257. This road is the only land access route. To the east of the site, this road connects Follets Island with Galveston Island via a toll bridge.

- Waterways

The Texas Intracoastal Waterway is located less than four miles north of the site. Barge access from the waterway would require construction of a channel across Bastrop or Christmas bays. Any dredging or channel construction would probably receive considerable environmental opposition.

SITE CH-1

Type: Cooling Pond Site Using Salt Water

Size: The cooling pond will inundate approximately 3,800 acres. The total land area for the site will be somewhat dependent on the parcel size but should be about 4,800 acres.

Location: The Ch-1 site is located in Chambers County. It is 5 miles northwest of Winnie, 57 miles east of the center of Houston, and 10 miles south of Nome.

Factors: The summary findings from application of the regional environment protection considerations listed below are discussed on the following pages.

Regional Environmental Protection Considerations

- Geology and Seismology
- Meteorology
- Hydrology
- Ecology
- Demography
- Land Use
- Aesthetics
- Transporation

Geology and Seismology

- Geologic Setting

Age: Pleistocene

Surficial Sediment Assemblage: Fluvial-deltaic System

- Surface Material Types

Interdistributary muds incluing bay, marsh, flood basin, and locally, abandoned channel facies.

- Underlying Deposits

Pleistocene: Beaumont Clay Formation

Pleistocene age delta plain deposits; principally calareous red, brown, or yellow clay that weathers bluish-gray or black; with logs, peat, fossil plants and some shells; represents interdistributary muds, abandoned channel-fill muds, fluvial overbank muds, and locally, bay, marsh, lagoon and backswamp muds. These sands exhibit moderate to high permeability, moderate to good drainage, moderate water-holding capacity, moderate to low compressibility, low shrink-swell potential, high shear strength and low plasticity.

- Geological Hazards

Salt Domes

The areas of potential salt dome activity closest to the site are Figridge Dome (1-1/2 miles south) and Hankamer Dome (2-1/2 miles west).

Seismicity

The recorded earthquake epicenters closest to the site are:

Date	Lat. (N)	Long. (W)	Intensity (MM)	Location	Distance (Mi.)
3/24/66	30.000	94.00	None Reported	Sabine, Texas	27
10/17/52	30.120	93.730	IV	Orange, Texas	47
1/7/56	29.300	94.800	IV	Galveston Island Texas	37

Three earthquakes of intensity I, reported at Hobby Airport, Houston, Texas, in June 1969, have been recorded but are possible sonic booms.

Linears and Subsurface "Fault" Projections

Two literature linears are located north of the site and two run through the southern part of the cooling pond. A series of subsurface fault projections associated with the Sea Breeze oil field fall to the south and east of the site.

Confirmation of surface and subsurface geology, especially the surface location of subsurface faults, should be accomplished through a detailed exploration program, using various investigative techniques shown effective in similar studies. This should include both remote and on-site investigative methods.

- Topography, Soil Stability and Construction Suitability

  The topography of the site is flat, with irrigation levees for agriculture. Rush Ditch and Spindletop Bayou run through the middle of the site from north to south. The soils have moderate slope stability and moderate shrink-swell. Bearing capacity is low to moderate. Excavation will be relatively easy, with no blasting required. The soil has fair drainage with low to moderate permeability.

- Subsidence

  Total recorded subsidence in this area is between 0.2 and 1.0 feet. The site area is believed to be affected by natural regional coastal subsidence. Local groundwater withdrawal is thought to have had little effect on subsidence in this region, although a major increase in groundwater withdrawal in the site area would likely be accompanied by ground surface subsidence.

- Aquifers

  This site is located on a "conditionally acceptable" aquifer zone. A detailed on-site hydrogeological investigation is needed to establish the conformance of this site to current requirements

Meterology

- Atmospheric Dispersion

  Evaluation of preliminary information including wind speed, atmospheric stability and topography indicates that the short-term diffusion characteristics of the site are equal to or better than the diffusion characteristics of the NRC models appearing in the Regulatory Guides. It also appears that good annual average diffusion characteristics exist and are such that additional engineering features designed to limit fission product release should not be required.

- Tornado and Extreme Winds

  All of the sites under consideration lie within Design Basis Tornado Region I.

  > General Design Criteria 2, "Design Bases for Protection Against Natural Phenomena" of Appendix A to 10 CFR 50, "Licensing of Production Facility", requires that structure, systems and components important to safety be designed to withstand the effects of natural phenomena such as tornadoes without loss of capability of their safety functions. A design basis tornado, acceptable to the Regulatory Staff, has been specified in Regulatory Guide 1.76. The requirements are shown in Table I below.

TABLE I

DESIGN BASIS TORNADO CHARACTERISTICS
(from Regulatory Guide 1.76)

	Region		
	I	II	III
Maximum Wind Speed (mph)[a]	360	300	240
Rotational Speed (mph)	290	240	190
Translational Speed (mph)			
Maximum	70	60	50
Minimum[b]	5	5	5
Radius of Maximum Rotational Speed (ft)	150	150	150
Pressure Drop (psi)	3.0	2.25	1.5
Rate of Pressure Drop (psi/sec)	2.0	1.2	0.6

[a] The maximum wind speed is the sum of the rotational speed component and the maximum translational speed component.

[b] The minimum translational speed, which allows maximum transit time of the tornado across exposed plant features, is to be used whenever low travel speeds (maximum transit time) are a limiting factor in design of the ultimate heat sink. The ultimate heat sink is that complex of water sources, including associated retaining structures, and any canals or conduits connecting the sources with, but not including, the intake structures of nuclear reactor units. Regulatory Guide 1.27 (Safety Guide 27), "Ultimate Heat Sink," describes a basis that may be used to implement General Design Criterion 44 of Appendix A to 10 CFR Part 50 with regard to the ultimate heat sink.

- Fogging and Icing

  Cooling pond or tower fogging tendencies are such that when the air is colder than the surface water temperatures, shallow fogs may occur which, in the case of the Ch-1 site, could cause reduced visibility on Interstate Route 10, Texas Routes 124, 326, 73 and 65, the town of Winnie and on local farm to market roads.

- Wind Characteristics

  The mean wind speed for the Ch-1 is 10.5 mph. The prevailing wind direction is from the south - southeast, which does not place any major population center on the streamline of prevailing winds for gaseous effluent releases.

Hydrology

- Availability of Cooling Water

  Water necessary to meet the makeup requirements for a 2,600 MWe nuclear station (LWR) would be taken from the Gulf.

  For the Ch-1 site, it would be necessary to pump the water approximately 24 miles to the proposed cooling lake.

- Water Quality

  The quality of the cooling water available at the Ch-1 site should be acceptable. The cooling system will use saltwater makeup from, and return blowdown to, the Gulf.

- Flood Protection

  The safety related features of the plant and, in fact, the entire plant will be protected against the probable maximum flood and against the failure of upstream dams by siting above the flood plain. Backwater studies will be made to verify selection prior to finalized site selection.

Ecology

- Environmentally Sensitive Considerations

  Flora

  Due to present land use, the flora of the site area is in an early state of succession and probably does not contain any environmentally sensitive species. Agricultural use and grazing has served to degrade the flora of the site.

Fauna

While no specific environmentally sensitive fauna are believed to inhabit the specific site area, the region is part of the range of the following endangered fauna:

American Alligator
Eskimo Curlew
Brown Pelican
Arctic Peregrine Falcon
Southern Bald Eagle
Red Wolf

Demography

The plant site falls outside of the exclusion areas defined by the demographic criteria provided below.

- Cumulative population versus distance from the reactor will not exceed:

  0 - 5 miles ≤ 30,000 persons

  0 - 20 miles ≤ 500,000 persons

  0 - 40 miles ≤ 2,000,000 persons

- Local population densities should not exceed 220 persons per square mile within 2 miles of the reactor.

- The exclusion zone distance from the reactor to the site boundary should be greater than or equal to that calculated for the specific reactor type and size and in any event should be greater than 0.5 miles.

Land Use

- Existing Land Use

  The land is presently used for rice farming and is excellent agricultural land. The community of Winnie is located to the southeast of the prospective site. Approximately 17 residences are located within the prospective site boundaries. Due to the high quality of agricultural land and the large area of land that would be removed from production by a cooling pond, licensing problems associated with conflicts in land use could be a major licensing issue. The use of saltwater cooling towers could reduce the land area required for the facility, but would not be economically viable since the make-up water is taken from the Gulf, 24 miles away.

- Airspace

  The plant site lies outside of aircraft, prohibited, restricted, warning and alert areas, and airport control zones extending upwards from the surface. Low altitude Federal Airway V-20 crosses over the proposed cooling pond site.

- Mineral Reserves

  No known mineral reserves are believed to exist within the plant site area.

- Oil and Gas Fields

  The available literature indicates possible oil and gas fields in the western portion of the proposed cooling pond site. Two pipelines cross the proposed cooling ponds.

- Archeological & Historical Sites

  No known archeological or historical sites are believed to exist within the projected site boundaries. Further detailed archeological and historical investigation should confirm the initial investigations.

- Recreational Sites

  No recreational sites are known to exist within the plant site area.

- Proposed Land Use Plans

  The proposed site area does not conflict with any known land use plans.

Aesthetics

Due to the topography of the site area, the reactor building complex and the transmission lines will be visible from Interstate 10, Texas Routes 65, 73, 124, 326, the town of Winnie and local farm to market roads. The plant complex, heat dissipation system, and transmission structures would be dominant features on the landscape.

- Noise

  The noise created by construction and operation of the facility is not expected to cause undue impact in the site area. The make-up water intake structure, however, will have to be located and designed to mitigate the noise associated with the traveling screens.

  If a mechanical draft cooling tower system is selected as the heat dissipation system, more detailed analyses should be performed to determine the buffer zone required for abatement of fan noise.

Transportation

- Motor Carrier Service and Access

  The Ch-1 site could be served by carriers operating over Interstate Highway 10 to the south.

- Railroad Service and Access

  The Ch-1 site could be served by a railroad spur extending from the Texas and New Orleans (Southern Pacific) Railroad which runs north of the site.

- Roads and Highways

  The Ch-1 site is located one mile north of Interstate 10, near Farm Road 1406, which provides excellent east-west access.

- Waterways

  The Ch-1 site is land locked.

SITE JE-2

Type: Cooling Pond Site Using Salt Water

Size: The cooling pond will inundate approximately 3,800 acres. The total land area for the site will be somewhat dependent on the parcel size but should be about 4,800 acres.

Location: The Je-2 site is located in Jefferson County. It is 27 miles southwest of the center of Port Arthur, 9 miles northeast of High Island, and 67 miles east of the center of Houston.

Factors: The summary findings from application of the regional environmental protection considerations listed below are discussed on the following pages.

Regional Environmental Protection Considerations

Geology and Seismology

Meteorology

Hydrology

Ecology

Demography

Land Use

Aesthetics

Transportation

Geology and Seismology

- Geologic Setting

  Age: Pleistocene

  Surficial Sediment Assemblage: Fluvial-deltaic System

- Surface Material Types

  Some coastal marsh, salt, brackish and fresh water.

  Some interdistributary muds including bay, flood basin, and, locally, abandoned channel facies.

- Underlying Deposits

  Pleistocene: Beaumont Clay Formation

  Pleistocene age delta plain deposits; principally calareous red, brown or yellow clay that weathers bluish-gray or black; with logs, peat, fossil plants and some shells; represents interdistributary muds, abandoned channel-fill muds, fluvial overbank muds, and locally, bay, marsh, lagoon and backswamp muds. These deposits are characterized by low permeability, high water-holding capacity, high compressibility, high to very high shrink-swell potential, poor drainage, low shear strength and high plasticity. The clays are interbedded with highly lenticular beds of gray to bluish-gray sandy clay, silt, and very find-grained to medium grained sand representing levee, crevasse splay, distributary and locally, meanderbelt sand. These deposits exhibit low to moderate permeability, high to moderate water-holding capacity, moderate compressibility, moderate to low shrink-swell potential, moderate drainage, moderate to high shear strength and low plasticity. Meanderbelt sand may be under-consolidated and subject to liquification.

  Pleistocene: Lissie Formation

  Alternating beds of fine to coarse gray sand and thin lenses of fine gravel interbedded with gray, brown, blue and red clayey sand and sandy clay representing fine-grained meanderbelt sands, levee, crevasse splay, and distributary sands, and floodbasin mud over meanderbelt sand. Units are typically lenticular, but a few thicker clay strata may be traced over county-sized areas. These sands exhibit moderate to high permeability, moderate to good drainage, moderate water-holding capacity, moderate to low compressibility, low shrink-swell potential, high shear strength and low plasticity. Some sands may be under-compacted and subject to liquification. These sandy clays exhibit moderate permeability, moderate drainage, moderate to high shear strength, and moderate to low shrink-swell potential. A few thicker clays have high water-holding capacity, high compressibility, high to very high shrink-swell potertial, poor drainage, low shear strength and high plasticity.

- Geologic Hazards

Salt Domes

The closest edge of an area defined as being influenced by salt dome activity is Big Hill Dome, 1 mile north, and Clam Lake Dome, 2 miles west of the site.

Seismicity

The closest reported earthquake epicenters to the site recorded in historic time were:

Date	Lat. (N)	Long. (W)	Intensity (MM)	Location	Distance (Mi.)
3/24/66	30.000	94.000	None Reported	Sabine, Texas	20
10/17/52	30.120	93.730	IV	Orange, Texas	38
1/7/56	29.300	94.800	IV	Galveston Island, Texas	35

Linears and Subsurface "Fault" Projections

No linears are shown in the literature to run through the site area. The closest linear is 1/4 mile north of the cooling pond, paralleling the Intercoastal Waterway in a northeast, southeast direction.

The closest projection of subsurface faulting is one mile east and two miles west of the cooling pond boundaries.

Confirmation of surface and subsurface geology, especially the surface location of subsurface faults and the correlation with photo-linears, should be accomplished through a detailed exploration program, using various investigative techniques shown effective in similar studies. This should include both remote and on-site investigative methods.

- Topography, Soil Stability and Construction Suitability

The topography of the site is flat. One arm of Star Lake extends into the eastern end of the site area. The site lies in a region where salt water/fresh water marsh covers the majority of the land, depending on the season. The soils have low to moderate slope stability and moderate to high shrink-swell. Bearing capacity is low. Excavation will be easy, with no blasting required. The clays are fairly impermeable and therefore will not drain easily.

- Subsidence

  Total recorded subsidence in this area is between 0.2 feet and 1.0 feet. The site area is believed to be affected by natural regional coastal subsidence. Local groundwater withdrawal is thought to have had little effect on subsidence in this region, although a major increase in groundwater withdrawal in the site area would likely be accompanied by ground surface subsidence.

- Aquifers

  This site is located on a "conditionally acceptable" aquifer zone. A detailed on-site hydrogeologic investigation is needed to establish the conformance of this site to current requirements.

Meteorology

- Atmospheric Dispersion

  Evaluation of preliminary information including wind speed, atmospheric stability and topography indicates that the short-term diffusion characteristics of the site are equal to or better than the diffusion characteristics of the NRC models appearing in the Regulatory Guides. It also appears that good annual average diffusion characteristics exist and are such that additional engineering features designed to limit fission product release should not be required.

- Tornado and Extreme Winds

  All of the sites under consideration lie within Design Basis Tornado Region I.

  > General Design Criteria 2, "Design Basis for Protection Against Natural Phenomena" of Appendix A to 10 CFR 50, "Licensing of Production Facility", requires that structure, systems and components important to safety be designed to withstand the effects of natural phenomena such as tornadoes without loss of capability of their safety functions. A design basis tornado, acceptable to the Regulatory Staff, has been specified in Regulatory Guide 1.76. The requirements are shown in Table I below.

TABLE I

DESIGN BASIS TORNADO CHARACTERISTICS
(from Regulatory Guide 1.76)

	Region		
	I	II	III
Maximum Wind Speed (mph)[a]	360	300	240
Rotational Speed (mph)	290	240	190
Translational Speed (mph)			
Maximum	70	60	50
Minimum[b]	5	5	5
Radius of Maximum Rotational Speed (ft)	150	150	150
Pressure Drop (psi)	3.0	2.25	1.5
Rate of Pressure Drop (psi/sec)	2.0	1.2	0.6

[a] The maximum wind speed is the sum of the rotational speed component and the maximum translational speed component.

[b] The minimum translational speed, which allows maximum transit time of the tornado across exposed plant features, is to be used whenever low travel speeds (maximum transit time) are a limiting factor in design of the ultimate heat sink. The ultimate heat sink is that complex of water sources, including associated retaining structures, and any canals or conduits connecting the sources with, but not including, the intake structures of nuclear reactor units. Regulatory Guide 1.27 (Safety Guide 27), "Ultimate Heat Sink," describes a basis that may be used to implement General Design Criterion 44 of Appendix A to 10 CFR Part 50 with regard to the ultimate heat sink.

- Fogging and Icing

  Cooling pond or tower fogging tendencies are such that when the air is colder than the surface water temperatures, shallow fogs may occur which, in the case of the Je-2 site, could cause reduced visibility on the Intracoastal Waterway, on local site access roads and possibly on Texas Coastal Highway 87 and Route 124.

- Wind Characteristics

  The mean wind speed for the Je-2 site is 11.3 mph. The prevailing wind direction is from the south - southeast, which does not place any major population center on the streamline of prevailing winds for gaseous effluent releases.

Hydrology

- Availability of Cooling Water

  Water necessary to meet the makeup requirements for a 2,600 MWe nuclear station (LWR) would be taken from the Gulf.

  For the Je-2 site, it would be necessary to pump the water approximately 2 miles to the proposed cooling lake.

- Water Quality

  The quality of the cooling water available at the Je-2 site should be acceptable. The cooling system will be saltwater makeup from, and return blowdown to, the Gulf.

- Flood Protection

  The plant grade should be raised to prevent flooding caused by hurricane surge and wave run up. Slope protection should be provided below this level.

Ecology

- Environmentally Sensitive Considerations

  Flora

  The site is almost completely marshland which has been degraded somewhat by grazing. The marshland vegetation includes seashore saltgrass, seashore paspalum, common reed, cordgrass, rush, and bulrush.

Fauna

The site, with its extensive open water and appropriate food plants, provides excellent waterfowl habitat. The marshland may serve as nursery grounds for commercially important marine species (e.g. shrimp, crab, various fishes). Because there is limited access between the Gulf and the marshes the present nursery value of the area is uncertain. Rare and endangered species which may reside in the area are the alligator and red wolf. Peregine falcons may traverse the area in migration. The region is also part of the range of the following endangered fauna:

Eskimo Curlew
Brown Pelican
Southern Bald Eagle

It has been determined that due to the ecological sensitivity of this area there would be high probability that ecologic issues would be raised in licensing proceedings.

Demography

The plant site falls outside of the exclusion areas defined by the demographic criteria provided below.

- Cumulative population versus distance from the reactor will not exceed:

  0 - 5 miles ≤ 30,000 persons

  0 - 20 miles ≤ 500,000 persons

  0 - 40 miles ≤ 2,000,000 persons

- Local population densities should not exceed 220 persons per square miles within 2 miles of the reactor.

- The exclusion zone distance from the reactor to the site boundary should be greater than or equal to that calculated for the specific reactor type and size and, in any event, should be greater than 0.5 miles.

Land Use

- Existing Land Use

  The site is almost completely marshland. The higher, drier portions of this marshland are presently being used for grazing. The land ranges from poor to fair agricultural land. There are no residences within the prospective site boundaries. The entire site is located within the boundaries of the McFadden Ranch.

- Airspace

  The plant site lies outside aircraft, prohibited, restricted, warning and alert areas, and airport control zones extending upwards from the surface.

- Mineral Reserves

  No known mineral reserves are believed to exist within the plant site area.

- Oil and Gas Fields

  No known or developed oil and gas fields are believed to exist within the site boundaries.

- Archeological & Historical Sites

  No known archeological or historical sites are believed to exist within the projected site boundaries. Further detailed archeological and historical investigation should confirm the initial investigations.

- Recreational Sites

  No recreational sites are known to exist within the plant site area.

- Proposed Land Use Plans

  The proposed site area does not conflict with any known land use plans.

Aesthetics

Due to the flat topography of the site area, the reactor building complex and the transmission lines will be visible from Texas Routes 73, 87 and 124, the Intracoastal Waterway and the Gulf. The plant complex heat dissipation system and transmission structures would be dominant features on the landscape.

- Noise

  The noise created by construction and operation of the facility is not expected to cause undue impact in the site area. The make-up water intake structure, however, will have to be located and designed to mitigate the noise associated with the traveling screens.

  If a mechanical draft cooling tower system is selected as the heat dissipation system, more detailed analyses should be performed to determine the buffer zone required for abatement of fan noise.

Transportation

- Motor Carrier Service and Access

  The Je-2 could be served by carriers operating over Texas Highway 87 to the south.

- Railroad Service and Access

  The Je-2 site could be served by a railroad spur extending from a barge facility located on the Intracoastal Waterway just north of the site.

- Roads and Highways

  The Je-2 site is located just north of Texas Highway 87, which provides good east-west access.

- Waterways

  The Je-2 site could be served from the Intracoastal Waterway by building a barge facility and constructing a railroad spur to the site.

SITE JE-3

Type: Cooling Pond Site Using Salt Water

Size: The cooling pond will inundate approximately 3,800 acres. The total land area for the site will be somewhat dependent on the parcel size but should be about 4,800 acres.

Location: The Je-3 site is located in Jefferson and Chamber Counties. It is 5 miles north of High Island, 13 miles south of Winnie, and 60 miles east of the center of Houston.

Factors: The summary findings from the application of the regional environmental protection considerations listed below are discussed on the following pages.

Regional Environmental Protection Considerations

Geology and Seismology

Meteorology

Hydrology

Ecology

Demography

Land Use

Aesthetics

Transportation

- Geologic Setting

  Age: Pleistocene

  Surficial Sediment Assemblage: Fluvial-deltaic System

- Surface Material Types

  Mostly interdistributary muds including bay, marsh, flood basin and locally abandoned channel facies.

  Some flood plain mud veneer over meander belt sands.

  Some coastal marsh, salt, brackish and fresh water.

- Underlying Deposits

  Pleistocene: Beaumont Clay Formation

  Pleistocene age delta plain deposits; principally calareous red, brown, or yellow clay that weathers bluish-gray or black; with logs, peat, fossil plants and some shells; represents interdistributary muds, abandoned channel-fill muds, fluvial overbank muds, and locally, bay, marsh, lagoon and backswamp muds. These deposits are characterized by low permeability, high water-holding capacity, high compressibility, high to very high shrink-swell potential, poor drainage, low shear strength and high plasticity. The lays are interbedded with highly lenticuler beds of gray to bluish-gray sandy clay, silt, and very fine-grained to medium grained sand representing levee, crevasse splay, distributary and, locally, meanderbelt sand. These high to moderate water-holding capacity, moderate compressibility, moderate to low shrink-swell potential, moderate drainage, moderate to high shear strength and low plasticity. Meanderbelt sand may be under-consolidated and subject to liquification.

  Pleistocene: Lissie Formation

  Alternating beds of fine to coarse gray sand and think lenses of fine gravel interbedded with gray, brown, blue and red clayey sand and sandy clay representing fine-grained meanderbelt sands, levee, crevasse, splay, and distributary sands, and floodbasin mud over meanderbelt sand. Units are typically lenticular, but a few thicker clay strata may be traced over county-sized areas. These sands exhibit moderate to high permeability, moderate to good drainage, moderate water-holding capacity, moderate to low compressibility, low shrink-swell potential, high shear strength and low plasticity. Some sands may be under-compacted and subject to liquification. The sandy clays exhibit moderate to high shear strength, and moderate to low shrink-swell potential. A few thicker clays have high water-holding capacity, high compressibility, high to very high shrink-swell potential, poor drainage, low shear strength and high plasticity.

- Geological Hazards

Salt Domes

The closest edge of an area defined as being influenced by salt dome activity is Big Hill, 2 miles east, and High Island, 2 miles south of the site.

Seismicity

The closest reported earthquake epicenters to the site recorded in historic time were:

Date	Lat. (N)	Long. (W)	Intensity (MM)	Location	Distance (Mi.)
3/24/66	30.000	94.000	None Reported	Sabine, Texas	26
10/17/52	30.120	93.730	IV	Orange, Texas	46
1/7/56	29.300	94.800	IV	Galveston Island, Texas	32

Linears and Subsurface "Fault" Projections

Four literature linears cross through the cooling pond, running east-west. Several projections of subsurface faults also cross through the pond, close to its eastern boundary.

Confirmation of surface and subsurface geology, especially the surface location of subsurface faults and the correlation with photolinears, should be accomplished through a detailed exploration program, using various investigative techniques shown effective in similar studies. This should include both remote and on-site investigative methods.

- Topography, Soil Stability and Construction Suitability

The topography of the site is flat, with Barnes Slough draining the south end of the site into the Intracoastal Waterway. Levees have been constructed throughout the site for control of drainage. The soils have low to moderate slope stability and moderate to high shrink-swell. Bearing capacity is low. Excavation will be easy, with no blasting required. The clays are faily impermeable and therefore will not drain easily.

- Subsidence

Total recorded subsidence in this area is between 0.2 feet and 1.0 feet. The site area is believed to be affected by natural regional coastal subsidence. Local groundwater withdrawal is thought to have had little effect on subsidence in this region, although a major increase in groundwater withdrawal in the site area would likely be accompanied by ground surface subsidence.

- Aquifers

  This site is located on a "conditionally acceptable" aquifer zone. A detailed on-site hydrogeologic investigation is needed to establish the conformance of this site to current requirements.

Meteorology

- Atmospheric Dispersion

  Evaluation of preliminary information including wind speed, atmospheric stability and topography indicates that the short-term diffusion characteristics of the site are equal to or better than the diffusion characteristics of the NRC models appearing in the Regulatory Guides. It also appears that good annual average diffusion characteristics exist and are such that additional engineering features designed to limit fission product release should not be required.

- Tornado and Extreme Winds

  All of the sites under construction lie within Design Basis Tornado Region I.

  > General Design Criteria 2, "Design bases for Protection Against Natural Phenomena" of Appendix A to 10 CFR 50, "Licensing of Production Facility", requires that structure, systems and components important to safety be designed to withstand the effects of natural phenomena such as tornadoes without loss of capability of their safety functions. A design basis tornado, acceptable to the Regulatory Staff, has been specified in Regulatory Guide 1.76. The requirements are shown in Table I below.

TABLE I

DESIGN BASIS TORNADO CHARACTERISTICS

(from Regulatory Guide 1.76)

	Region		
	I	II	III
Maximum Wind Speed (mph)[a]	360	300	240
Rotational Speed (mph)	290	240	190
Translational Speed (mph)			
Maximum	70	60	50
Minimum[b]	5	5	5
Radius of Maximum Rotational Speed (ft)	150	150	150
Pressure Drop (psi)	3.0	2.25	1.5
Rate of Pressure Drop (psi/sec)	2.0	1.2	0.6

[a] The maximum wind speed is the sum of the rotational speed component and the maximum translational speed component.

[b] The minimum translational speed, which allows maximum transit time of the tornado across exposed plant features, is to be used whenever low travel speeds (maximum transit time) are a limiting factor in design of the ultimate heat sink. The ultimate heat sink is that complex of water sources, including associated retaining structures, and any canals or conduits connecting the sources with, but not including, the intake structures of nuclear reactor units. Regulatory Guide 1.27 (Safety Guide 27), "Ultimate Heat Sink," describes a basis that may be used to implement General Design Criterion 44 of Appendix A to 10 CFR Part 50 with regard to the ultimate heat sink.

- Fogging and Icing

  Cooling pond or tower fogging tendencies are such that when the air is colder than the surface water temperatures, shallow fogs may occur which, in the case of the Je-3 site, could cause reduced visibility on the Intracoastal Waterway, on local site access roads and possibly on Texas Coastal Highway 87 and Route 124.

- Wind Characteristics

  The mean wind speed for the Je-3 site is 11.2 mph. The prevailing wind direction is from the south - southeast, which does not place any major population center on the streamline of prevailing winds for gaseous effluent releases.

Hydrology

- Availability of Cooling Water

  Water necessary to meet the makeup requirements for a 2,600 MWe nuclear station (LWR) would be taken from the Gulf.

  For the Je-3 site, it would be necessary to pump the water approximately 6 miles to the proposed cooling lake.

- Water Quality

  The quality fo the cooling water available at the Je-3 site should be acceptable. The cooling system will use saltwater makeup from, and return blowdown to, the Gulf.

- Flood Protection

  The plant grade should be raised to prevent flooding caused by hurricane surge and wave run up. Slope protection should be provided below this level.

Ecology

- Environmentally Sensitive Considerations

  Flora

  Due to present land use, the flora of the site area is in an early stage of succession and probably does not contain any environmentally sensitive species. Agricultural use and grazing has served to degrade the flora of the site. Native vegetation consists mostly of grasses such as little bluestem, indiangrass, eastern gamagrass, switchgrass, and big bluestem. Introduced grasses (e.g. Bermudagrass and carpetgrass) occur in tame pastures. The rice irrigation system provides important waterfowl food such as smartweeds, wild millet and pond weeds.

Fauna

The area represents good waterfowl habitat. Wintering ducks and geese are attracted to the rice fields where food, including waste rice, is abundant. The irrigation system, including a diked lake, and the natural drainages provide open water for waterfowl and fish-eating birds. Nutria and various aquatic reptiles are common. The site is within the range and contains habitat appropriate for the alligator and red wolf. Migrating peregrine falcons may occur in the area. The region is also part of the range of the following endangered fauna:

Eskimo Curlew
Brown Pelican
Southern Bald Eagle

None of these are believed to inhabit the specific site. The site is dissected by a system of rice irrigation canals and several small drainages leading to marshland adjacent to the southern boundary. The impact of modifing the quantity and quality of water entering these marshes would have to be assessed and could become licensing issues.

Demography

The plant site falls outside of the exclusion areas defined by the demographic criteria provided below.

- Cumulative population versus distance from the reactor will not exceed:

  0 - 5 miles ≤ 30,000 persons

  0 - 20 miles ≤ 500,000 persons

  0 - 40 miles ≤ 2,000,000 persons

- Local population densities should not exceed 220 persons per square mile within 2 miles of the reactor.

- The exclusion zone distance from the reactor to the site boundary should be greater than or equal to that calculated for the specific reactor type and size and in any event should be greater than 0.5 miles.

Land Use

- Existing Land Use

  The land is presently being used for crop production, primarily rice, and grazing. The land is good to fair agricultural land. Approximately 3 residences are located within the prospective site boundaries, of which 2 are associated with White's Ranch which is just to the east of the prospective site.

- Airspace

  The plant site lies outside aircraft, prohibited, restricted, warning and alert areas, and airport control zones extending upwards from the surface. Low altitude Federai Airway V-198 crosses over the proposed cooling pond site.

- Mineral Reserves

  No known mineral reserves are believed to exist within the plant site area.

- Oil and Gas Fields

  No known or developed oil and gas fields are believed to exist within the plant site area. No major underground pipelines are believed to be located within the site boundaries.

- Archological & Historical Site

  No known archeological or historical sites are believed to exist within the projected site boundaries. Further detailed archeological and historical investigation should confirm the initial investigations.

- Recreational Sites

  No recreational sites are known to exist within the plant site area.

- Proposed Land Use Plans

  The proposed site area does not conflict with any known land use plans.

Aesthetics

Due to the flat topography of the site area, the reactor building complex and the transmission lines will be visible from Texas Routes 73, 87 and 124, the Intracoastal Waterway and the Gulf. The plant complex, heat dissipation system and transmission structures would be dominant features on the landscape.

- Noise

  The noise created by construction and operation of the facility is not expected to cause undue impact in the site area. The make-up water intake structure, however, will have to be located and designed to mitigate the noise associated with the traveling screens.

  If a mechanical draft cooling tower system is selected as the heat dissipation system, more detailed analyses should be performed to determine the buffer zone required for abatement of fan noise.

Transportation

- Motor Carrier Service and Access

  The Je-3 site could be served by carriers operating over Texas Highway 124 to the west.

- Railroad Service and Access

  The Je-3 site could be served by a railroad spur extending from a barge facility located on the Intracoastal Waterway just south of the site.

- Roads and Highways

  The Je-3 site is located one mile east of Texas Highway 124, which provides good north-south access.

- Waterways

  The Je-3 site could be served from the Intracoastal Waterway by building a barge facility and constructing a railroad spur to the site.

SITE MA-1

Type: Cooling Pond Site Using Salt Water

Size: The cooling pond will inundate approximately 3,800 acres. The total land area for the site will be somewhat dependent on the parcel size but should be about 4,800 acres.

Location: The Ma-1 Site is in Matagorda County. It is 2 miles southeast of Sargeant, 13 miles south of Sweeny, and 65 miles southwest of the center of Houston.

Factors: The summary findings from application of the regional environmental protection considerations listed below are discussed on the following pages.

Regional Environmental Protection Considerations

Geology and Seismology

Meteorology

Hydrology

Ecology

Demography

Land Use

Aesthetics

Transportation

Geology and Seismology

- Geologic Setting

  Age: Modern Holocene

  Surficial Sediment Assemblage: Fluvial System

- Surface Material Types

  Mostly meander belt sand, inactive, primary sediment within filled (non-entranched) valley, including levee, crevasse splay and, locally, flood basin mud deposit

  Some interdistributary silt and mud includes, locally, bay, and lacustrine and crevasse splay facies

- Underlying Deposits

  Pleistocene: Beaumont Clay Formation

  Pleistocene age delta plain deposits; principally calareous red, brown, or yellow clay that weathers bluish-gray or black; with logs, peat, fossil plants and some shells; represents interdistributary muds, abandoned channel-fill muds, fluvial overbank muds, and, locally, bay, marsh, lagoon and backswamp muds. These deposits are characterized by low permeability, high water-holding capacity, high compressibility, high to very high shrink-swell potential, poor drainage, low shear strength and high plasticity. The clays are interbedded with highly lenticular beds of gray to bluish-gray sandy clay, silt, and very fine-grained to medium grained sand representing levee, crevasse splay, distributary and, locally, meanderbelt sand. These high to moderate water-holding capacity, moderate compressibility, moderate to low shrink-swell potential, moderate drainage, moderate to high shear strength and low plasticity. Meanderbelt may be under-consolidated and subject to liquification.

  Pleistocene: Lissie Formation

  Alternating beds of fine to coarse gray sand and thin lenses of fine gravel interbedded with gray, brown, blue and red clayey sand and sandy clay representing fine-grained meanderbelt sands, levee, crevasse splay, and distributary sands, and floodbasin mud over meanderbelt sand. Units are typically lenticular, but a few thicker clay strata may be traced over county-sized areas. These sands exhibit moderate to high permeability, moderate to good drainage, moderate water-holding capacity, moderage to low compressibility, low shrink-swell potential, high shear strength and low pasticity. Some sands may be under-compacted and subject to liquification. The sandy clays exhibit moderate to high shear strength, and moderate to low shrink-swell potential. A few thicker clays have high water-holding capacity, high compressibility, high to very high shrink-swell potential, poor drainage, low shear strength and high plasticity.

- Geologic Hazards

Salt Domes

The closest edge of an area defined as being influenced by salt dome activity is Hawkinsville, 1 mile north of the site.

Seismicity

The closest reported earthquake epicenter to the site recorded in historic time was:

Date	Lat. (N)	Long. (W)	Intensity (MM)	Location	Distance (Mi.)
1/7/56	29.300	94.800	IV	Galveston Island, Texas	53

Note that three earthquakes of intensity I, reported at Hobby Airport in Houston, Texas, in June 1969 have been recorded as possible sonic booms.

The unnamed events in 1910 north of Sealy, Texas and the Anderson event in 1914 near Sealy, Texas have not been substantiated by literature survey.

Linears and Subsurface "Fault" Projections

One literature linear bisects the cooling pond from northeast to southwest. The closest subsurface fault projection lies 3 miles east of the site.

Confirmation of surface and subsurface geology, especially the surface location of subsurface faults and the correlation with photo-linears, should be accomplished through a detailed exploration program, using various investigative techniques shown effective in similar studies. This should include both remote and on-site investigative methods.

- Topography, Soil Stability and Construction Suitability

The site is flat, with several small levees and draws running north-south through the site. The soils have low to moderate slope stability and moderate to high shrink-swell. Bearing capacity is low. Excavation will be easy, with no blasting required. The clays are fairly impermeable and therefore will not drain easily.

- Subsidence

Total recorded subsidence in this area is between 0.2 feet and 1.0 feet. The site area is believed to be affected by natural regional coastal subsidence. Local groundwater withdrawal is thought to have had little effect on subsidence in this region, although a major increase in groundwater withdrawal in the site area would likely be accompanied by ground surface subsidence.

- Aquifers

This site is located on a "conditionally acceptable" aquifer zone. A detailed on-site hydrogeologic investigation is needed to establish the conformance of this site to current requirements.

Meteorology

- Atmospheric Dispersion

Evaluation of preliminary information including wind speed, atmospheric stability and topography indicates that the short-term diffusion characteristics of the site are equal to or better than the diffusion characteristics of the NRC models appearing in the Regulatory Guides. It also appears that good annual average diffusion characteristics exist and are such that additional engineering features designed to limit fission product release should not be required.

- Tornado and Extreme Wind

All of the sites under consideration lie within Design Basis Tornado Region I.

> General Design Criteria 2, "Design Bases for Protection Against Natural Phenomena" of Appendix A to 10 CFR 50, "Licensing of Production Facility", requires that structure, systems and components important to safety be designed to withstand the effects of natural phenomena such as tornadoes without loss of capability of their safety functions. A design basis tornado, acceptable to the Regulatory Staff, has been specified in Regulatory Guide 1.76. The requirements are shown in Table I below.

TABLE I

DESIGN BASIS TORNADO CHARACTERISTICS
(from Regulatory Guide 1.76)

	Region		
	I	II	III
Maximum Wind Speed (mph)[a]	360	300	240
Rotational Speed (mph)	290	240	190
Translational Speed (mph)			
Maximum	70	60	50
Minimum[b]	5	5	5
Radius of Maximum Rotational Speed (ft)	150	150	150
Pressure Drop (psi)	3.0	2.25	1.5
Rate of Pressure Drop (psi/sec)	2.0	1.2	0.6

[a] The maximum wind speed is the sum of the rotational speed component and the maximum translational speed component.

[b] The minimum translational speed, which allows maximum transit time of the tornado across exposed plant features, is to be used whenever low travel speeds (maximum transit time) are a limiting factor in design of the ultimate heat sink. The ultimate heat sink is that complex of water sources, including associated retaining structures, and any canals or conduits connecting the sources with, but not including, the intake structures of nuclear reactor units. Regulatory Guide 1.27 (Safety Guide 27), "Ultimate Heat Sink," describes a basis that may be used to implement General Design Criterion 44 of Appendix A to 10 CFR Part 50 with regard to the ultimate heat sink.

- Fogging and Icing

  Cooling pond or tower fogging tendencies are such that when the air is colder than the surface water temperatures, shallow fogs may occur which, in the case of the Ma-I site, could cause reduced visibility on the Intercoastal Waterway and on local farm to market roads.

- Wind Characteristics

  The mean wind speed for the Ma-I site is 10.9 mph. The prevailing wind direction is from the south - southeast, which does not place any major population center on the streamline of prevailing winds for gaseous effluent releases.

Hydrology

- Availability of Cooling Water

  Water necessary to meet the makeup requirements for a 2,600 MWe nuclear station (LWR) would be taken from the Gulf.

  For the Ma-I site, it would be necessary to pump the water approximately 4 miles to the proposed cooling lake.

- Water Quality

  The quality of the cooling water available to the Ma-I site should be acceptable. The cooling system will use saltwater makeup from, and return blowdown to, the Gulf.

- Flood Protection

  The plant grade should be raised to prevent flooding caused by hurricane surge and wave run up. Slope protection should be provided below this level.

Ecology

- Environmentally Sensitive Considerations

  Flora

  Due to present land use, the flora of the site area is in an early stage of succession and probably does not contain any environmentally sensitive species. Agricultural use and grazing has served to degrade the flora of the site. Narrow strips of marshland along drainages extend into the site from the south but comprise less than 1% of the total area of the site. Wooded corridors composing less than 15% of the total area of the site follow drainages running northwest to southeast in the northern half of the site. Lower, wetter portions of the site are dominated by species such as gulf cordgrass, marshhay cordgrass, brushy sea ox-eye, seashore saltgrass, and shoregrass. Drier portions support sedges, Virginia wildrye, eastern gamagrass, and various paspalums and panicums. Wooded areas contain small to medium trees of such species as pecan, live oak, water oak, cedar elm, Chinese tallow, willow, cottonwood, and ash with an understory of various shrubs and vines.

Fauna

Waterfowl habitat is scarce on the site, being limited to the bayous, where some open water exists, and plowed fields. Fish-eating birds are common. The wooded corridors provide habitat for a higher diversity of plants and animals than the open grasslands. White-tailed deer and squirrel are important game animals associated with wooded habitats. Bobwhite quail and mourning doves frequent brushy forest edges and fence rows. One rare and endangered species, the alligator, is likely to reside in the area. The peregrine falcon may occur in transit. Bald eagles are known to occur in Matagorda County; however, appropriate nesting habitat (i.e., tall dead trees) does not appear to occur in Ma-1.

The region is also part of the range of the following endangered fauna:

Eskimo Curlew
Brown Pelican

None of these are believed to inhabit the specific site.

The site does contain several small drainages leading to marshland adjacent to the southern boundary. The impact of modifying the quantity and quality of water entering these marshes would have to be assessed and could become licensing issues.

Demography

The plant site falls outside the exclusion areas defined by the demographic criteria provided below.

- Cumulative population versus distance from the reactor will not exceed:

  0 - 5 miles ≤ 30,000 persons

  0 - 20 miles ≤ 500,000 persons

  0 - 40 miles ≤ 2,000,000 persons

- Local population densities should not exceed 220 persons per square mile within 2 miles of the reactor.

- The exclusion zone distance from the reactor to the site boundary should be greater than or equal to that calculated for the specific reactor type and size and in any event should be greater than 0.5 miles.

Land Use

- Existing Land Use

  The site is dominantly low coastal rangeland with some cultivation in higher areas. The land is fair agricultural land. The community of Sargeant is located just to the west of the prospective site. Approximately 14 residences would be displaced by the prospective site. The San Bernard Wildlife Refuge is located approximately one mile to the east.

- Airspace

  The plant site lies outside of aircraft, prohibited, restricted, warning and alert areas, and airport control zones extending upwards from the surface.

- Mineral Reserves

  No known mineral reserves are believed to exist within the plant site area.

- Oil and Gas Fields

  No known or developed oil and gas fields are believed to exist within the plant site area. No major underground pipelines are believed to be located within the site boundaries.

- Archeological & Historical Sites

  No known archeological or historical sites are believed to exist within the projected site boundaries. Further detailed archeological and historical investigation should confirm the initial investigations.

- Recreational Sites

  No recreational sites are known to exist within the plant site area. Some recreational homes are being developed to the west and south of the site.

- Proposed Land Use Plans

  The proposed site area does not conflict with any known land use plans.

Aesthetics

Due to the flat topography of the site area, the reactor building complex and the transmission lines will be visible from Texas Routes 60 and 36, the town of Matagorda, the Intracoastal Waterway, and Matagorda Bay. The plant complex, heat dissipation system and transmission structures would be dominant features on the landscape.

- Noise

The noise created by construction and operation of the facility is not expected to cause undue impact in the site area. The make-up water intake structure, however, will have to be located and designed to mitigate the noise associated with the traveling screens.

If a mechanical draft cooling tower system is selected as the heat dissipation system, more detailed analyses should be performed to determine the buffer zone required for abatement of fan noise.

Transportation

- Motor Carrier Service and Access

The Ma-1 site could be served by carriers operating over Texas Highway 35 to the north and Texas Highway 36 to the east.

- Railroad Service and Access

The Ma-1 site could be served by a railroad spur extending from a barge facility located on the Intracoastal Waterway just south of the site.

- Road and Highways

The Ma-1 site is located just one mile east of Farm Road 457, which provides good access to Texas Highways 35 and 36.

- Waterways

The Ma-1 site could be served from the Intracoastal Waterway by building a barge facility and constructing a railroad spur to the site.

SITE MA-2

Type: Cooling Pond Site Using Salt Water

Size: The cooling pond will inundate approximately 3,800 acres. The total land area for the site will be somewhat dependent on the parcel size but should be about 4,800 acres.

Location: The Ma-2 site is located in Matagorda County. It is 7 miles west of Sargeant, 15 miles southeast of Bay City, and 70 miles southwest of the center of Houston.

Factors: The summary findings from application of the regional environmental protection considerations listed below are discussed on the following pages.

Regional Environmental Protection Considerations

Geology and Seismology

Meteorology

Hydrology

Ecology

Demography

Land Use

Aesthetics

Transportation

Geology and Seismology

- Geologic Setting

Age: Tertiary-Pleistocene

Surficial Sediment Assemblage: Fluvial-deltaic System

- Surface Material Types

Mostly flood plain mud veneer meander belt sands

Some flood basin overbank mud and silt, prairie

- Underlying Deposits

Pleistocene: Beaumont Clay Formation

Pleistocene age delta plain deposits; principally calareous red, brown, or yellow clay that weathers bluish-gray or black; with logs, peat, fossil plants and some shells; represents interdistributary muds, abandoned channel-fill muds, fluvial overbank muds, and locally, bay, marsh, lagoon and backswamp muds. These deposits are characterized by low permeability, high water-holding capacity, high compressibility, high to very high shrink-swell potential, poor drainage, low shear strength and high plasticity. The clays are interbedded with highly lenticular beds of gray to bluish-gray sandy clay, silt, and very fine-grained to medium grained sand representing levee, crevasse splay, distributary and locally, meanderbelt sand. These deposits exhibit low to moderate permeability, high to moderate water-holding capacity, moderate compressibility, moderate to low shrink-swell potential, moderate drainage, moderate to high shear strength and low plasticity. Meanderbelt sand sand may be underconsolidated and subjected to liquification.

Pleistocene: Lissie Formation

Alternating beds of fine to coarse gray sand and thin lenses of fine gravel interbedded with gray, brown, blue and red clayey sand and sandy clay representing fine-grained meanderbelt sands, levee, crevasse splay, and distributary sands, and floodbasin mud over meanderbelt sand. Units are typically lenticular, but a few thicker clay strata may be traced over county-sized areas. These sands exhibit moderate to high permeability, moderate to good drainage, moderate water-holding capacity, moderate to low compressibility, low shrink-swell potential, high shear strength and low plasticity. Some sands may be under-compacted and subject to liquification. The sandy clays exhibit moderate permeability, moderate drainage, moderate to high shear strength, and moderate to low shrink-swell potential. A few thicker clays have high to very high shrink-swell potential, poor drainage, low shear strength and high plasticity.

- Geological Hazards

Salt Domes

The closest edge of an area defined as being influenced by salt dome activity is Hawkinsville, 1-1/2 miles northwest of the site.

Seismicity

The closest reported earthquake epicenter to the site recorded in historic time was:

Date	Lat. (N)	Long. (W)	Intensity (MM)	Location	Distance (Mi.)
1/7/56	29.300	94.800	IV	Galveston Island, Texas	70

Note that three earthquakes of intensity I, reported at Hobby Airport in Houston, Texas, in June 1969 have been recorded as possible sonic booms.

The unnamed events in 1910 north of Sealy, Texas and the Anderson event in 1914 near Sealy, Texas have not been substantiated by literature survey.

Linears and Subsurface "Fault" Projections

Two literature linears cross near the site; one lies one mile north of the site and the other parallels the southern boundary of the cooling pond. One projection of a subsurface fault falls within the cooling pond, at the eastern edge, running north-south.

Confirmation of surface and subsurface geology, especially the surface location of subsurface faults and the location of subsurface faults and the correlation with photo-linears, should be accomplished through a detailed exploration program, using various investigative techniques shown effective in similar studies. This should include both remote and on-site investigative methods.

- Topography, Soil Stability and Construction Suitability

The site is flat, with Canoe Bayou running northwest to southeast through the site to join Live Oak Bayou that borders the site to the east. The soils have low to moderate slope stability and moderate to high shrink-swell. Bearing capacity is low. Excavation will be easy, with no blasting required. The clays are faily impermeable and therefore will not drain easily.

- Subsidence

Total recorded subsidence in this area is between 0.2 feet and 1.0 feet. The site area is believed to be affected by natural regional coastal subsidence. Local groundwater withdrawal is thought to have had little effect on subsidence in this region, although a major increase in groundwater withdrawal in the site area would likely be accompanied by ground surface subsidence.

- Aquifers

  This site is located on a "conditionally acceptable" aquifer zone. A detailed on-site hydrogeologic investigation is needed to establish the conformance of this site to current requirements.

Meteorology

- Atmospheric Dispersion

  Evaluation of preliminary information including wind speed, atmospheric stability and topography indicates that the short-term diffusion characteristics of the site are equal to or better than the diffusion characteristics of the NRC models appearing in the Regulatory Guides. It also appears that good annual average diffusion characteristics exist and are such that additional engineering features designed to limit fission product release should not be required.

- Tornado and Extreme Winds

  All of the sites under consideration lie within Design Basis Tornado Region I.

  General Design Criteria 2, "Design Bases for Protection Against Natural Phenomena" of Appendix A to 10 CFR 50, "Licensing of Production Facility", requires that structure, systems and components important to safety be designed to withstand the effects of natural phenomena such as tornadoes without loss of capability of their safety functions. A design basis tornado, acceptable to the Regulatory Staff, has been specified in Regulatory Guide 1.76. The requirements are shown in Table I below.

TABLE I

DESIGN BASIS TORNADO CHARACTERISTICS
(from Regulatory Guide 1.76)

	Region		
	I	II	III
Maximum Wind Speed (mph)[a]	360	300	240
Rotational Speed (mph)	290	240	190
Translational Speed (mph)			
Maximum	70	60	50
Minimum[b]	5	5	5
Radius of Maximum Rotational Speed (ft)	150	150	150
Pressure Drop (psi)	3.0	2.25	1.5
Rate of Pressure Drop (psi/sec)	2.0	1.2	0.6

[a] The maximum wind speed is the sum of the rotational speed component and the maximum translational speed component.

[b] The minimum translational speed, which allows maximum transit time of the tornado across exposed plant features, is to be used whenever low travel speeds (maximum transit time) are a limiting factor in design of the ultimate heat sink. The ultimate heat sink is that complex of water sources, including associated retaining structures, and any canals or conduits connecting the sources with, but not including, the intake structures of nuclear reactor units. Regulatory Guide 1.27 (Safety Guide 27), "Ultimate Heat Sink," describes a basis that may be used to implement General Design Criterion 44 of Appendix A to 10 CFR Part 50 with regard to the ultimate heat sink.

- Fogging and Icing

  Cooling pond or tower fogging tendencies are such that when the air is colder than the surface water temperatures, shallow fogs may occur which, in the case of the Ma-2 site, could cause reduced visibility on local farm to market roads.

- Wind Characteristics

  The mean wind speed for the Ma-2 site is 10.8 mph. The prevailing wind direction is from the south - southeast, which does not place any major population center on the streamline of prevailing winds for gaseous effluent releases.

Hydrology

- Availability of Cooling Water

  Water necessary to meet the makeup requirements for a 2,600 MWe nuclear station (LWR) would be taken from the Gulf.

  For the Ma-2 site, it would be necessary to pump the water approximately 10 miles to the proposed cooling lake.

- Water Quality

  The quality of the cooling water available at the Ma-2 site should be acceptable. Because the cooling system will use saltwater makeup from and return blowdown to the Gulf.

- Flood Protection

  The plant grade should be raised to prevent flooding caused by hurricane surge and wave run up. Slope protection should be provided below this level.

Ecology

- Environmentally Sensitive Considerations

  Flora

  Native grasses on the open rangeland include little bluestem, indiangrass, low panicum, big bluestem, and switchgrass. Introduced Bermudagrass also occurs. Common trees of the bayou forest are live oak, pecan, cedar elm, willow, ash, and cottonwood.

  Due to present land use, the flora of the site area is in an early stage of succession and probably does not contain any environmentally sensitive species.

Fauna

Habitat for waterfowl and fish-eating birds is limited to the marshes and bayous. Deer, squirrels, and furbearers (e.g. raccoon, fox, opossum) inhabit the bayou forest. Alligators may occur in the marshes and bayous. Peregrine falcons are infrequent transients. It is not known if or to what extent bald eagles may use the area. The region is also part of the range of the following endangered fauna:

Eskimo Curlew
Brown Pelican

Neither of these are believed to inhabit the specific site.

The site does contain several small drainages leading to marshland adjacent to the southern and eastern boundaries. The impact of modifying the quantity and quality of water entering these marshes would have to be assessed and could become licensing issues.

Demography

The plant site falls outside the exclusion areas defined by the demographic criteria provided below.

- Cumulative population versus distance from the reactor will not exceed:

  0 - 5 miles ≤ 30,000 persons

  0 - 20 miles ≤ 500,000 persons

  0 - 40 miles ≤ 2,000,000 persons

- Local population densities should not exceed 220 persons per square mile within 2 miles of the reactor.

- The exclusion zone distance from the reactor to the site boundary should be greater than or equal to that calculated for the specific reactor type and size and in any event should not be greater than 0.5 miles.

Land Use

- Existing Land Use

  The Ma-2 site consists mainly of open grazing land (about 90%) with some woodland and freshwater marshes associated with Live Oak Bayou which lies to the east. The land is fair agricultural land. The community of Sargeant is located to the east of the prospective site. Approximately 5 residences are located within the prospective site boundaries.

- Airspace

  The plant site outside aircraft, prohibited, restricted, warning and alert areas, and airport control zones extending upwards from the surface.

- Mineral Reserves

  No known mineral reserves are believed to exist within the plant site area.

- Oil and Gas Fields

  No known or developed oil and gas fields are believed to exist within the plant site area. No major underground pipelines are believed to be located within the site boundaries.

- Archeological & Historical Sites

  No known archeological or historical sites are believed to exist within the projected site boundaries. Further detailed archological and historical investigation should confirm the initial investigations.

- Recreational Sites

  No recreational sites are known to exist within the plant site area.

- Proposed Land Use Plans

  The proposed site area does not conflict with any known land use plans.

Aesthetics

Due to the flat topography of the site area, the reactor building complex and the transmission lines will be visible from Texas Route 60, the town of Matagorda, the Intracoastal Waterway and Matagorda Bay. The plant heat complex, heat dissipation system and transmission structures would be dominant features on the landscape.

- Noise

  The noise created by construction and operation of the facility is not expected to cause undue impact in the site area. The make-up water intake structure, however, will have to be located and designed to mitigate the noise associated with the traveling screens.

  If a mechanical draft cooling tower system is selected as the heat dissipation system, more detailed analyses should be performed to determine the buffer zone required for abatement of fan noise.

Transportation

- Motor Carrier Service and Access

  The Ma-2 site could be served by carriers operating over Texas Highway 60 to the west and Texas Highway 35 to the north.

- Railroad Service and Access

  The Ma-2 site could be served by a railroad spur extending from the Gulf Colorado and Santa Fe which runs west of the site.

- Roads and Highways

  The Ma-2 site is located three miles from Farm Road 521 which provides good access to Texas Highways 35 and 60.

- Waterways

  The Ma-2 site could be served from the Intracoastai Waterway by building a barge facility and constructing a railroad spur to the site.

SITE MA-3

Type: Cooling Pond Site Using Salt Water

Size: The cooling pond will inundate approximately 3,800 acres. The total land area for the site will be somewhat dependent on the parcel size but should be about 4,800 acres.

Location: The Ma-3 site is located in Matagorda County. It is 9 miles northeast of Matagorda, 13 miles south of Bay City, and 73 miles southwest of the center of Houston.

Factors: The summary findings from application of the regional environmental protection considerations listed below are discussed on the following pages.

Regional Environmental Protection Considerations

Geology and Seismology

Meteorology

Hydrology

Ecology

Demography

Land Use

Aesthetics

Transportation

Geology and Seismology

- Geologic Setting

Age: Modern Holocene

Surficial Sediment Assemblage: Fluvial-deltaic System

- Surface Material Types

Mostly distributary, channel, and other fluvial sands and silts, including levee and crevasse splay deposits.

Some coastal marsh, salt, brackish and fresh water.

Some interdistributary silt and mud, includes locally, bay, lacustrine, and crevasse splay facies.

- Underlying Deposits

Pleistocene: Beaumont Clay Formation

Pleistocene age delta plain deposits; principally calcareous red, brown, or yellow clay that weathers bluish-gray or black; with logs, peat, fossil plants and some shells; represents interdistributary muds, abandoned channel-fill muds, fluvial overbank muds, and locally, bay, marsh, lagoon and backswamp muds. These deposits are characterized by low permeability, high water-holding capacity, high compressibility, high to very high shrink-swell potential, poor drainage, low shear strength and high plasticity. The clays are interbedded with highly lenticular beds of gray to bluish-gray sandy clay, silt, and very find-grained to medium grained sand representing levee, crevasse splay, distributary and locally, meanderbelt sand. These deposits exhibit low to moderate permeability, high to moderate water-holding capacity, moderate compressibility, moderate to low shrink-swell potential, moderate drainage, moderate to high shear strength and low platicity. Meanderbelt sand may be under-consolidated and subject to liquification.

Pleistocene: Lissie Formation

Alternating beds of fine to coarse gray sand and thin lenses of fine gravel interbedded with gray, brown, blue and red clayey sand and sandy clay representing fine-grained meanderbelt sands, and floodbasis mud over meanderbelt sand. Units are typically lenticular, but a few thicker clay strata may be traced over county-sized areas. These sands exhibit moderate to high permeability, moderate to good drainage, moderate water-holding capacity, moderate to low compressibility, low shrink-swell potential, high shear strength and low plasticity. Some sands may be under-compacted and subject to liquification. The sandy clays exhibit moderate permeability, moderate drainage, moderate to high shear strength, and moderate to low shrink-swell potential. A few thicker clays have high water-holding capacity, high compressibility, high to very high shrink-swell potential, poor drainage, low shear strength and high plasticity.

- Geologic Hazards

Salt Domes

The closest edge of an area defined as being influenced by salt dome activity is Gulf Dome, southern edge of the cooling pond.

Seismicity

The closest reported earthquake epicent to the site recorded in historic time was:

Date	Lat. (N)	Long. (W)	Intensity (MM)	Location	Distance (Mi.)
1/7/56	29.300	94.800	IV	Galveston Island, Texas	80

Note that three earthquakes of intensity I, reported at Hobby Airport in Houston, Texas, in June 1969 have been recorded as possible sonic booms.

The unnamed events in 1910 north of Sealy, Texas and the Anderson event in 1914 near Sealy, Texas have not been substantiated by literature survey.

Linears and Subsurface "Fault" Projections

No linears or subsurface fault projects cross the site. Three linears cross 1/2 mile north of the site, and projections of subsurface faults are plotted to fall around the site in all directions.

Confirmation of surface and subsurface geology, especially the surface location of subsurface faults and the correlation with photo-linears, should be accomplished through a detailed exploration program, using various investigative techniques shown effective in similar studies. This should include both remote and on-site investigative methods.

- Topography, Soil Stability and Construction Suitability

The site is flat, with levees at the northeast and southwest ends and big Boggy Creek running southeast through the middle of the site. The soils have low to moderate slope stability and moderate to high shrink-swell. Bearing capacity is low. Excavation will be easy, with no blasting required. The clays are fairly impermeable and therefore will not drain easily.

- Subsidence

Total recorded subsidence in this area is between 0.2 feet and 1.0 feet. The site area is believed to be affected by natural regional coastal subsidence. Local groundwater withdrawal is thought to have had little effect on subsidence in this region, although a major increase in groundwater withdrawal in the site area would likely be accompanied by ground surface subsidence.

- Aquifers

This site is located on a "conditonally acceptable" aquifer zone. A detailed on-site hydrogeologic investigation investigation is needed to establish the conformance of this site to current requirements.

Meteorology

- Atmospheric Dispersion

Evaluation of preliminary information including wind speed, atmospheric stability and topography indicates that the short-term diffusion characteristics of the site are equal to or better than the diffusion characteristics of the NRC models appearing in the Regulatory Guides. It also appears that good annual average diffusion characteristics exist and are such that additional engineering features designed to limit fission product release should not be released.

- Tornado and Extreme Winds

All of the sites under consideration lie within Design Basis Tornado Region I.

> General Design Criteria 2, "Design Bases for Protection Against Natural Phenomena" of Appendix A to 10 CFR 50, "Licensing of Production Facility", requires that structure, systems and components important to safety be designed to withstand the effects of natural phenomena such as tornadoes without loss of capability of their safety functions. A design basis tornado, acceptable to the Regulatory Staff, has been specified in Regulatory Guide 1.76. The requirements are shown in Table I below.

TABLE I

DESIGN BASIS TORNADO CHARACTERISTICS

(from Regulatory Guide 1.76)

	Region		
	I	II	III
Maximum Wind Speed (mph)[a]	360	300	240
Rotational Speed (mph)	290	240	190
Translational Speed (mph)			
Maximum	70	60	50
Minimum[b]	5	5	5
Radius of Maximum Rotational Speed (ft)	150	150	150
Pressure Drop (psi)	3.0	2.25	1.5
Rate of Pressure Drop (psi/sec)	2.0	1.2	0.6

[a] The maximum wind speed is the sum of the rotational speed component and the maximum translational speed component.

[b] The minimum translational speed, which allows maximum transit time of the tornado across exposed plant features, is to be used whenever low travel speeds (maximum transit time) are a limiting factor in design of the ultimate heat sink. The ultimate heat sink is that complex of water sources, including associated retaining structures, and any canals or conduits connecting the sources with, but not including, the intake structures of nuclear reactor units. Regulatory Guide 1.27 (Safety Guide 27), "Ultimate Heat Sink," describes a basis that may be used to implement General Design Criterion 44 of Appendix A to 10 CFR Part 50 with regard to the ultimate heat sink.

- Fogging and Icing

  Cooling pond or tower fogging tendencies are such that when the air is colder than the surface water temperatures, shallow fogs may occur which, in the case of the Ma-3 site, could cause reduced visibility on Texas Route 60, the Intercoastal Waterway, and on local farm to market roads.

- Wind Characteristics

  The mean wind speed for the Ma-3 site is 10.7 mph. The prevailing wind direction is from the south - southeast, which does not place any major population center on the streamline of prevailing winds for gaseous effluent releases.

Hydrology

- Availability of Cooling Water

  Water necessary to meet the makeup requirements for a 2,600 MWe nuclear station (LWR) would be taken from the Gulf.

  For the Ma-3 site, it would be necessary to pump the water approximately 15 miles to the proposed cooling lake.

- Water Quality

  The quality of the cooling water available at the Ma-3 site should be acceptable. The cooling system will use saltwater makeup from, and return blowdown, to the Gulf.

- Flood Protection

  The plant grade should be raised to prevent flooding caused by hurricane surge and wave run up. Slope protection should be provided below this level.

Ecology

- Environmentally Sensitive Considerations

  Flora

  Rangeland vegetation on the site includes native grass such as little bluestem, indiangrass, switchgrass, eastern gamagrass, big bluestem, and various paspalums, as well as introduced Bermudagrass. Woody vegetation is mostly hackberry, live oak, Chinese tallow, baccharis, and greenbriar.

  Due to present land use, the flora of the site area is in an early stage of succession and probably does not contain an environmentally sensitive species. Agricultural use and grazing has served to degrade the flora of the site.

Fauna

Waterfowl and fish-eating bird habitat is limited to the bayous, canals, and rice fields. Good marsh habitat with extensive open water exists southeast of the site along Big Boggy Creek. Quail and doves frequent the brushy canal banks and fence rows. Alligators may inhabit the canals and bayous, while peregrine falcons may traverse the site during the fall and spring migration. The presence of the bald eagle is possible, although no breeding sites were observed.

The region is also part of the range of the following endangered fauna:

Eskimo Curlew
Brown Pelican

Neither of these are believed to inhabit the specific site.

The site does contain several small drainages leading to marshlands adjacent to the southeastern boundary. The impact of modifying the quantity and quality of water entering these marshes would have to be assessed and could become licensing issues.

Demography

The plant site falls outside the exclusion areas defined by the demographic criteria provided below.

- Cumulative population versus distance from the reactor will not exceed:

  0 - 50 miles ≤ 30,000 persons

  0 - 20 miles ≤ 500,000 persons

  0 - 40 miles ≤ 2,000,000 persons

- Local population densities should not exceed 220 persons per square mile within 2 miles of the reactor.
- The exclusion zone distance from the reactor to the site boundary should be greater than or equal to that calculated for the specific reactor type and size and in any event should not be greater than 0.5 miles.

Land Use

- Existing Land Use

  The Ma-3 site is predominantly open rangeland and rice farmland. Woody vegetation occurs only along fence rows, irrigation canals, and a short stretch of Big Boggy Creek. The land is fair agricultural land. The community of Wadsworth is located to the northwest of the prospective site. The community of Gulf Hill is located to the southwest of the prospective site. Approximately 11 residences are located within the site boundaries.

- Airspace

  The plant site lies outside aircraft, prohibited, restricted, warning and alert areas, and airport control zones extending upwards from the surface.

- Mineral Reserves

  No known mineral reserves are believed to exist within the plant site area.

- Oil and Gas Fields

  No known or developed oil and gas fields are believed to exist within the plant site area. Several pipelines cross the proposed cooling pond.

- Archeological & Historical Sites

  No known archeological or historical sites are believed to exist within the projected site boundaries. Further detailed archeological and h torical investigation should confirm the initial investigations.

- Recreational Sites

  No recreational sites are known to exist within the plant site area.

- Proposed Land Use Plans

  The proposed site area does not conflict with any known land use plans.

Aesthetics

Due to the flat topography of the site area, the reactor building complex and the transmission lines will be visible from Texas Routes 60 and 36, the town of Matagorda, the Intracoastal Waterway, and Matagorda Bay. The plant complex, heat dissipation system and transmission structures would be dominant features on the landscape.

- Noise

  The noise created . nstruction and operation of the facility is not expected to cause un. : impact in the site area. The make-up water intake structure, however, will have to be located and designed to mitigate the noise associated with the traveling screens.

  If a mechanical draft cooling tower system is selected as the heat dissipation system, more detailed analyses should be performed to determine the buffer zone required for abatement of fan noise.

Transportation

- Motor Carrier Service and Access

  The Ma-3 site could be served by carriers operating over Texas Highway 60 to the west, and Texas Highway 35 to the north.

- Railroad Service and Access

  The Ma-3 site could be served by a railroad spur extending from the Gulf Colorado and Santa Fe which runs west of the site.

- Roads and Highways

  The Ma-3 site is located two miles from Farm Road 521, which provides good access to Texas Highways 35 and 60.

- Waterways

  The Ma-3 site could be served from the Intracoastal Waterway by building a barge facility and constructing a railroad spur to the site.

3.5 RESULTS

The results of the candidate site evaluations are presented on the Candidate Site Evaluation Matrix, Figure 3.5-1, and are shown in Table 3.5-1.

Of the eight sites compared, Au-1 (Allens Creek) was found to be the most economic site, followed by Ma-3 and Bz-1 as second and third, respectively. From an environmental and licensing standpoint, Au-1 ranked first, with Ma-1 and Ma-3 second and third, respectively. The combined ranking showed Au-1 to be first, with Ma-3 second and Ma-1 third.

Sensitivity analyses were performed on both the economic, and environmental and licensing evaluations to determine if any factors needed additional consideration or evaluation. These analyses showed that the Au-1 site (Allens Creek) continued to receive the highest rating when logical changes in the evaluation factors were made. Based on this evaluation TERA has concluded that none of the alternative sites is obviously superior to the Au-1 site.

The following sections describe the site evaluation methods used in making these rankings, and the results of sensitivity analyses performed by varying certain weighting factors.

3.5.1 SITE EVALUATION METHODS

During the site selection process, Site Evaluation Factors (Appendix A) were used to rank the candidate sites and to identify the prime site. Site Evaluation Factors, which are a more detailed refinement of the regional screening factors, were developed for the following areas:

- Economics
- Geology
- Meteorology
- Hydrology
- Demography
- Land Use

TABLE 3.5-1
CANDIDATE SITE RANKING SUMMARY

Site	Economic Ranking	Environmental/Licensing Ranking	Overall Ranking
Au-1	1	1	1
Bz-1	3	8	7
Ch-1	5	6	4
Je-2	8	7	8
Je-3	6	5	5
Ma-1	4	2	3
Ma-2	7	4	5
Ma-3	2	3	2

- Aesthetics
- Transportation

The Candidate Site Evaluation Matrix, Figure 3.5-1, was prepared using two types of evaluation methods to rate each candidate site based upon the above factors. One was a subjective or qualitative evaluation using the written descriptions and the color coded circles to depict the different factors. The other factor was a numerical evaluation system computed on a zero-to-five scale. The following sections describe these methods.

3.5.1.1 SUBJECTIVE EVALUATION METHOD

The Subjective Evaluation Method is based upon the written site descriptions presented in the matrix. As such, the method provides a qualitative assessment of both the economic evaluations factors and the environmental and licensing factors. Based upon this subjective assessment, color coded circles are used to represent the ratings of the various factors. This subjective method provides a means for rating the intangible or non-quantifiable features of each site. On the matrix, green circles represent a most desirable rating; half green circles depict a favorable rating; white circles indicate an acceptable rating; half black circles show an adequate rating; and black circles emphasize a least desirable rating. The black circles emphasize potentially significant economic consequences or environmental and licensing issues for a certain site.

3.5.1.2 NUMERICAL EVALUATION METHOD

The Numerical Evaluation Method is based upon an assessment of the economic, environmental and licensing evaluation factors. The method involves rating each factor using a zero-to-five scale, where zero is least desirable and five is most desirable.

For each of the factors, an evaluation is made of relevant characteristics to establish the appropriate numerical rating. Appendix A, Site Evaluation Factors, provides the definitions for the rating system.

To account for the relative importance of each of the factors, the weights are developed, as illustrated below:

Economic weighting factor	.5
Geology weighting factor	.1
Meteorology weighting factor	.025
Hydrology weighting factor	.05
Ecology weighting factor	.1
Demography weighting factor	.05
Land Use weighting factor	.1
Aesthetics weighting factor	.025
Transportation weighting factor	.05
Combined weighting factor	1.0

During the evaluation, the numerical rating given to each category for each site is multiplied by the appropriate weighting factor. The overall site rating number is obtained by totaling the various categories for each site. The sites with the highest total would naturally be the most desirable.

Appendix A, Site Evaluation Factors, describes the rating systems for each of the above factors.

3.5.2 SENSITIVITY ANALYSIS

Sensitivity analyses were conducted both on the site rankings presented on the Site Evaluation Matrix and the economic evaluation discussed in Section 3.3 to determine the significance of parameter variation.

3.5.2.1 WEIGHTING FACTOR SENSITIVITY ANALYSIS

A sensitivity analysis was conducted to determine the effects on candidate site rankings of varying the weighting factors utilized in the Site Evaluation Matrix over a range of values. The following four cases were analyzed and the results are presented in Table 3.5-2 for the candidate sites.

TABLE 3.5-2

ECONOMIC AND ENVIRONMENTAL AND LICENSING WEIGHTING FACTOR SENSITIVITY ANALYSIS FOR CANDIDATE SITE RANKINGS

Site	RANKING				
	Base	Case 1	Case 2	Case 3	Case 4
AU-1	1	1	1	1	1
MA-3	2	2	2	2	2
MA-1	3	3	3	4	3
CH-1	4	4	5	3	6
JE-3	5	6	6	6	4
MA-2	5	7	4	5	5
BZ-1	7	5	8	7	7
JE-2	8	8	7	8	8

- Base Case

Economic weighting factor	.5	
Geology		.10
Meteorology weighting factor		.025
Hydrology weighting factor		.05
Ecology weighting factor		.10
Demography weighting factor		.05
Land Use weighting factor		.10
Aesthetics weighting factor		.025
Transportation weighting factor		.05
Total Environmental and Licensing weighting factor	.5	
Combined weighting factor	1.0	

- Case 1

Economic weighting factor increased by 40% to	.7
Environmental and Licensing weighting factor decreased by 40% to	.3
Combined weighting factor	1.0

- Case 2

Economic weighting factor decreased by 40% to	.3
Environmental and Licensing weighting factor increased by 40% to	.7
Combined weighting factor	1.0

- Case 3

Economic weighting factor decreased by 20% to	.4
Environmental and Licensing weighting factor increased 20% by increasing the Ecology weighting factor 100%	.6
Combined weighting factor	1.0

- Case 4

Economic weighting factor decreased by 20% to	.4
Environmental and Licensing weighting factor increased 20% by increasing the Hydrology weighting factor 100%	.6
Combined weighting factor	1.0

The sensitivity analysis results presented above demonstrate that Au-1 (Allens Creek) remains the highest ranked site and is insensitive to 40% changes in Economic, Environmental and Licensing weighting factors.

3.5.2.2 ECONOMIC EVALUATION SENSITIVITY ANALYSIS

The results of the economic study are shown in Tables 3.5-3 through 3.5-11. These tables include the results of a sensitivity analysis to determine the effects on the candidate site economic ranking of varying individual cost sources. The following cases were analyzed:

Base Case - Economic ranking based on an annualized differential cost in mills/kw-hr which includes a capacity penalty.

- Case 1 - Economic ranking with 20% decrease in Heat Dissipation System Cost Source.
- Case 2 - Economic ranking with 20% increase in Heat Dissipitation System Cost Source.
- Case 3 - Economic ranking with 20% decrease in Transmission System Cost Source.
- Case 4 - Economic ranking with 20% increase in Transmission System Cost Source.
- Case 5 - Economic ranking with 20% decrease in Water Transport System Cost Source.
- Case 6 - Economic ranking with 20% increase in Water Transport System Cost Source.
- Case 7 - Economic ranking with 20% decrease in Transportation and Site Development Cost Source.
- Case 8 - Economic ranking with 20% increase in Transportation and Site Development Cost Source.

TABLE 3.5-3

SITE RANKING SUMMARY FOR CASES 1 THROUGH 8

Site	Base Order	Case 1 Order	Case 2 Order	Case 3 Order	Case 4 Order	Case 5 Order	Case 6 Order	Case 7 Order	Case 8 Order
AU-1	1	1	1	1	1	1	1	1	1
MA-3	2	2	2	2	2	2	3	3	2
BZ-1	3	3	4	4	3	5	2	2	4
MA-1	4	4	3	3	5	4	4	4	3
CH-1	5	5	5	5	4	3	5	5	5
JE-3	6	6	7	7	6	7	6	6	7
MA-2	7	7	6	6	7	6	7	7	6
JE-2	8	8	8	8	8	8	8	8	8

TABLE 3.5-4
CASE I
ECONOMIC RANKING
VARIATION OF SOURCES
HEAT DISSIPATION SYSTEM
VARIATION = -20%

BASE ORDER	BASE DIFFERENTIAL (MILLS/KW-HR)	SITE	REVISED ORDER	REVISED DIFFERENTIAL (MILLS/KW-HR)
1	BASE	AU-1	1	BASE
2	.104	MA-3	2	.115
3	.138	BZ-1	3	.128
4	.145	MA-1	4	.149
5	.160	CH-1	5	.171
6	.213	JE-3	6	.206
7	.217	MA-2	7	.217
8	.257	JE-2	8	.238

TABLE 3.5-5
CASE 2
ECONOMIC RANKING
VARIATION OF SOURCES
HEAT DISSIPATION SYSTEM
VARIATION = +20%

BASE ORDER	BASE DIFFERENTIAL (MILLS/KW-HR)	SITE	REVISED ORDER	REVISED DIFFERENTIAL (MILLS/KW-HR)
1	BASE	AU-1	1	BASE
2	.104	MA-3	2	.094
3	.138	BZ-1	3	.148
4	.145	MA-1	5	.146
5	.160	CH-1	4	.150
6	.213	JE-3	6	.220
7	.217	MA-2	7	.218
8	.257	JE-2	8	.277

TABLE 3.5-6

CASE 3

ECONOMIC RANKING

VARIATION OF SOURCES

TRANSMISSION SYSTEM

VARIATION = -20%

BASE ORDER	BASE DIFFERENTIAL (MILLS/KW-HR)	SITE	REVISED ORDER	REVISED DIFFERENTIAL (MILLS/KW-HR)
1	BASE	AU-1	1	BASE
2	.104	MA-3	2	.066
3	.138	BZ-1	4	.131
4	.145	MA-1	3	.118
5	.160	CH-1	5	.152
6	.213	JE-3	7	.191
7	.217	MA-2	6	.187
8	.257	JE-2	8	.220

TABLE 3.5-7
CASE 4
ECONOMIC RANKING
VARIATION OF SOURCES
TRANSMISSION SYSTEM
VARIATION = +20%

BASE ORDER	BASE DIFFERENTIAL (MILLS/KW-HR)	SITE	REVISED ORDER	REVISED DIFFERENTIAL (MILLS/KW-HR)
1	BASE	AU-1	1	BASE
2	.104	MA-3	2	.144
3	.138	BZ-1	3	.145
4	.145	MA-1	5	.178
5	.160	CH-1	4	.170
6	.213	JE-3	6	.236
7	.217	MA-2	7	.249
8	.257	JE-2	8	.296

TABLE 3.5-8

CASE 5

ECONOMIC RANKING

VARIATION OF SOURCES

WATER TRANSPORT SYSTEM

VARIATION = -20%

BASE ORDER	BASE DIFFERENTIAL (MILLS/KW-HR)	SITE	REVISED ORDER	REVISED DIFFERENTIAL (MILLS/KW-HR)
1	BASE	AU-1	1	BASE
2	.104	MA-3	2	.084
3	.138	BZ-1	5	.152
4	.145	MA-1	4	.146
5	.160	CH-1	3	.123
6	.213	JE-3	7	.208
7	.217	MA-2	6	.207
8	.257	JE-2	8	.262

TABLE 3.5-9

CASE 6

ECONOMIC RANKING

VARIATION OF SOURCES

WATER TRANSPORT SYSTEM

VARIATION = +20%

BASE ORDER	BASE DIFFERENTIAL (MILLS/KW-HR)	SITE	REVISED ORDER	REVISED DIFFERENTIAL (MILLS/KW-HR)
1	BASE	AU-1	1	BASE
2	.104	MA-3	3	.126
3	.138	BZ-1	2	.125
4	.145	MA-1	4	.149
5	.160	CH-1	5	.199
6	.213	JE-3	6	.219
7	.217	MA-2	7	.229
8	.257	JE-2	8	.254

TABLE 3.5-10

CASE 7

ECONOMIC RANKING

VARIATION OF SOURCES

TRANSPORTATION AND SITE DEVELOPMENT

VARIATION = -20%

BASE ORDER	BASE DIFFERENTIAL (MILLS/KW-HR)	SITE	REVISED ORDER	REVISED DIFFERENTIAL (MILLS/KW-HR)
1	BASE	AU-1	1	BASE
2	.104	MA-3	3	.136
3	.138	BZ-1	2	.123
4	.145	MA-1	4	.155
5	.160	CH-1	5	.165
6	.213	JE-3	6	.211
7	.217	MA-2	7	.222
8	.257	JE-2	8	.265

TABLE 3.5-11

CASE 8

ECONOMIC RANKING

VARIATION OF SOURCES

TRANSPORTATION AND SITE DEVELOPMENT

VARIATION = +20%

BASE ORDER	BASE DIFFERENTIAL (MILLS/KW-HR)	SITE	REVISED ORDER	REVISED DIFFERENTIAL (MILLS/KW-HR)
1	BASE	AU-1	1	BASE
2	.104	MA-3	2	.073
3	.138	BZ-1	4	.153
4	.145	MA-1	3	.141
5	.160	CH-1	5	.156
6	.213	JE-3	7	.216
7	.217	MA-2	6	.214
8	.257	JE-2	8	.251

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APPENDIX A
SITE EVALUATION FACTORS

During the site selection process, Site Evaluation Factors were used to rank the sites and to identify the prime site. Site Evaluation Factors, which are a more detailed refinement of the regional screening factors, were developed for the following areas of concern:

- Economics
- Geology
- Meteorology
- Hydrology
- Ecology
- Demography
- Land Use
- Aesthetics

ECONOMIC RATING SYSTEM

The economic ratings presented in the Site Evaluation Matrix were based on cost differentials in mills/kw-hr. The cost differentials are combined into the following rating system, with five representing the most desirable economic rating and zero representing the least desirable.

Rating	Mills/kw-hr. Differential
5	0
4	0.1
3	0.2
2	0.3
1	0.4
0	0.5

GEOLOGY RATING SYSTEM

The geology ratings were based on evaluation of the following factors:

- Surface material types
- Underlying deposits
- Geologic hazards including:
  - Proximity to salt domes
  - Area seismicity
  - Proximity to literature linears and subsurface fault projections
- Topography, soil stability and construction suitability.
- Subsidence

The above factors were combined into the following rating system with number five representing ideal geologic siting conditions and zero representing the least desirable.

GEOLOGY RATING SYSTEM

Rating	
5	Low shrink-swell potential
	High slope stability
	High bearing capacity
	Low permeability
	Good drainage
	No geologic hazards in region
4	Low to moderate shrink-swell potential
	Moderate to high slope stability
	Moderate to high bearing capacity
	Low to moderate permeability
	Moderate to good drainage
	Geologic hazards in region
3	Moderate shrink-swell potential
	Moderate slope stability
	Moderate bearing capacity
	Moderate drainage
	Geologic hazards in region; literature linears or subsurface fault projections cross site; but not within .5 mi. of plant area.
2	Moderate to high shrink-swell potential
	Moderate to low slope stability
	Moderate to low bearing capacity
	Moderate to high permeability
	Moderate to poor drainage
	Geologic hazards near site; literature linears or subsurface fault projections cross site, but not within .2 mi. of plant area.

1	High shrink-swell potential
	Low slope stability
	Low bearing capacity
	High permeability
	Poor drainage
	Geologic hazards near site; literature linears or subsurfact fault projections with .2 mi. of plant area.
0	High shrink-swell potential
	Low slope stability
	Low bearing capacity
	High permeability
	Poor drainage
	Geologic hazards at site; literature linears or subsurface fault projections cross plant area.

METEOROLOGY RATING SYSTEM

The meteorological rating system was based on evaluation of the following meterological characteristics:

- Atmospheric diffusion
  - Average annual diffusion characteristics
  - Short term diffusion characteristics
- Tornado and extreme winds
- Fogging and icing
- Wind characteristics

The above factors were combined into the following rating system with number five representing ideal meteorological conditions and zero representing least desirable.

METEOROLOGY RATING SYSTEM

Rating	
5	Good average annual diffusion characteristics; good short term diffusion characteristics. Design Basis Tornado Region II or III. Insignificant fogging and icing conditions caused by plant operation. No major population center on streamline of prevailing winds for gaseous effluent releases.
4	Good to average annual diffusion characteristics; good to average short term diffusion characteristics. Design Basis Tornado Region I Occasional fogging and icing conditions caused by plant operation. No major population center on streamline of prevailing winds for gaseous effluent releases.
3	Average annual diffusion characteristics; average short term diffusion characteristics. Design Basis Tornado Region I. Occasional fogging and icing conditions caused by plant operation. No major population center on streamline of prevailing winds for gaseous effluent releases.
2	Average to poor annual diffusion characteristics; average to poor short term diffusion characteristics. Design Basis Tornado Region I. Occasional fogging and icing conditions caused by plant operation. No major population center on streamline of prevailing winds for gaseous effluent releases.

1 Poor to average annual diffusion characteristics; poor short term diffusion characteristics. Additional engineering features will probably be required to limit fission product releases.

Design Basis Tornado Region I.

Frequent fogging and icing conditions caused by plant operation.

No major population center on streamline of prevailing winds for gaseous effluent releases.

0 Poor average annual diffusion characteristics; poor short term diffusion characteristics. Additional engineering features will be required to limit fission product releases.

Design Basis Tornado Region I.

Major fogging and icing conditions caused by plant operation.

Major population center on streamline of prevailing winds for gaseous effluent releases.

HYDROLOGY RATING SYSTEM

The hydrology rating system was based on evaluation of the following hydrological characteristics.

- Availability of cooling water and pumping requirements
- Water quality
- Flood protection
- Aquifer classification using rating system described in Section 2.2.1.2.

The above factors were combined into the following rating system with number five representing the ideal hydrologic siting conditions and zero representing the least desirable.

HYDROLOGY RATING SYSTEM

Rating	
5	Adequate cooling water is available and pumping distance is small. Water quality is excellent and blowdown water should have insignificant impact on receiving water. Little or no flood protection of safety related plant features will be required. Site is located on "acceptable" aquifer zone.
4	Adequate cooling water is available and pumping distance is small to average. Water quality is good and blowdown water should have minor impact on receiving waters. Minor flood protection of safety related plant features will be required. Site is located on "conditionally acceptable" aquifer zone.
3	Adequate cooling water is available and pumping distance is average. Water quality is acceptable. Blowdown water could have medium impact on receiving waters. Economically acceptable flood protection of safety related plant features will be required. Site is located on "conditionally acceptable" aquifer zone.
2	Adequate cooling water is available and pumping distance is average to large. Water quality is acceptable. Blowdown water could have medium impact on receiving waters. Economically acceptable flood protection of safety related plant features will be required. Site is located on "conditionally acceptable" aquifer zone.
1	Adequate cooling water is available and pumping distance is large. Water quality is conditionally acceptable. Blowdown water could possibly have a significant impact on receiving water.

Flood protection of safety related plant features will be required, which could prove unacceptable economically.

Site is located on "conditionally acceptable" aquifer zone.

0 Adequate cooling water is available and pumping distance is large.

Water quality could prove unacceptable. Blowdown water would have significant impact on receiving water and could require treatment which could prove unacceptable economically.

Economically unacceptable flood protection of safety realted plant features will be required.

Site is located on "unacceptable" aquifer zone.

ECOLOGY RATING SYSTEM

The ecological rating system was based on the evaluation of the following ecological characteristics:

- The presence of important species, either plant or animal
- Environmentally unique areas
- The uniqueness, sensitivity, succesional status and biotic diversity of the sites
- The presence of recreationally or commercially important species
- The presence of rare or endangered species.
- The presence of breeding or feeding grounds for important migrating species

The above factors were combined into the following rating system with number five representing the least sensitivity or smallest impact and zero representing the highest sensitivity or greatest impact.

ECOLOGY RATING SYSTEM

Rating	
5	The potential negative impact would be minimal.
4	Based on available information the potential negative impact would be minimal.
3	The potential neg-ıtive impact would be limited.
2	The potential negative impact would be substantial but acceptable.
1	Based on available information, the potential negative impact would be marginally acceptable.
0	The potential negative impact would be excessive and unacceptable.

DEMOGRAPHY RATING SYSTEM

The demography rating system was based on evaluation of the following demographic characteristics:

- Compliance with demographic criteria described in Section 2.2.1.5.
- Transient population variations which are dependent on a seasonal, daily or special event basis.
- Proximity of public facilities and institutions

The above factors were combined into the following rating system with number five representing the ideal demographic siting conditions and zero representing the least desirable.

DEMOGRAPHY RATING SYSTEM

Rating	
5	Site is outside of exclusion area defined by demographic criteria. Insignificant transient population variations. No public facilities or institutions near site.
4	Site is outside of exclusion area defined by demographic criteria. Minor transient population variations. Very few public facilities or institutions near site.
3	Site is outside of exclusion area defined by demographic criteria. Large, infrequent and predictable transient population variations. Several public facilities or institutions near site.
2	Site is outside of exclusion area defined by demographic criteria. Large, frequent and predictable transient population variations. Several public facilities or institutions near site.
1	Site is outside of exclusion area defined by demographic criteria. Large, frequent and unpredictable transient population variations. Several public facilities or institutions near site.
0	Site is within exclusion area defined by demographic criteria. Significant transient population variations. Major public facilities or institutions near site.

LAND USE RATING SYSTEM

The land use rating system was based on evaluation of the following land use characteristics:

- Existing land use
- Airspace
- Mineral reserves
- Oil and gas fields
- Archeological & historical sites
- Recreational sites
- Proposed land use plans

LAND USE RATING SYSTEM

Rating	
5	Low yield land, few low value residences.
	No major airways pass over site.
	No known mineral reserves within site area.
	No oil or gas wells within site - No pipelines cross site.
	No known archeological & historical sites within site area.
	No known recreational sites within site area.
	No conflict with known proposed land use plans.
4	Some improved pasture, several low value residences.
	No major airways pass over site.
	No known mineral reserves within site area.
	No oil or gas wells within site - Few pipelines cross site.
	No known archeological & historical sites within site area.
	Small park acreage within site area.
	No conflict with known proposed land use plans.
3	Improved pasture, some crops, several low to moderate value residences.
	No major airway passes over site.
	No known mineral reserves within site area.
	No oil or gas wells within site - Few pipelines cross site.
	No known archeological & historical sites within site area.
	Modest park and/or forest acreage.
	No conflict with known proposed land use plans.
2	Rare crops, important forest products, numerous moderate value residences.

Several major airways pass over site - Within ten miles of frequently used airport.

Few oil or gas wells within site area - Several pipelines cross site.

Minor archeological or historical sites within site area.

Modest park and/or forest acreage.

Minor conflict with proposed land use plans.

1 Intensively farmed, numerous high value residences.

Within five miles of frequently used airport.

Several oil or gas wells on site - Several pipelines cross site.

Minor archeological or historical sites within site area.

Significant park and/or forest acreage.

Significant conflict with proposed land use plans.

0 Intense speciality crop farming; numerous high value residences.

Major industrial facilities site area with excluded airspace.

Valuable mineral reserve area within site area.

Major archeological or historical sites within site area.

Major recreational areas within site area.

Major conflict with proposed land use plans.

AESTHETICS RATING SYSTEM

The aesthetic rating system was based on evaluation of the following aesthetic considerations:

- Visibility of plant features from transportation routes
- Visibility of plant features from nearby communities and/or recreational areas
- Impact of noise created by construction and operation of plant

The above considerations were combined into the following rating system with number five representing least impact and zero representing the greatest impact.

AESTHETICS RATING SYSTEM

Rating	
5	The potential negative aesthetic impact would be minimal.
4	Based on available information the potential negative aesthetic impact would be minimal.
3	The potential negative aesthetic impact would be limited.
2	The potential negative aesthetic impact would be substantial but acceptable.
1	Based on available information the potential negative aesthetic impact is marginally acceptable.
0	The potential negative aesthetic impact would be excessive and unacceptable.

TRANSPORTATION RATING SYSTEM

The transportation rating system was based on the evaluation of the following transportation factors:

- Highways and road access
- Railroad service and access
- Waterway access
- Labor supply and labor housing

The above factors were combined into the following rating system with number five representing the ideal transportation siting conditions and zero representing the least desirable.

TRANSPORTATION RATING SYSTEM

Rating	
5	Major highway with good secondary roads.
	Good rail network.
	Adjacent to navigable waterway.
	Good skilled labor pool, labor housing good.
4	Several good secondary roads.
	Good single line railroad within a few miles or navigable waterway with a few miles of site.
	Fair labor pool, labor housing fair.
3	Few secondary roads.
	Good single line railroad within several miles of site.
	Fair labor pool, labor housing fair.
2	One secondary road.
	Low traffic rail service within a few miles of site.
	Limited labor pool, labor housing poor.
1	Farm roads only with several miles of site.
	Low traffic rail service within several miles of site.
	No labor pool, no labor housing.
0	Inaccessible.