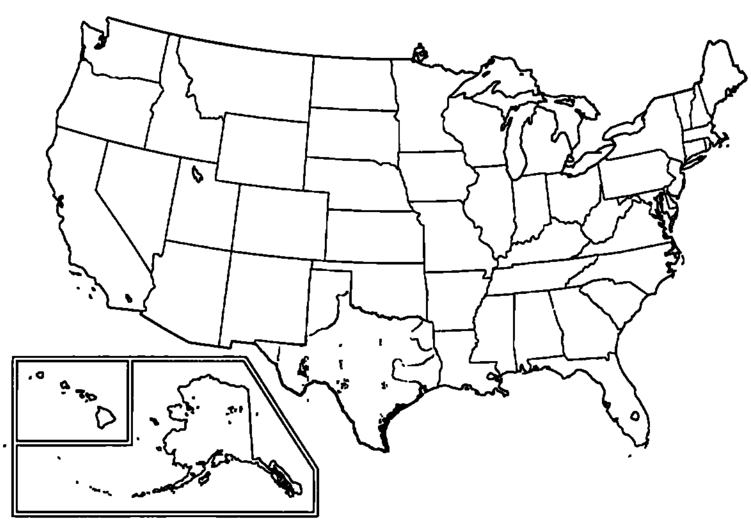
US Army Corps
of Engineers

National Hydroelectric Power Resources Study

Volume XXI
September 1981

Regional Assessment: Electric Reliability Council of Texas



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This volume briefly describes existing conditions (physical, social, economic) affecting electric supply and demand in the Electric Reliability Council of Texas. It discusses the existing electric energy system and the role of hydropower therein. Projections of electrical supply and demand through the year 2000 are discussed. The hydropower resources, developed and undeveloped, of the region are evaluated and a regional ranking of specific projects and sites which are recommended to be studied in further detail is presented. The public involvement in the planning process is described.

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US ARMY CORPS OF ENGINEERS

NATIONAL HYDROELECTRIC POWER RESOURCES STUDY

REGIONAL REPORT: VOLUME XXI
ELECTRIC RELIABILITY COUNCIL OF TEXAS

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September 1981

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PREFACE

The economic success and standard of living in this country have been achieved, in part, at the expense of abundant supplies of low cost, non-renewable, energy sources. In recent years however, diminishing reserves of the preferred non-renewable energy sources, i.e. oil and natural gas, have prompted a national energy policy which emphasizes conservation and the development of new and renewable sources of energy. This report is a direct result of the national energy policy as it focuses on our major existing renewable energy resource, hydroelectric power.

Congress, in the Water Resources Development Act of 1976 (P. L. 94-587), authorized and directed the Secretary of the Army, acting through the Chief of Engineers, to undertake a National Hydroelectric Power Resources Study (NHS). The primary objectives of the NHS were (1) to determine the amount and the feasibility of increasing hydroelectric capacity by development of new sites, by the addition of generation facilities to existing water resources projects, and by increasing the efficiency and reliability of existing hydroelectric power systems; and (2) to recommend to Congress a national hydroelectric power development program.

The final NHS report consists of 23 volumes. Volumes I and II are the Executive Summary and National Reports respectively. Volumes III and IV evaluate the existing and projected electric supply and demand in the United States. Volumes V through XI discuss various generic policy and technical issues associated with hydroelectric power development and operation. Volumes XII and XIII describe the procedures used to develop the data base and include a complete listing of all sites. Volumes XIV through XXII are regional reports defined by Electric Reliability Council (ERC) regions. The index map at the inside back cover defines the ERC regions. Alaska and Hawaii are presented in Volume XXIII.

This volume, number XXI, describes the hydroelectric power potential in the Electric Reliability Council of Texas (ERCOT) region. A map depicting all sites described in the text is located in the jacket, inside back cover.

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Chapter 1

REGIONAL OBJECTIVES

This report describes information developed during the course of the National Hydroelectric Power Resources Study and is particularly related to the developable hydropower resources within the geographic boundaries of the Electric Reliability Council of Texas (ERCOT).

ERCOT was formally organized as a regional council of the National Electric Reliability Council in 1970. The national council was formed in 1968 to augment the reliability and adequacy of bulk power supply in North America. ERCOT membership is available on a voluntary basis to any Texas utility engaged in the generation, transmission, or distribution of electric power. Membership as of January 1978 was 27 municipalities, 50 cooperatives, 8 investor-owned utilities, and a state agency. Member utilities supply around 85% of total electric power in the state.

There are no unique objectives for developing hydroelectric power potential within ERCOT. However, development of the potential within ERCOT would contribute to the national objectives of reducing dependency on imports of foreign oil and the general improvement of the welfare and security of the nation.

The presentation is structured to show the current and projected electrical energy requirements; the physical potential for developing hydropower; some economic, environmental, political, social, and institutional constraints to developing the physical potential; and the probable use and impacts associated with developing the acceptable power potential within the region.

Informational listings have been presented with ranking numbers which indicate the probable order of interest which will be given to potential developments within ERCOT. Detailed studies on the sites have not been made. In some cases the potential capacity and energy estimates overstate the actual power which can be developed. At existing projects, this is particularly true because of upstream diversions, releases for fish and wildlife preservation and enhancement, flood control, water supply, navigation, and recreation. Recommendations of the Secretary of the Army will be presented to the Congress along with the final report.

Chapter 2

EXISTING CONDITIONS

(RELIABILITY COUNCIL PROFILE)

2.1 TOPOGRAPHY

The ERCOT system serves an area covering approximately 195,000 square miles, wholly within the State of Texas. Except for the southwestern edge, the ERCOT region is a series of plains. The southwestern edge extends into an eastern range of the Rocky Mountains.

The plain slopes gradually southeastward from 4,000 feet elevation in the Panhandle to sea level along the Gulf of Mexico Coast. It is interrupted by two abrupt transitional features which create three distinct physiographic provinces: the Great Plains, the Central Lowlands, and the Gulf Coastal Plains. The abrupt transitional features are the Cap Rock Escarpment and the Balcones Escarpment.

The Cap Rock Escarpment forms an irregular line from the Red River in the Panhandle south into the Colorado River basin, turning west into New Mexico. Formed by erosion, it is seen as a mountain wall decending in elevation. The Balcones Escarpment was formed by a geologic fault. It extends eastward from a point near Del Rio on the Rio Grande to near San Antonio, where it turns northeastward and intersects the Colorado River above Austin. The escarpment continues generally northward to the Red River near Lake Texoma, but the lines become less distinct.

The Cap Rock Escarpment forms the eastern boundary of the Great Plains in Texas known as the High Plains. The High Plains are almost completely without erosional features. Elevations characteristically range between 2,500 and 4,000 feet. The level-to-undulating surface is interrupted only by scattered shallow draws and lakes, and by the headwater courses of the Brazos and Colorado Rivers. To the south, the alluvial cover of the High Plains disappears, exposing the more resistant limestone substrata. This extension of the Great Plains is known as the Edwards Plateau. Elevations vary from about 750 feet at its southern and eastern borders to about 2,700 feet at its highest points. Its southeastern boundary is the Balcones Escarpment.

The extension of the central Lowland province in Texas is known as the North Central Plains. Covering approximately 16,000 square miles, the North Central Plains is a rolling, lightly timbered area bounded on the west by the Cap Rock Escarpment, on the south by a series of mesas known as the Callahan Divide, and on the east, less distinctly, by the West Cross

Timbers. While the North Central Plains was formed primarily as a slightly rolling prairie by the erosion of limestone, some uncharacteristic topographic features are found in the area. Chief among these is the deep entrenchment of the Brazos River in limestones, with the consequent development of steep tributary canyons and mesas. Elevations in the North Central Plains range from 2,500 feet in the west to 800 feet in the east. The area includes a considerable portion of the Brazos and Red River basins, and a small segment of the Colorado River basin.

All of the study area south and east of the Balcones Escarpment in general is related topographically. The rolling, heavily forested lands of eastern Texas give way toward the west and northwest to gently rolling prairies. To the south, along the Upper Texas Coast, the timbered hills grade into generally level coastal prairies and marshlands. Continuing south along the coast, and west to the Rio Grande, the prairies merge into undulating, brushy plains.

Elevations range from sea level along the coast to an average of about 500 feet at the uplift of the Balcones Escarpment, ranging somewhat higher in the northwestern section. The Coastal Plain province contains all of the Neches and San Jacinto River basins, most of the Trinity, San Antonio, and Nueces River basins, and large segments of the Red, Sabine, Brazos, Colorado, Guadalupe, and Rio Grande basins.

2.2 HYDROLOGIC CONDITIONS

Figure 2-1 shows the major river basins in the ERCOT region. All rivers except the Red drain directly to the Gulf of Mexico. The Red River drains into the Mississippi River. The principal drainage lines in ERCOT have distinctly parallel southeasterly courses following the regional slope. Except for the Rio Grande and Red, the main stem of each of the principal streams orginates east of the Cap Rock Escarpment, although the Brazos and Colorado Rivers are considered to rise in the High Plains. Headwaters for the Rio Grande are in Colorado. The Red River heads near the New Mexico-Texas border in Curry County, New Mexico. The streams tend to be perennial through the Coastal Plain and Lower Edwards Plateau, becoming intermittent in the North Central and High Plains areas. Figure 2-2 presents a flow duration curve typical of intermittent streams in the more arid plains areas, and Figure 2-3 shows a flow-duration curve representative of the Coastal Plain and Lower Edwards Plateau.

Mean annual precipitation in the study area ranges from 52 inches in the east to 12 inches in the west. The Gulf of Mexico is the principal source of moisture and also moderates the climate of the interior. Although the climatic zones are not sharply divided, major subregions exhibit significant differences.

In the upper coastal plain, temperatures are comparatively high and uniform, and average relative humidity is high. In a central belt

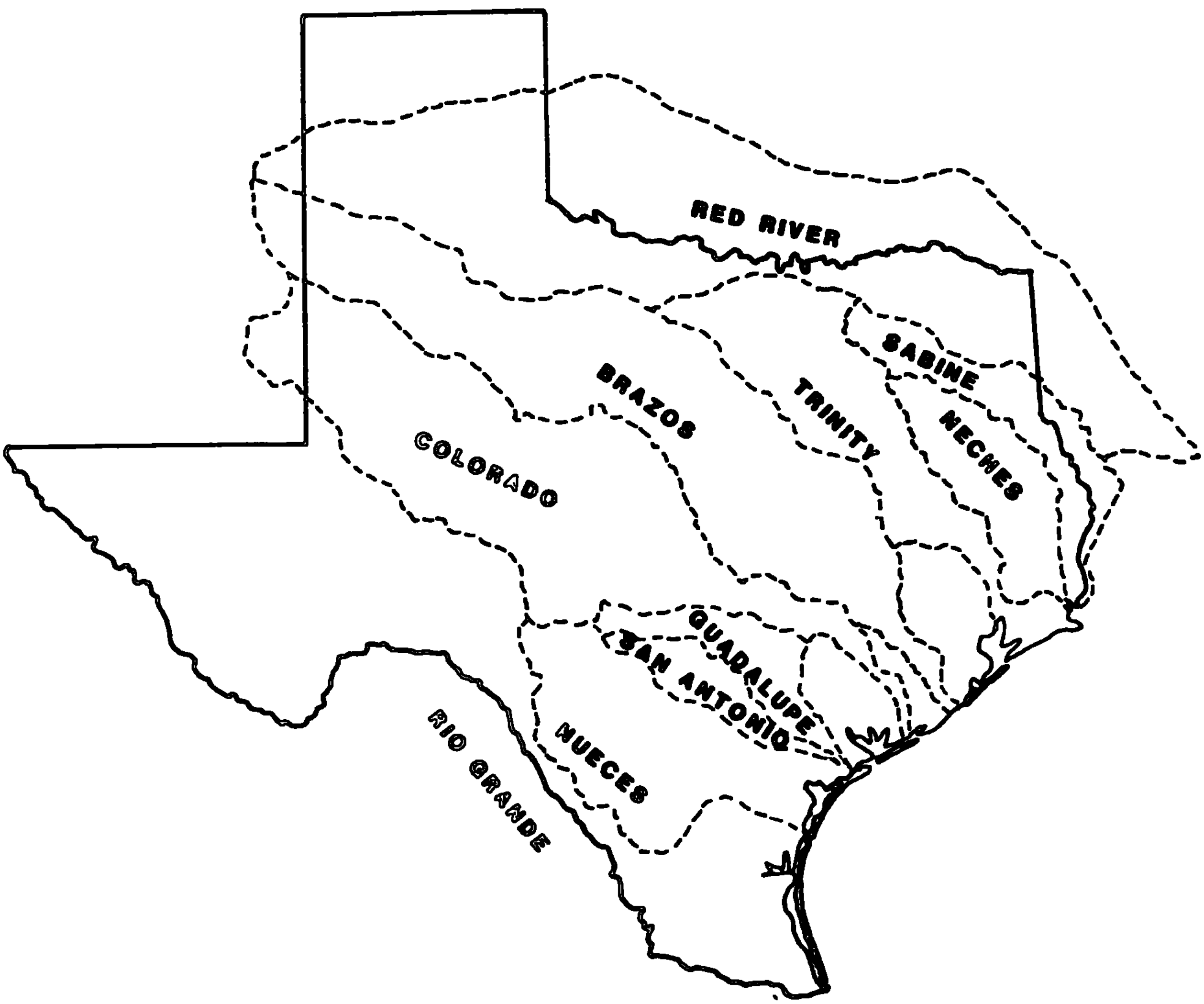


Figure 2-1

MAJOR RIVER BASINS IN ERCOT

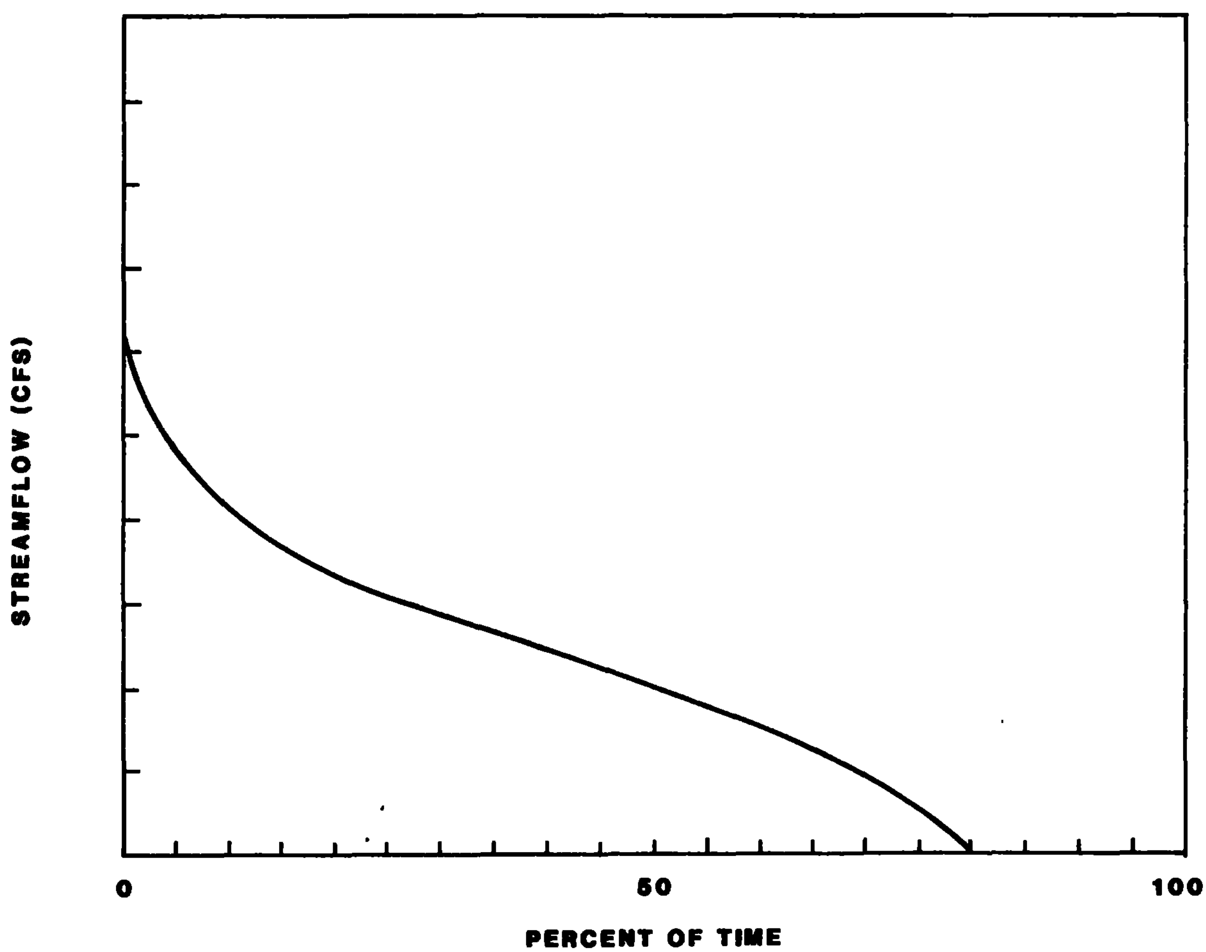


Figure 2-2
FLOW DURATION CURVE (SEMI-ARID REGION)

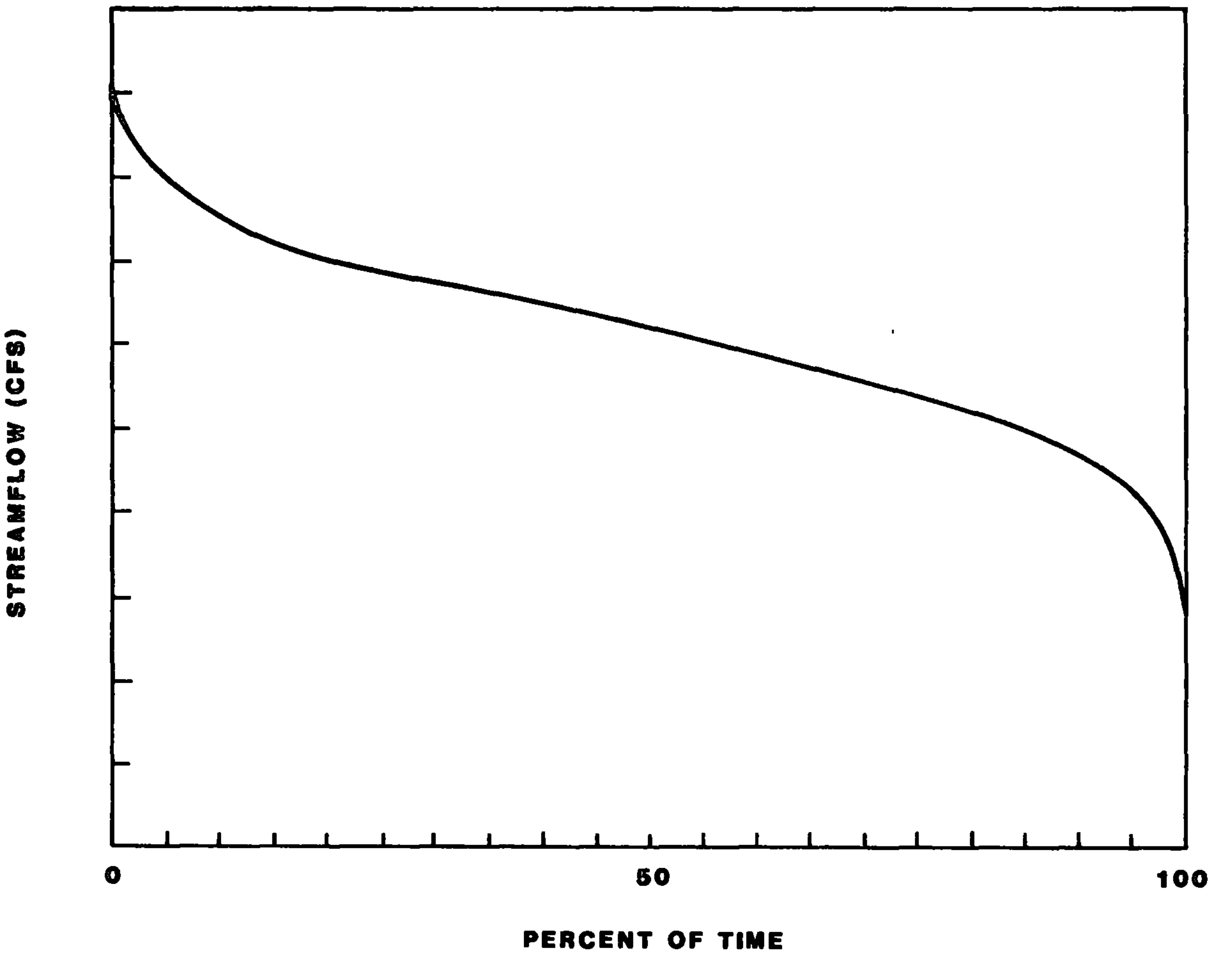


Figure 2-3
FLOW DURATION CURVE (WET REGION)

extending from around San Antonio to the Fort Worth area, drier and cooler continental airmasses surge into the area, particularly in winter, producing greater temperature variations. Precipitation in the central belt is more moderate and irregular in occurrence. In the lower Coastal plain warm and semiarid conditions prevail. Precipitation generally is light compared to the high rate of evaporation and transpiration, but tropical storms occasionally bring heavy rainfall. In the High Plains region, normal precipitation is low and temperatures vary over a wide range from summer to winter.

The interaction of contrasting airmasses over the study area generally produces both excesses and deficiencies of moisture. Heavy rainfall causes flooding, and droughts are sometimes prolonged, especially in the central section. Thus dependable flow can be a small amount of average annual flow.

Both topographically and hydrologically, the Balcones fault zone exerts a considerable influence throughout most of the basins of the Study Area. As they cross the fault zone, the streambeds of the Brazos and Colorado Rivers are sharply sloped and deeply entrenched. Consequently, many excellent natural reservoir sites and many of the best hydroelectric powersites in the Study Area are in this transitional zone. One fault-zone phenomenon is particularly characteristic of the upper Guadalupe, San Antonio, and Neuces River basins. Because of the great height of the western portion of the Balcones Escarpment, the streams of these three basins, as they cut through the faulted area, descend rapidly hundreds of feet through ravines. At the foot of the escarpment, they often cut into the heavily fissured Edwards limestone and lose considerble quantities of water, particularly in the Nueces and San Antonio basins. The Edwards limestone discharges unusually large quantities of ground water through springs, the largest of which are in the fault zone at New Braunfels, San Marcos, and Austin in south central Texas.

2.3 ECONOMICS OF AREA

Economic analysis for the National Hydropower Study is based on OBERS Projections, 1972: Regional Economic Activity in the US (1974). The seven-volume report was prepared jointly by the Bureau of Economic Analysis (Department of Commerce) and the Economic Research Service (Department of Agriculture). These projections have been designated by the US Water Resources Council for use in water resources planning studies. The nation is divided into 173 areas designated Bureau of Economic Analysis (BEA) Economic Areas. The ERCOT region is approximated by the following 12 BEA Economic Areas:

121 Wichita Falls, Texas
123 Lubbock, Texas
124 Odessa, Texas
125 Abilene, Texas
126 San Angelo, Texas

127 Dallas, Texas
128 Killeen-Temple, Texas
129 Austin, Texas
141 Houston, Texas
142 San Antonio, Texas
143 Corpus Christi, Texas
144 Brownsville - Harlingen - San Benito, Texas

Figure 2-4 shows the economic areas in the ERCOT region. The economic areas are outlined, and those included in the ERCOT analysis are identified. The shaded area represents the ERCOT region. In 1978 the estimated population of the ERCOT region was 11,283,000.

In 1970 combined earnings for the economic areas were $24.8 billion (1967 dollars). Total earnings in the ERCOT region accounted for 4.4% of 1970 national earnings. ERCOT's share of national earnings has increased since 1950. For the 20-year period 1950-1970, ERCOT earnings increased at an average annual rate of 4.6% compared to 4% for the nation. Table 2-1 shows total earnings and earnings by industry for the ERCOT region.

Government, manufacturing, and trade sectors have contributed most to the region's total earnings, accounting for 20%, 19%, and 18%, respectively. Mining earnings are only 3% of the total earnings but represent around 14% of national mining earnings. Agricultural earnings in 1970 represent 7% of national agricultural earnings and accounted for 5.6% of total earnings in the region.

Earnings accounted for 80% of personal income in ERCOT in 1970. Total personal income was $31 billion. Per capita personal income (PCPI) in ERCOT was $3,202 in 1970, increasing from $1,881 in 1950. The average annual growth rate of PCPI was 2.7% from 1950 to 1970. PCPI in ERCOT was 92% of the national average for 1970.

2.4 FUTURE DEVELOPMENT

Regional economic projections developed for the US Water Resources Council and published in OBERS Projections; 1972: Regional Economic Activity in the US are the basic projections of economic and demographic growth used in this study. The OBERS projections show expected growth in population, employment, personal income, and earnings. Employment and earnings by industry are projected for the US and earnings by industry is projected for economic areas.

The OBERS projections used in this study are developed from Bureau of the Census Series E population projections.[1/] While the national growth rate under the OBERS Series E assumption is considered valid for NHS planning purposes, regional projections of population have been revised to reflect regional growth experience for the 1970-78 period. Regional growth in earnings has not been adjusted to reflect the change in population.

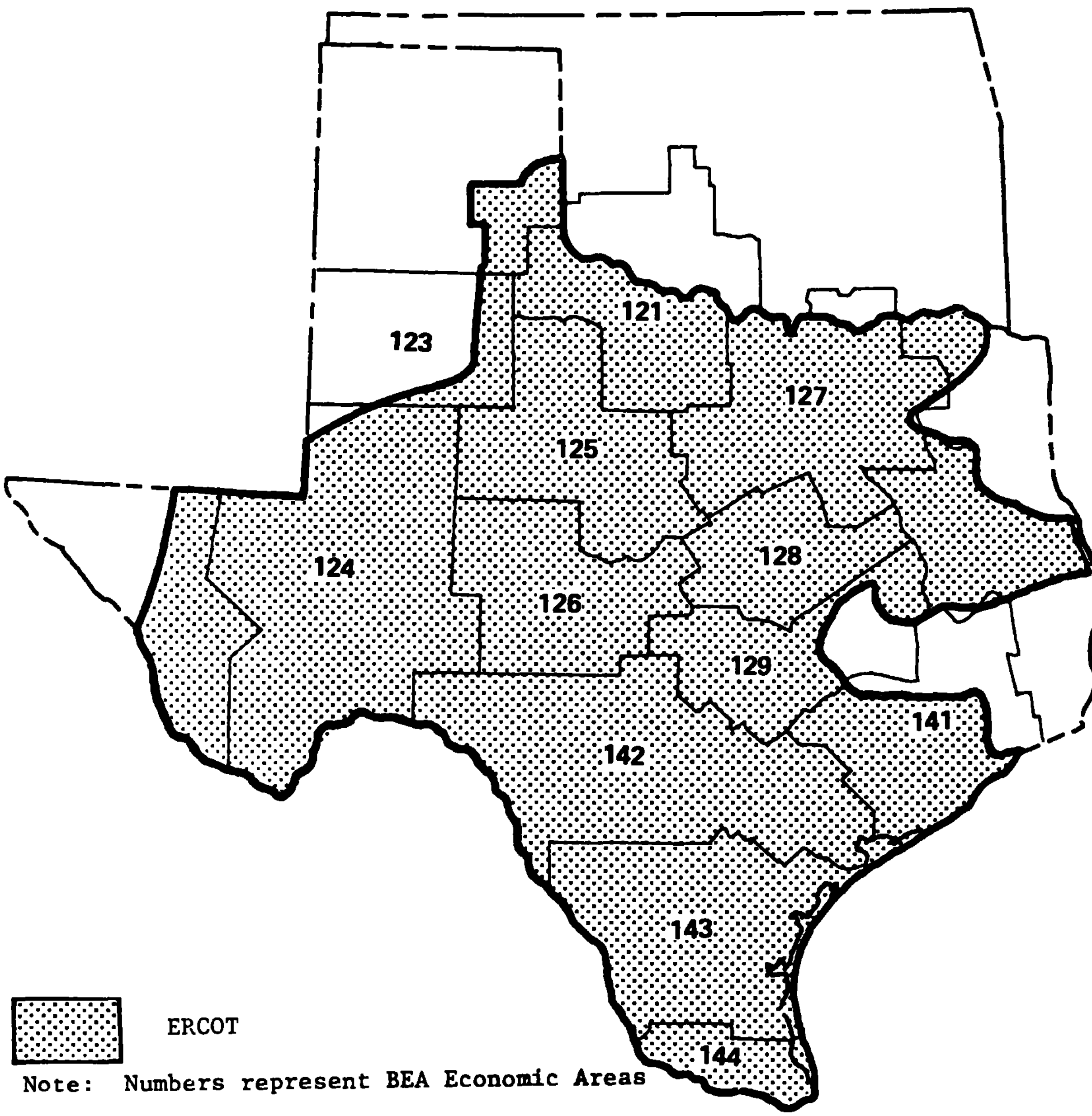


FIGURE 2-4

BEA ECONOMIC AREAS APPROXIMATING ERCOT

Table 2-1

TOTAL EARNINGS AND EARNINGS BY INDUSTRY - 1970
(MILLIONS OF 1967 DOLLARS)

SECTOR	VALUE	PERCENT OF TOTAL
Agriculture	1,379	5.6
Mining	828	3.3
Construction	1,660	6.7
Manufacturing	4,754	19.2
Transportation Utilities	1,753	7.1
Trade	4,570	18.4
Finance	1,309	5.3
Services	3,636	14.7
Government	4,911	19.8
TOTAL	24,800	100

Note: ERCOT Region is approximated by BEA Economic Areas: 121, 123, 124, 125, 126, 127, 128, 129, 141, 142, 143, 144.

SOURCE: Harza, Phase I, page IX-4

Commercial and Industrial Development

Table 2-2 shows projected industrial and commercial development for the region for the years 1980, 1985, 1990, and 2000. Industrial growth is based on projected growth in manufacturing earnings and commercial growth is indicated by growth in earnings in transportation, utilities, trade, finance, services, and government. OBERS projections of these earnings for the US are also shown for comparison.

Manufacturing earnings for the ERCOT region are projected to be $7.1 billion in 1980, and increase to $14.1 billion in 2000, representing an average annual growth rate of 3.5%. Nationally, manufacturing earnings are projected to increase at a lower rate, around 2.9% annually.

Projected growth rates in commercial and related earnings are lower for the nation than for the ERCOT region. Commercial earnings in ERCOT are projected at $25 billion in 1980, increasing to $54.4 billion in 2000. This represents an average annual growth rate of 4.0%.

US commercial earnings are projected to increase at an average annual rate of 3.8%, increasing from a projected $538 billion in 1980 to a projected $1,137 billion in 2000. All values are in 1967 dollars.

Population

Estimated population for 1978 for the combined BEA Economics Areas approximating the ERCOT region is 11,283,000. This represents a 16% increase from 1970, exceeding the national increase of 8% for the same period. Table 2-3 shows historic and projected population for the United States and the ERCOT region from OBERS and from a summation of regional electric reliability council adjusted projections from Harza Phase II. Harza Phase II projections for the United States differ from OBERS by less than .2% in any projection year, and are considered Series E population projections. US population is projected to increase 29% over the 30-year period.

Harza adjusted projections for ERCOT are higher than OBERS projections by 13% for each projection year. The higher growth reflects the 1970-78 growth experience, and a revision of the OBERS projection to 1985. OBERS projected growth rates from 1985 to 2000 are retained in the revised projection. Population in ERCOT is forecast at 14,395,000 in 2000, representing a 48% increase from 1970. Analysis of future electric power needs for ERCOT is related to this population projection.

2.5 MAJOR ENERGY USERS

Annual electric energy generation in ERCOT for 1970-78 is shown in Table 2-4. Energy generation has grown from 79,200 GWH in 1970 to 147,300 GWH in 1978, an average annual growth rate of 8.1%.

Table 2-2

COMMERCIAL AND INDUSTRIAL EARNINGS PROJECTIONS

(MILLIONS OF 1967 DOLLARS)

	INDUSTRIAL EARNINGS[1/]		COMMERCIAL EARNINGS[2/]	
	US	ERCOT	US	ERCOT
1980	$219,486	$7,141	$ 538,332	$24,965
1985	252,985	8,518	649,138	30,403
1990	291,595	10,165	783,434	37,088
2000	388,479	14,096	1,137,011	54,439
		FACTOR OF CHANGE FROM 1980		
1980	1.00	1.00	1.00	1.00
1985	1.15	1.19	1.21	1.22
1990	1.33	1.42	1.46	1.49
2000	1.77	1.97	2.11	2.18

1/ Manufacturing earnings projections

2/ Transportation, utilities, trade, finance, services, and government earnings projections.

SOURCE: US Water resources Council. OBERS Projections, 1972: Regional Economic Activity in the US, Series E Population. Washington, April 1974. ERCOT projections summed for BEA Economic Areas shown on page 2-7 and reported in Harza, Phase II, Exhibit IX-I.

Table 2-4

HISTORIC AND PROJECTED POPULATION-US and ERCOT

1970-2000
(Thousands)

	UNITED STATES		ERCOT REGION	
	OBERS SERIES E	HARZA, ADJ	OBERS SERIES E	HARZA, ADJ
1970	203,858	203,858	9,706	9,706
1978	-	219,170[1/]	-	11,283
1980	223,532	NA	10,505	NA
1985	234,517	234,210	11,119	12,523
1990	246,039	245,826	11,781	13,292
2000	263,830	263,710	12,755	14,395
		FACTORS OF CHANGE FROM 1970		
1970	1.00	1.00	1.00	1.00
1978		1.08	-	1.16
1980	1.10	NA	1.08	NA
1985	1.15	1.15	1.15	1.29
1990	1.21	1.21	1.21	1.37
2000	1.29	1.29	1.31	1.48

1/ As reported in Harza, Phase II, Exhibit 1-4. Current Population Reports. Series P-25, No. 799, April 1979, quoted as the source of the 1978 population estimate, shows US population for 1978 at 218,059,000.

SOURCE: US Water Resources Council. OBERS PROJECTIONS, 1972, Series E Population, April 1974. ERCOT projections as shown in Harza, Phase I p. IX-4, and Phase II, Exhibits IX-1 and IX-2.

Table 2-4

ANNUAL ELECTRIC ENERGY GENERATION - ERCOT

YEAR	GWH
1970	79,200 1/
1971	NA
1972	NA
1973	105,400
1974	108,600
1975	115,900
1976	122,200
1977	136,400
1978	147,313

1/ From FPC Power Supply Areas 37 and 38.

SOURCES: 1970-77 Harza Phase I, Part II. Exhibit IX-3. NERC, "8th Annual Review of Overall Reliability and Adequacy of the North American Bulk Power System," August 1978.

Energy consumption by consumer class is shown in Figure 2-5 for 1976. Consumer class distribution is based on 1977 distribution for the State of Texas. Industrial use is the largest consumer category in ERCOT, followed by Residential and Commercial classes. Industrial use consumed 57,000 GWH of electric energy in 1977, while 41,500 GWH were consumed by residences, and 33,700 GWH were consumed commercially.

Industrial. Major industrial consumers in ERCOT are primary metals and chemicals and allied products. Nationally, these industries account for 26.5% and 20.1%, respectively, of the electricity purchased by manufacturers. Over 14% of the nation's petrochemicals are produced in the Houston area. Major primary metals industries in ERCOT include steel and aluminum.

Residential. Table 2-5 shows residential energy consumption and residential electric energy consumption by end use for ERCOT. Data are estimated using 1977 residential electric use, and 1970 total residential and end use distribution. Major total energy uses are space heating, water heating, and air conditioning. Space heating accounts for over half of total residential energy use, but only 3.8% is supplied by electric energy. Water heating is also supplied mainly by other fuel sources, with only 5.5% supplied by electricity.

In total electric energy use, air conditioning, refrigeration, and lighting are the major residential end uses, accounting for 36%, 21%, and 14%, respectively, of the estimated 41,500 GWH hours of electric energy consumed for residential purpose in ERCOT.

Commercial. Commercial usage in ERCOT in 1977 was 33,700 GWH, accounting for around 25% of total electric consumption. The principal commercial electric energy uses are lighting, space heating and cooling, ventilation, and water heating.[2/]

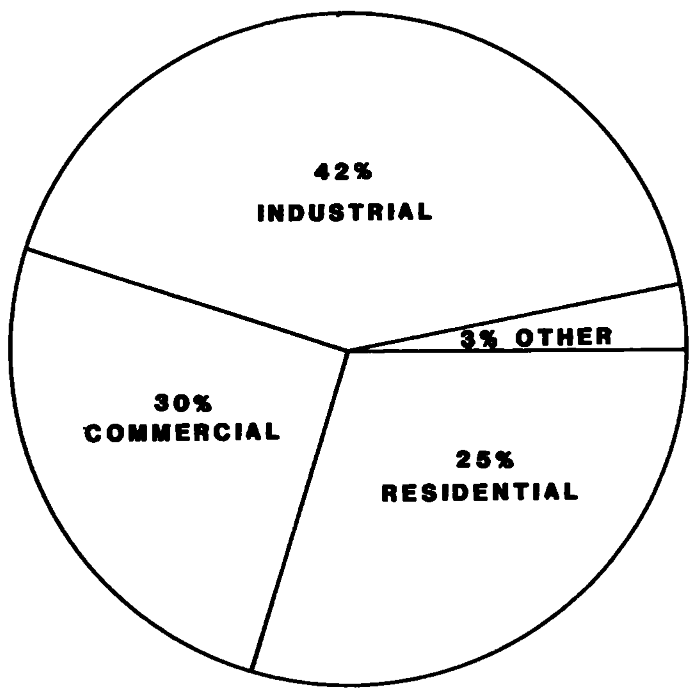


Figure 2-5

MAJOR ENERGY USERS BY CONSUMER CLASS

(1977)

Table 2-5

RESIDENTIAL ENERGY USE - ERCOT
(1970 DISTRIBUTION -- 1976 ENERGY USE)

END USE	TOTAL RESIDENTIAL ENERGY USE: GWh EQUIVALENTS	PERCENT OF TOTAL RESIDENTIAL ENERGY USE	ELECTRIC RESIDENTIAL ENERGY USE: (GWh)	PERCENT OF TOTAL RESIDENTIAL ELECTRIC ENERGY	ELECTRIC ENERGY AS A PERCENT OF TOTAL RESIDENTIAL ENERGY USE:
Space Heating	98,300	51.1	3,735	9	3.8
Water Heating	30,200	16.4	1,660	4	5.5
Cooking	6,900	6.5	830	2	12.1
Clothes Drying	2,000	1.1	1,245	3	63.0
Refrigeration	8.700	4.4	8.715	21	100.0
Lighting	5,800	3.1	5,810	14	100.0
Air Conditioning	14,900	7.8	14,940	36	100.0
Other	19,200	9.6	4,565	11	23.8
TOTAL	186,000 1/	100.0	41,500	100	22.3

1/ 186,000 GWh = 634 trillion BTU's

Source: Computed from Harza, Phase I, Part II, Exhibit IX - 3.
Harza, Phase 2, Table C-1, p C-4. Table C-2, pC-5. Table C-3, pC-7.

Residential energy use data are for West South Central Census Region, Arkansas, Louisiana, Oklahoma, and Texas.

FOOTNOTES

1/ US Bureau of the Census. Current Population Reports, p 25, No. 493, December 1972, plus unpublished tabulations.

2/ Harza cites California studies for this information.

REFERENCES

Harza Engineering Company, 1979, The Magnitude and Regional Distribution of Needs for Hydropower, Phase I, 1978 Electric Power Demand and Supply, Parts I and II. Draft Report: National Hydropower Study, Chicago, January 1979.

Harza Engineering Company, 1980, Phase II - Future Electric Power Demand and Supply, Draft Report: Chicago, March 1980.

Oak Ridge National Laboratory, 1978, Regional Econometric Model for Forecasting Electric Demand by Sector and by State: Oak Ridge, Tennessee, 1978.

US Water Resources Council, 1974, OBERS Projections, 1972: Regional Economic Activity in the US, Volumes 1 and 2: Washington, April 1974.

Chapter 3

EXISTING ENERGY SYSTEMS

3.1 EXISTING ENERGY SYSTEMS EXCLUDING HYDROPOWER

The electric utilities industry serving the ERCOT region is made up primarily of private utilities. Ownership of generating capacity was 81.5% private, 14.7% municipal, 3.5% state, and less than 1.0% other, including Federal and cooperatives. ERCOT has operated as a closed system, with little interconnection and exchange with other regional reliability councils. Existing and planned generating capacity by major fuels are discussed below. As of January 1, 1978, generating capacity in ERCOT was 37,029 MW: 86.5% gas; 11.1% coal; 1.5% combined cycle; and 0.6% hydroelectric.[3/]

NUCLEAR

There are no operating nuclear plants in ERCOT at this time. Five units are under construction. Comanche Peak #1, a 1150 MW unit at Glen Rose, is scheduled for completion in 1981. The second 1150 MW unit at Glen Rose is scheduled for completion in 1983. South Texas Project #1, a 1250 MW unit at Atascosa is scheduled for completion in 1984, and the second 1250 MW unit, South Texas project #2, is scheduled for completion in 1986. The fifth unit, Allens Creek #1, a 1130 MW unit in Austin County, is scheduled for completion in 1987. Collectively, these units would add 5,930 MW of base load capacity to the ERCOT system. Nuclear power development, however, has not proceeded on schedule. Plants under construction are privately owned.

The major favorable impact associated with nuclear power production is the assurances of a sufficient domestic energy source to permit continued high energy-based economic growth in the US.

Major environmental concern associated with the use of nuclear fuel is the danger of radioactive materials at all stages: mining, milling, fuel processing, power generation, transportation, and waste disposal. Specific points of possible contamination include human exposure to radioactive gas and dust in mining and milling, atmospheric releases of radioactive gases in fuel processing and power generation, disposal of long-life radioactive wastes, and accidents at all stages. Impacts on land use are felt at mining, generation, and disposal sites. Water pollution is a concern in the disposal of mine drainage water, and in thermal pollution from the release of cooling water. Additionally, water is consumptively used in cooling processes.

In addition to radioactive gases, fluoride, sulfides, and nitrides are released into the atmosphere during fuel fabrication. The sitings of nuclear plants and of waste disposal operations are of physical, environmental, and political concern.[4/]

COAL

Coal generating capacity as of 1 January 1978 was 4,127 MW in the ERCOT region. Coal accounted for 11.1% of generating capacity and 13.2% of total power production. As reported in April 1979, coal generating capacity had increased to 7,800 MW and, by 1988, is projected to increase to 20,300 MW. Federal policy encourages the use of coal for power generation. Coal is used primarily for base load. Ownership is primarily private.

Lignite coal is used extensively in power generation in ERCOT. Around 60% of existing and scheduled coal-fired capacity uses or will use lignite. Lignite reserves in Texas are estimated at 10.4 billion short tons at depths of less than 200 feet, and approximately 100 billion tons at deeper levels. Bituminous coal reserves are also located in the state, but sulfur content is high, and this coal is not mined extensively. Currently, utility companies are bringing in western coal for power generation.

A number of environmental problems result from the use of coal, including lignite coal. Surface mining is the prevalent mining process in Texas, and major environmental problems associated with these operations are potential damage to land and water resources. Careful planning is required to restore damaged lands and to protect water sources. Limited water supplies in western states complicate mining operations there. Land areas are required for waste materials disposal. Impacts on human health and safety from coal mining operations are well documented.

Transporting coal by rail contributes to noise and congestion in developed areas. Transporting slurry through proposed pipelines would raise a number of environmental, land use, social, legal, and political issues.

Power generation through direct coal burning is expected to account for 90% of coal power production through the year 2000. The major environmental concern with direct coal combustion is air pollution. Pollutants released into the atmosphere include sulfur dioxide, nitrogen oxides, particulates, hydrocarbons, and carbon monoxides. Sulfur dioxide and particulates can form sulfates which can be transported several hundred miles in the atmosphere and washed out in acid rain, impacting adversely on plant and animal life. Additionally, there is some concern for continued long-term emissions of carbon dioxide, which could cause global climate changes. Large quantities of fly ash and flue gas sludge result from coal combustion and create waste disposal problems. Coal gasification, liquefaction, and other advanced technologies are not expected to be developed extensively until after 2000.[5]

GAS

In 1978 gas-fired plants accounted for 86 percent of total generating capacity, and generated 79 percent of total electrical energy in ERCOT. Gas is used for base, intermediate, and peaking power.

While gas is the major generating fuel in ERCOT, its importance is expected to decline in future years. Conventional gas supplies are uncertain, and federal policy restricts the use of natural gas for power generation. ERCOT projects a decline in gas generating capacity over the 1978-87 period. In 1987, however, gas is still projected to account for 53% of total generating capacity.[6]

Natural gas is a clean fuel and is produced in ERCOT from conventional sources. Its use as projected would not involve additional environmental impacts. Use of natural gas from Alaska and Canada would require the construction of pipelines which have the potential to cause significant environmental damage. Production of natural gas from unconventional sources incurs possible contamination of groundwater sources and possible subsidence could result from withdrawals of large volumes of geopressured brines in the Gulf Coast.[7]

Over 80% of gas-fired generating capability is investor owned. Municipals own around 14%, cooperatives around 2%, and Lower Colorado River Authority (a state agency) around 3%.

3.2 ROLE OF EXISTING HYDROPOWER IN EXISTING ENERGY SYSTEM

Hydropower plays a small role in total electric power generation in ERCOT. Total hydroelectric capacity that can be considered, directly or indirectly, to be a part of the ERCOT system is around 370 MW. Table 3-1 shows hydroelectric plants in the ERCOT region. Only 6 of the 17 plants shown are listed by the reliability council as a part of their system. The plants shown are those belonging to the Lower Colorado River Authority. Capacity from Whitney, Denison, and Morris Sheppard are shown as imports to the system. Projects along the Guadalupe River account for 16.1 MW capacity. Falcon Dam and Eagle Pass plants sell power to an ERCOT member but are not shown as part of the system.

Lower Colorado River Authority (LCRA) is the major owner of hydropower capacity in ERCOT. Its 191 MW capacity accounts for 51% of total hydropower capacity shown in Table 3-1.[8] LCRA is a state agency providing electric power to 11 cooperatives and 33 cities in Central Texas. The agency owns a total of 1,503 MW capacity.

Federal power is generated at two Corps of Engineers plants, Whitney and Denison, and at Falcon Dam, an International Boundary Commission project. Power from Corps dams is marketed through the Southwestern Power Administration (SWPA), an agency under the US Department of Energy. The agency markets four basic classes of power to its customers: firm power, peaking power, interruptable capacity, and excess energy. The agency is phasing out firm power services as contracts expire since hydropower production marketed by SWPA is not well suited to such service. Peaking power contracts typically guarantee a minimum yearly usage of 1,200 hours per KW of peaking power. Interruptable capacity service generally involves a guaranteed capacity within a time range, but not for a specific time of production. Energy produced from water that would otherwise spill at reservoirs is marketed as excess energy. It is not a dependable source of power, and is marketed at an energy rate only, since the power does not reduce their capacity requirements.

PARAMETERS GOVERNING THE USE OF EXISTING HYDROPOWER

Since hydropower accounts for such a small percent of total electric power generation in ERCOT, its impact on total system operation is small. Water availability, multiple water use interests, and institutional arrangements are major parameters governing its production and use.

Water available in ERCOT is insufficient to permit continuous operation of hydropower plants. Additionally, there is considerable variation in annual rainfall, and the range of hydroelectric production can be wide. Thus, the dependable production at hydropower sites tend to be a small percent of average annual production.

As shown in Table 3-1, except for plants of Guadalupe-Blanco River Authority, hydropower plants are built as a part of a multipurpose system. In many cases, energy generation is scheduled with downstream demands for water supply rather than with the change in electric power demand. Additionally, rivers are operated as a system. Hydroelectric power, flood control, and other authorized purpose operations are made for mutual optimization. Water releases cannot always be timed when firm or peaking power is needed, and power produced from nonpower required releases is marketed at secondary power values, which are considerably less than the value of firm or peaking power. For the year ended 30 September 1979, over 40% of total energy sold from Corps projects in ERCOT was sold as excess energy.

A number of conflicts of interest are associated with hydroelectric production. Water releases for power generation result in wide and frequent variations in lake levels, and this has been objected to by sportsmen and property owners around lakes. Fluctuations in downstream flow has caused sloughing of stream banks, particularly in sandy areas.

Nearly all of the hydroelectric power plants in the ERCOT region have been developed by public entities. Lower Colorado River Authority (LCRA) operates its hydroelectric plants as a part of its larger generating system to market wholesale electric power and energy to 11 cooperatives and 33 cities in Central Texas. LCRA has no taxing authority and funds for operating its power facilities are generated from sales. Power rates for LCRA are subject to the approval of the Texas Public Utility Commission. Power from Federal projects is sold at cost of production. SWPA is required to market energy "in such a manner to encourage the most widespread use, consistent with sound business principles."[9/] The agency is also required to give preference to public bodies and cooperatives in marketing power.

Table 3-1
HYDROELECTRIC GENERATING PLANTS IN THE ERCOT AREA

SITE, STREAM, COUNTY	YEAR	PROJECT PURPOSES[2]	TYPE STORAGE[3]	DRAINAGE AREA (SQ MI)	EFFECTIVE HEAD (FEET)	CAPACITY (MW)	AVE. ANN ENERGY (GWH)	PLANT FACTOR
LOWER COLORADO RIVER AUTHORITY								
Alvin Wirtz, Colorado, Burnet	1928	H,I,S,R	RES	36,290	86	45.0	86	.21
Buchanan D, Colorado, Burnet	1938	H,S,R	RES	31,250	131	22.5	67	.33
Inks Dam, Colorado, Burnet	1938	H,S,R	RES	31,290	60	12.5	46	.42
Lake Travis, Colorado, Travis	1940	I,H,S	RES	25,250	170	67.5	200	.34
Max Starcke, Colorado, Burnet	1951	H,S,R	RES	36,325	56	30.0	56	.21
Tom Miller, Colorado, Travis	1938	H,S,R	RES	38,240	61	13.5	70	.59
GUADALUPE-BLANCO RIVER ATHORITY								
Abbott TP3, Guadalupe, Guadalupe	1928	H	RR	1,915	30	2.8	9	.37
Dunlap TPI, Guadalupe, Guadalupe	1928	H	RES	1,910	46	3.6	14	.43
Guadalupe-A, Guadalupe, Guadalupe	1927	H	RR	1,965	26	2.48	7	.33
Guadalupe-B, Guadalupe, Guadalupe	1932	H,R	RR	1,920	28	2.4	8	.38
H-4, Guadalupe, Gonzales	1931	H	RR	2,159	26	2.4	8	.37
H-5 Dam, Guadalupe, Gonzales	1931	H	RR	2,210	28	2.4	8	.37
BRAZOS RIVER AUTHORITY								
Morris Sheppard, Brazos, Palo Pinto	1941	H,I,S,R,O	RES	22,550	126	22.5	82	.41

Table 3 - 1 (continued)

SITE, STREAM, COUNTY	YEAR	PROJECT PURPOSES 2/	TYPE STORAGE 3/	DRAINAGE AREA (SQ MI)	EFFECTIVE HEAD (FEET)	CAPACITY (MW)	AVE. ANN ENERGY (GWH)	PLANT FACTOR
US GOVERNMENT CORPS OF ENGINEERS								
Denison, Red, Bryan, OK 5/	1944	C,H,S,N,O	RES	39,719	92	70	244.0	.39
Whitney Dam, Brazos, Bosque	1951	C,S,R,H	RES	26,600	92	30	72.4	.27
INTERNATIONAL BOUNDARY COMMISSION								
Falcon Dam, Rio Grande, Zapata	1969	C,I,H,R	RES	126,423	180	31.5	87.5	.32
CENTRAL POWER AND LIGHT								
Eagle Pass, Maverick, Maverick	N/A	H,I	RR	N/A	81	9.6	50.0	.59

1/ Only plants belonging to LCRA are listed as a part of the ERCOT system. Plants belonging to Brazos River Authority and Corps of Engineers are shown as imports to the system.

2/ I = Irrigation, H= Hydroelectric, C = Flood Control, N = Navigation, S = Water Supply, R = Recreation, O = Other.

3/ RES = Reservoir, RR = Run of River.

4/ Capacity as shown in Federal Power Commission, Hydroelectric Power Resources of the United States, Developed and Undeveloped. FPC-p43, Washington 1976.

5/ 1/2 in SWPP system.

FOOTNOTES

3/ Harza, Phase 1, Part II, Table IX-5, Page IX-7, Includes Hydropower

4/ US Department of Energy. "National Energy Plan II," Appendix, Environmental Trends and Impacts. Washington, DC, 1979.

5/ Ibid.

6/ National Electric Reliability Council.

7/ "National Energy Plan II," 1979.

8/ ERCOT shows 230 MW capacity in "Electric Reliability Council of Texas Report to the Department of Energy on Coordinated Bulk Power Supply Programs," San Antonio, Texas, April 1, 1980. Capacity reported here from FPC, Hydroelectric Power Resources of the United States, 1976.

9/ Federal Register, Volume 44, No. 150, August 2, 1979, p 45468. Statutory authority is Section 5 of the Flood Control Act of 1944. (58 Stat. 890, 16 USCA 825S).

REFERENCES

Harza Engineering Company, 1979, The Magnitude and Regional Distribution o Needs for Hydropower, Phase I, 1978 Electric Power Demand and Supply, Parts I and II. Draft Report: National Hydropower Study, Chicago, January 1979.

Harza Engineering Company, 1980, Phase II - Future Electric Power Demand and Supply, Draft Report: Chicago, March 1980.

National Electric Reliability Council, 1978, Eighth Annual Review of Overall Reliability and Adequacy of the North American Bulk Power Systems: Princeton, New Jersey, August 1978.

National Electric Reliability Council, 1979, Summary of Projected Peak Load, Generating Capability, and Fossil Fuel Requirements for the Regional Reliability Councils of NERC: Princeton, New Jersey, July 1979.

US Department of Energy, National Energy Plan II, Appendix II. Environmental Trends and Impacts, May 1979.

US Department of Energy, 1978, Proceedings Gulf Coast Lignite Conference; Geology, Utilization, and Environmental Aspects: W. R. Kaiser, ed., Austin, Texas, 1978.

US Water Resources Council, 1978, The Nation's Water Resources 1975-2000, Volume 4, Texas-Gulf Region: Washington, 1978.

Chapter 4

DEMAND SUMMARY

To define a reasonable range of future electricity demands, three electricity projections (Projections I, II, and III) are developed from published and readily available information and data on electric power demand forecasts.[10]

Projection I is derived from member utilities of ERCOT. Each NERC region is required to annually forecast electric demand and supply for the next 10 years and provide a "conceptual planning" projection for the following 10 years. The conceptual planning projection is for peak demand. The reports filed by the utilities through NERC to the Department of Energy on 1 April 1979 were used in this study.

Projection II is derived from forecasts made by the Institute for Energy Analysis (IEA) at the Oak Ridge Associated Universities in September 1976. The main finding of the IEA study is that both the Gross National Product (GNP) and energy demand are likely to grow significantly more slowly than has been assumed in most analyses of energy policy. From this study the annual per capita electric energy consumption growth rate in the United States is projected to be 2.6% for the period 1978-2000.[11]

Projection III is based on the "Consensus Forecast of US Electricity Demand." The electricity demand in the "Consensus Forecast" was derived from an average of 15 forecasts made by private and Federal economists in the post-embargo period. The forecasts are conservation oriented and do not reflect historical growth trends of the pre-embargo period. Based on this study, average annual growth in per capita electric energy consumption will increase at an average annual rate of 4.5% from 1978 to 1985 and decrease over the projection period to an average annual 3.2% for the 1995-2000 period.

Projections II and III are based on per capita electric energy growth rates. Adjusted OBERS population projections in Table 2-3, page 2-12, are used with Projections II and III to project total electric energy demand in ERCOT.

Projection I is projected as total electric energy demand to 1988. To project total electric energy demand to 2000 for the utility projection, peak load projections to 1998 are related to the projected 1985-88 load factor and extrapolated to 2000.

A summary of the Alternative projections is shown in Table 4-1.

Table 4-1

ALTERNATIVE ELECTRIC ENERGY DEMAND 1978 AND PROJECTED 1985-2000

	PROJECTION I*		PROJECTION II		PROJECTION III	
	TOTAL DEMAND (GWH) x 1000	PEAK DEMAND (GW)	TOTAL DEMAND (GWH) x 1000	PEAK DEMAND (GW)	TOTAL DEMAND (GWH) x 1000	PEAK DEMAND (GW)
1978	147.4	28.6	147.4	38.6	147.4	28.6
1985	206.2	41.3	195.8	39.2	222.6	44.6
1990	261.2	52.4	236.3	47.4	287.5	57.7
1995	328.0	65.8	279.6	56.1	351.9	70.6
2000	409.7	82.2	330.8	66.4	428.7	86.0
			FACTORS OF CHANGE FROM 1978			
1978	1.00	1.00	1.00	1.00	1.00	1.00
1985	1.40	1.44	1.33	1.37	1.51	1.56
1990	1.77	1.83	1.60	1.66	1.95	2.02
1995	2.26	2.30	1.90	1.96	2.39	2.46
2000	2.78	2.87	2.24	2.32	2.91	3.01

*Growth for ERCOT selected for analyses.

SOURCE: Harza Engineering, "The Magnitude and Regional Distribution of needs for Hydropower," Phase II, Exhibit IX-2, March 1980.

4.1 CAPACITY

Figure 4-1 presents alternative peak demand projections for ERCOT to 2000. Peak demand in 1978 was 28,600 MW, and the projections to 2000 range from 66,400 MW under Projection II to 86,000 MW under Projection III. Projection I, the utilities projection, is the median projection. Under Projection I peak demand is projected at 82,200 MW in 2000, increasing at an average annual rate of 4.9% over the 22-year period.

In 1978 existing capacity was 37,029 MW. Reserve margin was 29%. Projected reserve margin for ERCOT is 25% for 1985, 18% for 1990, and 17% for 1995 and 2000. Resources needed to serve the ERCOT system in 2000 are 96,200 MW, based on the median projection. To meet this demand, a net 59,200 MW of new capacity will have to be added to the system over the 1979-2000 period.

4.2 ENERGY

Total energy demand from the alternative projections are shown in Figure 4-2. Total energy demand in 1978 was 147,400 GWH. Projected growth in energy demand ranges from 330,800 GWH under the lower projection to 428,700 GWH under the highest projection. The median projection shows energy demand increasing to 409,700 GWH in 2000. As noted earlier, the median projection was used to analyze the need for hydropower development.

Demand for electric energy varies over the day, week, and year. Annual seasonal variations are represented by a summer peak, winter peak, and off- season load. Seasonal peak varies by region, but most regions, including ERCOT, experience the highest peak load in summer.

Figure 4-3 shows a weekly load curve representing summer peak load in ERCOT. Peak, intermediate, and base loads are designated on the figure. As defined for this study, base load is the mean minimum load of the Monday-Friday peak load period plus 10%.[12/] Peak load is defined as the greatest difference between the daily peak and the daily load equaled or exceeded 12 hours a day, Monday through Friday. The intermediate load is that portion between base load and peak load. It usually lasts from 12-14 hours beginning in the early morning and lasting until late afternoon. As shown in Figure 4-3, base load in ERCOT for 1977, is estimated at around 68% of the peak load demand, intermediate load at around 18% and peak load the remaining 14%.

4.3 PROJECTED GENERATION MIX

Table 4-2 shows the projected generating mix for total capacity needs discussed above. Both fuel and load mixes are shown. Gas, coal, and nuclear fuels are projected to provide the bulk of fuel requirements for

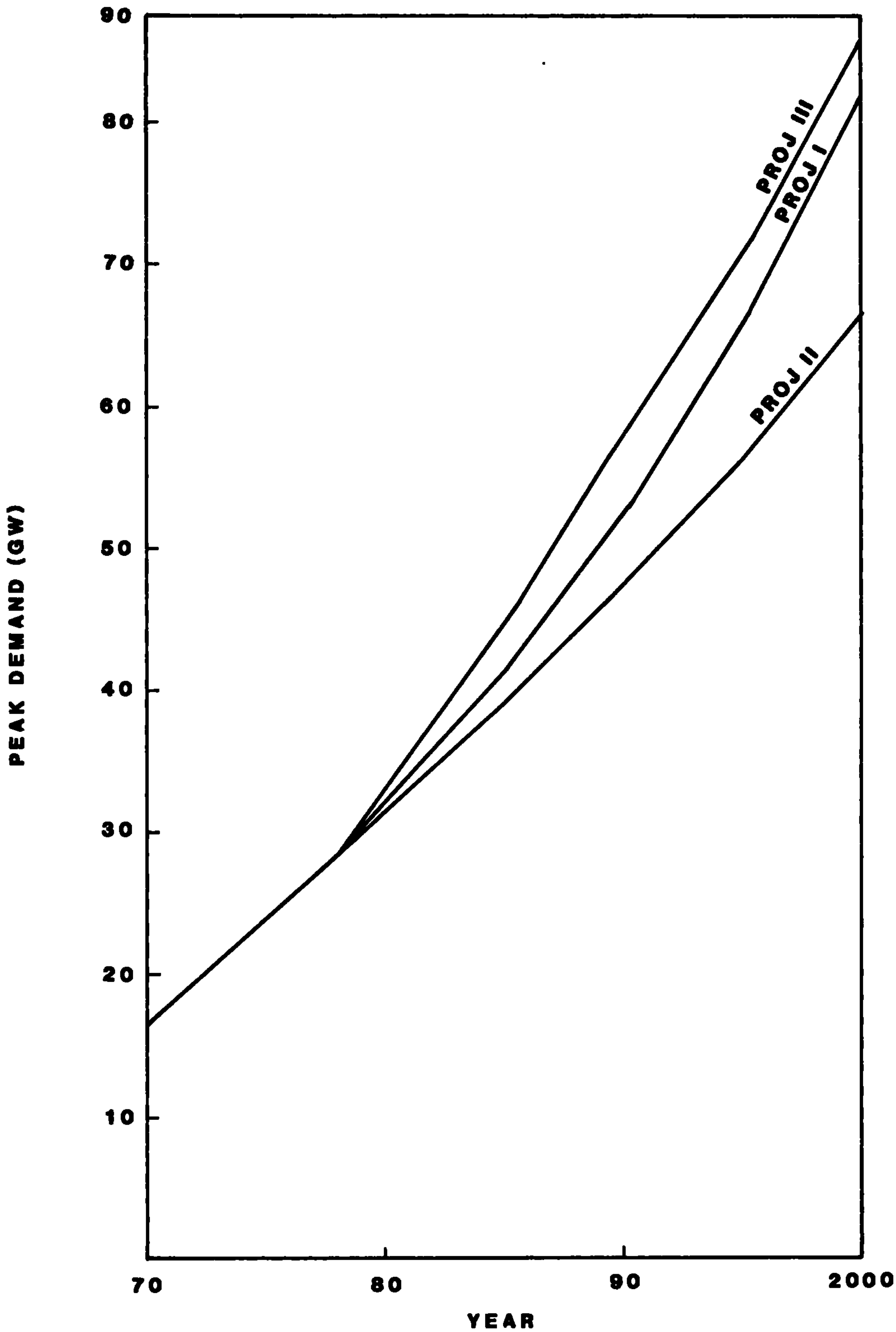


Figure 4 - 1
PEAK DEMAND

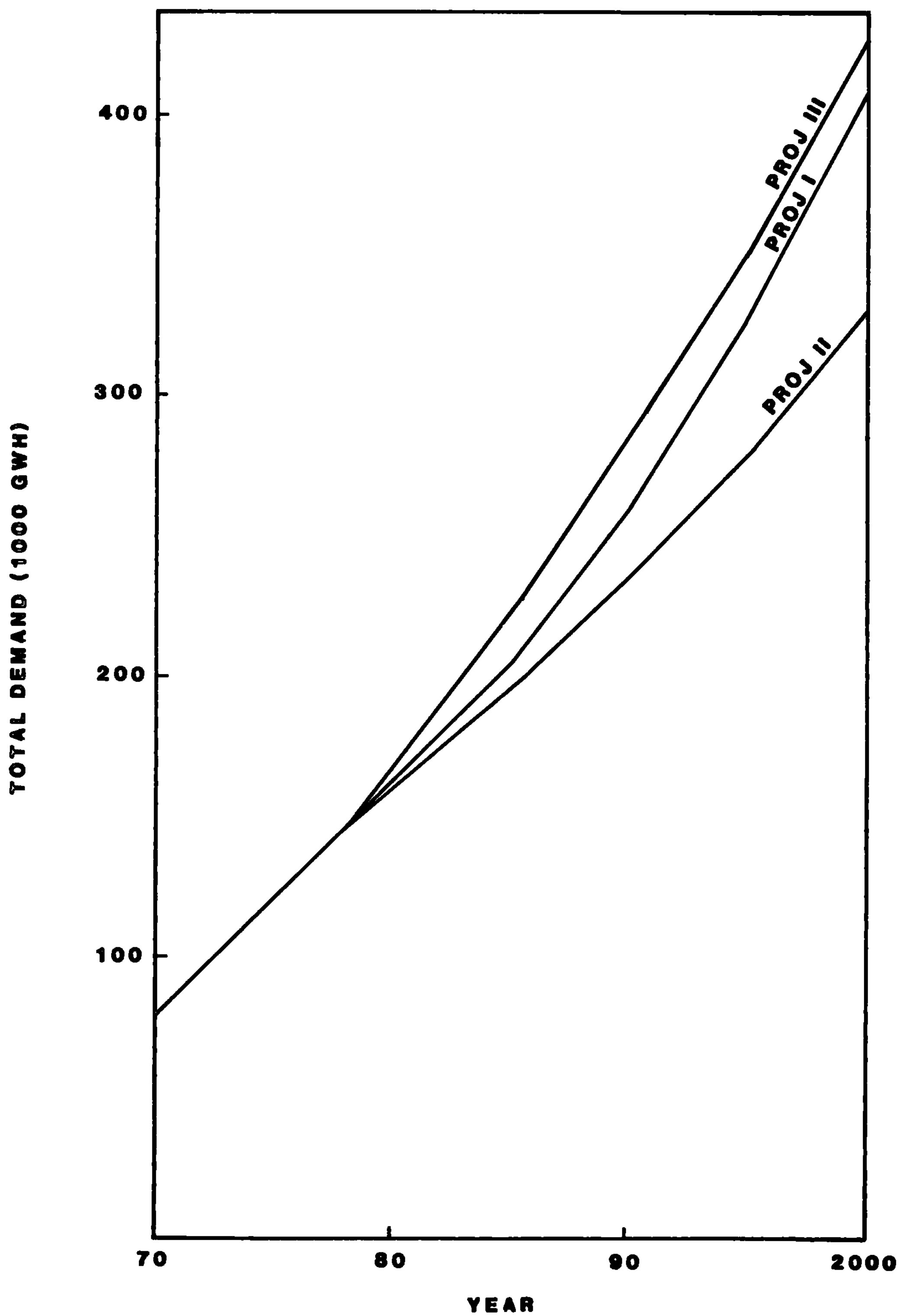


Figure 4 - 2
TOTAL DEMAND

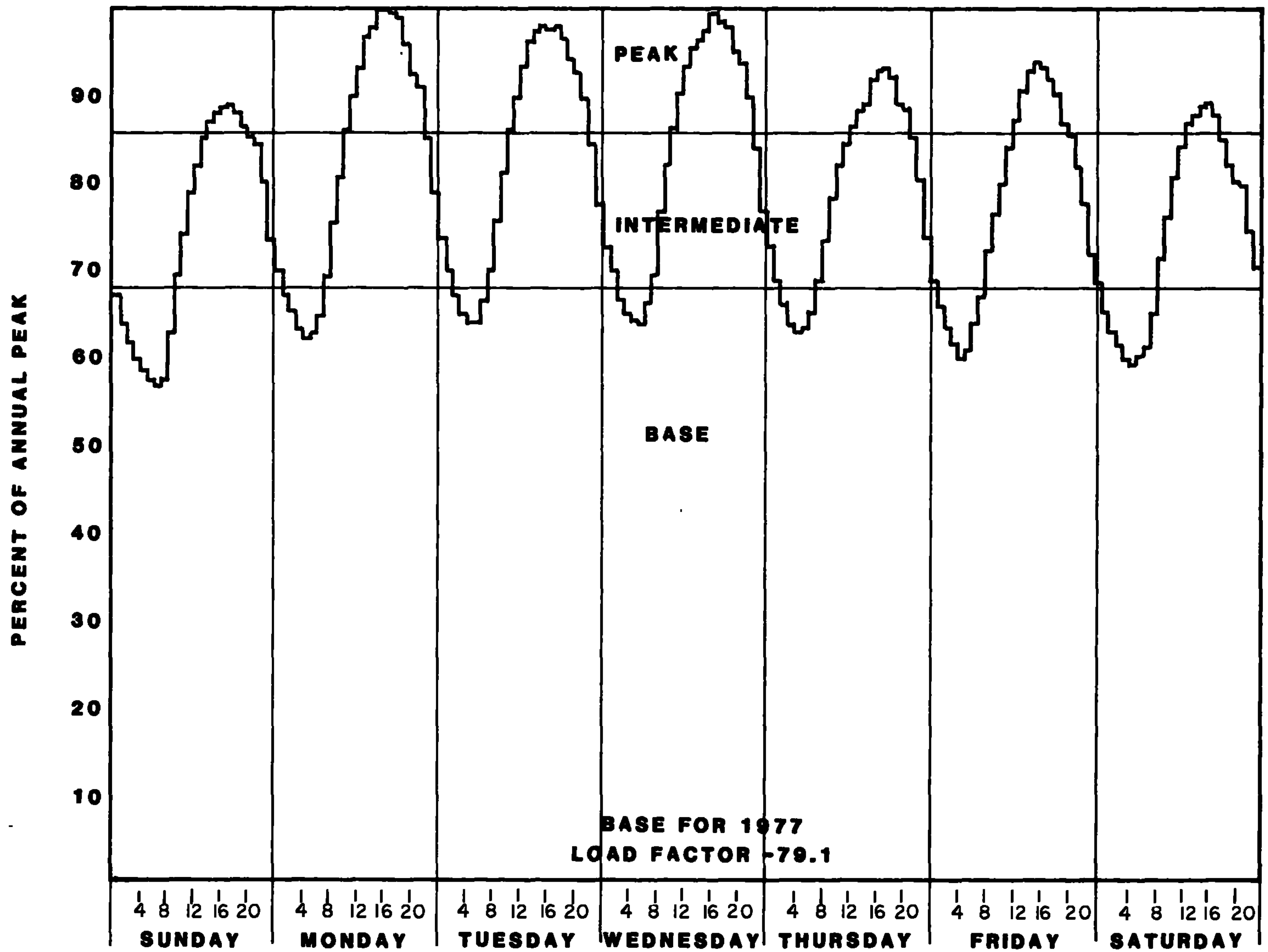


Figure 4-3
WEEKLY SUMMER LOAD CURVE
COMPOSITE FOR SELECTED UTILITIES IN ERCOT

Table 4-2

PROJECTED GENERATION MIX - ERCOT
(Percent of total capability)

GENERATION MIX	1985 %	1990 %	1995 %	2000 %
Base				
Nuclear	10-12	12-14	12-14	12-16
Coal	27-29	30-33	32-35	35-40
Gas	33-35	30-32	25-28	20-25
Intermediate				
Gas	15-17	15-17	15-17	14-17
Other	0	0	0	0
Peaking				
Gas	13-15	13-15	13-15	12-15
Oil	0-1	0-1	0-1	0-1
Conv. Hydro	0-1	0-1	0-1	0-1
Pumped Storage	0	0	0	0
Other	0	0	0	0
Total Capacity (MW)	51,600	61,800	77,000	96,200

SOURCE: Harza Engineering, "The Magnitude and Regional Distribution of the Needs for Hydropower," Phase II, P. IX-7.

electric generation in ERCOT. Conventional hydropower is projected to supply no more than 1 percent of total generating capability. See Figure 4-4 for changing patterns of generating fuel mix.

Conventional hydropower capacity is projected to range up to 500 MW in 1985, to 600 MW in 1990, to 800 MW in 1995, and to 1,000 MW in 2000. As shown in Chapter 3, existing hydroelectric capacity in ERCOT is 371 MW. The National Hydropower Study has identified 19 developed sites and 33 undeveloped sites with an estimated potential capacity of 604 MW. Table 4-3 shows a distribution of potential hydropower identified in the study. Methodologies used in estimating developable hydropower are discussed in the following chapter.

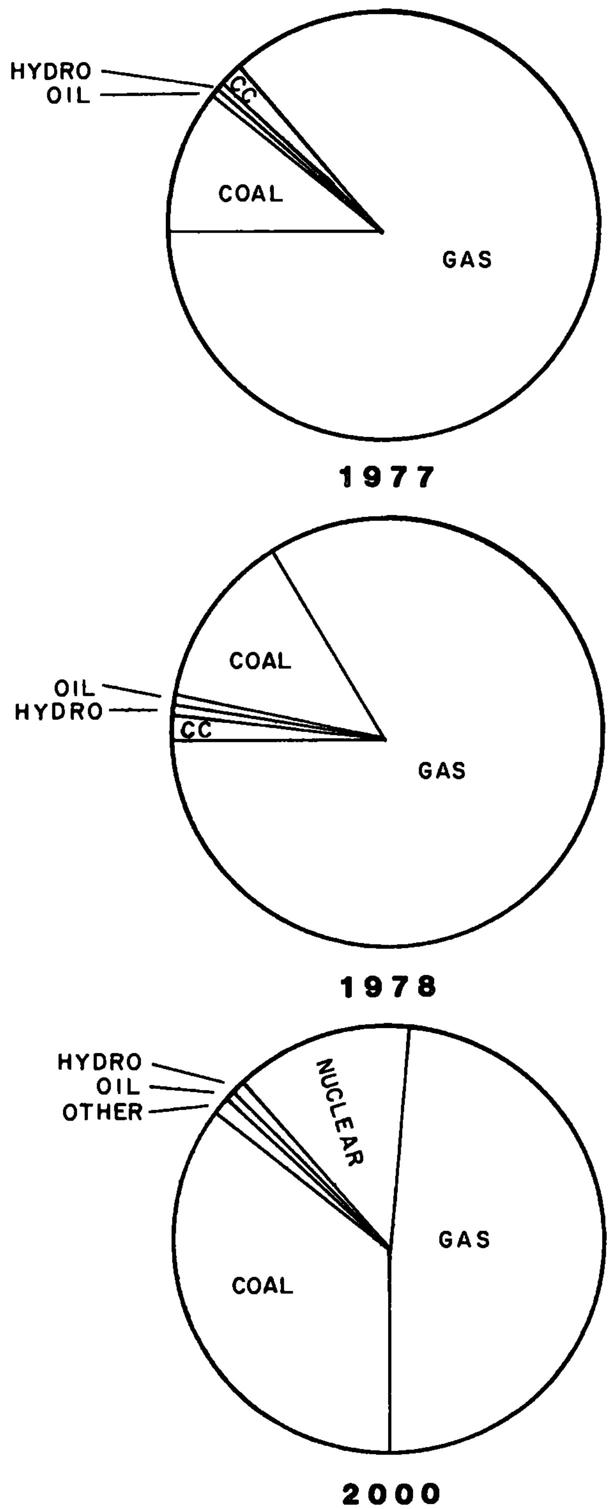


Figure 4 - 4

GENERATING CAPACITY BY FUEL SOURCE - ERCOT
1977, 1978 AND PROJECTED 2000

Table 4-3

POTENTIAL HYDROPOWER DEVELOPMENT

SITES		CAPACITY MW	ENERGY[1/] GWH	PLANT FACTOR
		EXISTING PROJECTS - NO POWER		
Reservoir:	18	136.3[2/]	285.9[2/]	.24
Run of River:	1	1.1	6.8	.71
Total:	19	137.4	292.7	.24
		UNDEVELOPED SITES		
Reservoir:	32	453.8	906.4	.23
Run of River:	1	12.6	43.2	.39
Total:	33	466.4	949.6	.23
Grand Total:	52	603.8	1,242.3	.23

1/ Average annual

2/ Includes estimates for Amistad from Federal Power Commission, Hydroelectric Power Resources of the United States, Developed and Undeveloped, Washington, January, 1976. Values are 80 MW capacity and 156,000 GWH average annual energy.

FOOTNOTES

10/ This section is adapted from pages 4 and 5 of Harza Engineering, "The Magnitude and Regional Distribution of Needs for Hydropower, The National Hydropower Study," Phase II. The source of Projection I is "Regional Electric Reliability Council," Reply to Appendix A-2 of Order No. 383-5. Docket R-362, April 1, 1979. Source for Projection II is Institute for Energy Analysis, "US Electricity Supply and Demand for the year 2000," Oak Ridge National Laboratory, May 1977. Source for Projection III is J. A. Lane, "Consensus Forecast of US Electricity Supply and Demand to the year 2000," Oak Ridge National Laboratory, May 1977.

11/ This is the lower of two forecasts made in the IEA study.

12/ The 10% addition provides for the fact that baseload can be cycled, and that maximum efficiency occurs at less than full load. Harza, II, p 121.

Chapter 5
METHODOLOGY

5.1 PROCEDURES AND CRITERIA

The evaluation of potential hydropower sites was accomplished through a series of computation and screening stages. These stages were designed to apply more detailed and accurate analyses to a successively smaller number of potential sites. The first stage of analysis and screening was based only on the physical power potential at the site and was used essentially to determine which sites would be included in the NHS preliminary computer data base. The second stage provided for a hydrologic, power, energy, and economic analysis and a screening based on both power potential and benefit-to-cost ratio. During this stage, only the specific power facilities (i.e., turbines, generators, powerhouse, etc.) were considered in the economic analysis. The third stage consisted of two distinct phases. The first phase allowed for much improved power, cost, and benefit analyses. The second phase of stage three involved collection of available information on the environmental, social, and institutional impacts and the general public attitude toward development of the hydropower potential at sites remaining after the first phase screening.

The final stage of preparation for presentation of information on hydropower potential in the regional report consisted of three major elements: first, identification of that potential which might be developed in the near future (by 1990) as opposed to that which might be developed thereafter; second, ranking of projects by several criteria which might indicate the relative merit or probability of development; and third, showing how this potential might be utilized in meeting the projected power and energy needs of the region.

In the first stage, extensive use was made of the existing computer data base developed by the Corps in a National Program of Inspection of Dams. For purposes of the National Hydropower Program, the earlier data base provided name, location, maximum storage capacity, and maximum hydraulic height of dam for some 49,500 existing dams. Since drainage area and flow data were not given, some assumptions had to be made which would allow a relative assessment of the potential at each site. The assumptions used were based on the rationale that height of dam and storage capacity provided in the construction of the dam would give some indication of the flow at the dam. The assumptions used were: that continuous flow would be available sufficient to refill the maximum storage capacity of the reservoir in each 24-hour period; that this flow could be converted to power with a net head equal to the maximum hydraulic height of the dam; and that the combined efficiency of this conversion would be 85%. Thus the equation:

$$KW = \frac{QHE}{11.8} = 0.072\ QH$$

where KW = power in kilowatts

Q = flow in cubic feet per second

H = net power head in feet

E = efficiency

Since one acre-foot yields approximately 0.5 cubic feet per second for a 24-hour period,

$$KW = 0.072 \times 0.5\ SH = 0.036\ SH$$

where S = storage in acre-feet

This computation, with its associated assumptions, gave an extremely optimistic estimate on power potential for most dams. Therefore, the screening level based on these results was 1,000 KW. Data on all existing dams which met these screening criteria were transferred by machine to the National Hydropower data base. Data on undeveloped sites which met these screening criteria were coded by field personnel, keypunched, and added to the National Hydropower data base. Undeveloped sites were identified from previous studies by local, State, and Federal water resources agencies.

Information required for the second stage screening were: power potential in KW; average annual energy in KWH; annual costs for construction, operation, and maintenance of the power features of the projects; and annual benefits from the power potential. Annual benefits were computed in each case based on the power potential, the average annual energy, the average annual plant factor, and regionalized unit benefit values provided by the Federal Energy Regulatory Commission. Annual benefits were computed in each case based on parametric cost estimating curves developed for this purpose which related construction costs of the power features to power potential in KW and design head for the project. Allowances for contingencies, engineering, design, supervision, and administration were added to the construction cost to determine a total investment cost. The total investment was annualized assuming a 50-year life and an interest rate of 6 5/8%. Estimated annual costs of operation, maintenance, and major replacement were then added to the annual investment cost to determine the total annual project cost.

In order for the computer program to compute the costs, benefits, power potential, and the average annual energy, the average net power head (assumed to be the design head) and the FERC benefit region must be determined. The field personnel were given three options for providing this information. First, information from a previous study could be entered into the data base. Second, a field estimate performed specifically for this study could be entered. Third, sufficient basic data to allow machine computation of this required information could be entered into the data base along with a coded request for machine computation. Basic data required for the third option included drainage area above the site, the average net power head, and a selected representative US Geological Survey streamflow gage.

Field determination of the drainage area was mandatory. However, options were given on the other two items. In the event the average net power head was not estimated by the field, a machine determination was made based on either the maximum hydraulic height of dam (mandatory) or on the height to normal retention (optional). Assumptions made in the machine selection resulted in an average net head equal to 85% of the height to normal retention, when given, or to 72.25% of the maximum hydraulic height of dam when the height to normal retention was not given. In the event that field personnel opted not to select a representative USGS flow gage, the latitude and longitude of the dam site were required as input data. Given drainage area, latitude, and longitude, the computation routines automatically selected a gage representative of the dam site.

Given an average net power head and a representative streamflow gage, the machine computations proceeded as follows: historical daily flows at the representative gage site were converted to a flow-duration curve; the gage flow-duration curve was transferred to the dam site by a simple drainage area ratio; and the resulting dam-site flow-duration curve was converted to a power duration by multiplying each flow ordinate by the average net power head and a conversion factor of 1/11.8 or 0.08475.

For each of 10 points on the power duration curve ranging from the value exceeded 95% of time to 5% of time, the following computations were performed: average annual energy was assumed to be equal to the area of the power-duration curve below the selected power ordinate; average annual plant factor was computed using the selected power value and the average annual energy; unit capacity and energy values were selected from the FERC power benefit curves and multiplied by the selected power value and average annual energy to obtain annual benefits; total annual power costs were computed, as stated above, based on the selected power and the average net head; and benefit-to-cost ratio and annual net benefits were calculated.

A curve was fitted to the 10 values of annual net benefits obtained above and the point of maximum net benefits within the range of investigation (5% to 95% exceedance) was determined.

The power potential and average annual energy computed at this point of maximum net benefits were selected for subsequent screening and were printed in our report "National Hydroelectric Power Resources Study - Preliminary Inventory of Hydropower Resources" (July 1979) for those projects with power potential greater than 50 KW and a benefit-to-cost ratio greater than one.

Table 5-1 shows the regionalized benefit rates for ERCOT as provided by FERC on 23 June 1978.

Tables 5-2 and 5-3 show the parametric cost data for power features which were used in the second stage computer analyses.

Additional data were gathered for sites passing stage two screening to permit more refined estimates of costs, energy potential, and benefits associated with hydropower development. Additional physical data gathered

Table 5-1

FERC REGIONAL POWER VALUES

ERCOT

APF 1/	CAPACITY 2/	ENERGY 3/
0	39.8	.0
10	29.3	29.8
20	29.3	23.8
30	65.9	22.6
40	65.9	21.1
50	119.1	9.4
60	119.1	9.6
70	119.1	9.7
80	119.1	9.8
90	119.1	9.9
100	119.1	9.9

1/ Annual plant factor.

2/ Capacity benefit in dollars per kilowatt.

3/ Energy benefit in mills per kilowatt hour.

NOTE: Federal Energy Regulatory Commission power values are for January 1978.

Table 5-2

PRELIMINARY COST CURVES

SINGLE UNIT POWER PLANT COST DATA (.1-10 MW)

($1,000)

DESIGN HEAD (FEET)

INSTALLED CAPACITY (MW)	10	20	30	40	50	60	70	80	90	100
.1	$145	$90	$64	$44	$41	$38	$36	$33	$30	$26
.2	185	130	80	52	49	46	42	39	36	32
.3	230	150	95	61	57	53	49	45	41	37
.4	300	180	115	71	67	62	57	53	49	44
.5	370	210	135	84	77	70	64	59	54	50
.6	470	260	160	98	91	84	77	71	65	60
.7	600	300	180	110	103	96	90	83	74	69
.8	760	340	210	131	122	113	105	96	87	79
.9	960	390	250	160	147	134	122	113	105	97
1.0	1,200	440	280	180	167	153	140	131	122	114
2.0	1,450	1,000	810	640	582	526	470	441	413	385
3.0	1,800	1,550	1,450	1,400	1,306	1,213	1,120	1,040	966	890
4.0	2,300	2,100	2,100	2,100	2,040	1,970	1,900	1,800	1,700	1,600
5.0	3,200	3,100	3,100	3,100	2,980	2,870	2,750	2,630	2,500	2,400
6.0	4,600	4,100	4,100	4,100	3,983	3,870	3,750	3,600	3,450	3,300
7.0	5,800	5,300	5,300	5,300	5,170	5,030	4,900	4,730	4,570	4,400
8.0	7,000	6,700	6,700	6,700	6,530	6,370	6,200	6,000	5,800	5,600
9.0	8,700	8,200	8,200	8,200	7,970	7,730	7,500	7,270	7,030	6,800
10.0	10,000	10,000	10,000	10,000	9,570	9,130	8,700	8,430	8,170	7,900

NOTE: Cost items vary somewhat with type of unit. Cost items considered include excavation, bulkheads, turbine, generators, accessory electrical equipment, auxiliary mechanical systems, and contractor mobilization and preparation, intake works, and if applicable, intake and tailrace gantry crane and powerhouse bridge crane.

Table 5-3

SINGLE UNIT POWER PLANT COST DATA (10-200 MW)

($1,000)

DESIGN HEAD (FEET)

INSTALLED CAPACITY (MW)	10	20	30	40	50	60	70	80	90	100	200	300	400	500	600	700	800
10	10,000	10,000	10,000	10,000	9,570	9,130	8,700	8,430	8,170	7,900	6,400	5,600	5,400	5,300	5,200	5,100	5,000
20	-	15,000	15,000	15,000	14,400	13,800	13,200	12,400	11,600	10,800	7,400	6,700	6,500	6,200	6,100	6,000	5,900
30	-	-	18,500	18,500	17,530	16,570	15,600	14,500	13,400	12,300	8,800	8,000	7,200	7,200	7,000	7,000	6,700
40	-	-	-	20,000	19,170	18,330	17,500	16,330	15,170	14,000	10 000	9,300	8,500	8,100	8,000	8,000	7,900
50	-	-	-	25,000	23,170	21,330	19,500	18,170	16,830	15,500	11,400	10,200	9,500	9,000	8,900	8,700	8,600
60	-	-	-	28,500	26,270	24,033	21,800	20,370	18,930	17,500	13,000	11,000	10,400	10,000	9,900	9,700	9,100
70	-	-	-	31,500	29,000	26,500	24,000	22,600	21,200	19,800	14,100	12,800	11,500	11,000	10,800	10,400	10,200
80	-	-	-	35,000	32,170	29,333	26,500	25,000	23,500	22,000	13,500	13,500	12,500	11,900	11,200	11,000	10,900
90	-	-	-	38,000	35,000	32,000	29,000	27,330	25,670	24,000	17,000	14,500	13,000	12,700	12,100	12,000	11,800
100	-	-	-	41,000	37,830	34,670	31,500	29,660	27,830	26,000	18,100	15,500	14,000	13,300	12,900	12,600	12,200
120	-	-	-	47,000	44,000	41,000	38,000	36,330	34,670	33,000	21,000	18,000	16,000	15,000	14,600	14,000	13,500
140	-	-	-	53,000	50,000	47,000	44,000	42,000	40,000	38,000	24,000	20,000	17,800	16,700	16,000	15,300	15,000
160	-	-	-	-	-	-	-	-	-	43,000	26,800	21,600	19,000	17,500	17,000	16,500	16,000
180	-	-	-	-	-	-	-	-	-	48,000	29,500	23,500	20,800	19,400	18,300	17,800	17,000
200	-	-	-	-	-	-	-	-	-	53,000	32,000	25,500	22,500	20,800	19,700	18,700	18,100

Note: Cost items vary somewhat with type of unit. Cost items considered include excavation, bulkheads, turbine, generators, accessory electrical equipment, auxiliary mechanical systems, contractor mobilization and preparation, intake works, and, if applicable, intake and tailrace gantry cranes and powerhouse bridge crane. Curve for larger (Francis) units do not include intake works.

permitted a more accurate estimate of water surface evaporation losses, storage, and elevation relationships, and tailwater elevation and discharge relationships. In this stage, diversions for other uses were also considered to more accurately estimate flow for hydropower production. Added physical data on undeveloped sites also permitted more complete cost estimates.

Dependable capacity benefits were taken for capacity for which flow was available 85% of the time. The remaining capacity was assigned a benefit of one-half the value per KW of dependable capacity.

During this phase, the total cost of development (i.e., dams, reservoirs, relocations, etc.) was estimated for each undeveloped site. Field office personnel were given considerable latitude in judgment during this phase; hydrologic analysis could be specified as either a flow-duration technique or as a sequential analysis using average monthly inflows; capacity selection could be based on maximum net benefits, minimum cost per unit of energy, average annual plant factor, or as the result of some previous study of power potential at the site; and cost estimates could be refined by field input of certain specific cost items unique to the site.

Field judgment was also used in this stage to screen projects based on size, since interest in smaller size potential projects varies in different regions of the country.

The second phase of stage three involved collection of available information on the environmental, social, and institutional impacts and the general public attitude toward development of the hydropower potential at sites remaining after the first phase screening. Public meetings were held throughout the country as well as meetings with interested individuals, groups, and representatives of state governments.

The screening of projects during the second phase of stage three was essentially by judgment of Corps district personnel based on the information available, the response from public meetings, the recommendations of state agencies, and the experience of working intimately in the development of water resources of the region.

The computation procedures for stage three are covered in detail in Volumes XII and XIII of the final NHS report.

5.2 REGIONAL DEMAND ASSESSMENT

The primary objectives for assessment of the current and projected demands for power and energy within the Electric Realiability Council of Texas were to show that the production from potential hydropower development could be used to meet specific segments of the projected need and to indicate the type and amounts of alternative fuel consumption which might be foregone.

Presentation of needs is based on the information developed for this report under one of the Policy and Technical Overview Studies contracts for the National Hydropower Study. Complete documentation of this contract effort is included in Volumes III and IV of this report.

Specific contract products include: hourly loads for representative weeks (weekly load shapes) for representative utilities within each ERC; cumulative ERC projections of annual peak loads and annual load factors; suggested techniques for adjusting current load shapes to represent future load shapes (primarily an adjustment of annual load factor); and suggested techniques for "placing" potential hydropower within the future load shape.

The first three products have been utilized in our assessment of the ERCOT demands. However, the technique suggested for placing potential hydropower on the future load shape, as suggested by the contractor, depends too heavily on the availability of data on the seasonal characteristics of the available power production.

The flow-duration technique developed for analysis of power potential for the NHS provides average annual characteristics. Consequently, a method for indicating annual demand characteristics has been developed which utilizes the basic load shape data furnished by the contractor. For the ERCOT region, hourly loads presented for the representative utilities have been added to produce composite load shapes for three representative weeks of the year. These hourly load shapes were then converted to weekly load-duration curves. Figures 5-1 through 5-3 show hourly load shapes and weekly load-duration curves for representative summer, winter, and off-season weeks, respectively. The weekly load-duration curves were then combined to represent an annual load-duration curve by weighting each weekly curve by the duration of the season for which that week represents (i.e., x-weeks of summer, y-weeks of winter, and z-weeks off-season).

The resulting annual load-duration curve was then adjusted to match the projected regional peak and annual load factor for 1990 and 2000. In this form, the annual characteristics of existing, near-term, and long-term potential power developments can be indicated in relation to their placement on the future load shapes. Figure 5-4 shows the 1990 load shape with existing projects and near-term potential projects occupying the upper peaking and intermediate portions of the load shape. Figure 5-5 shows the projected load shape for 2000 with existing plus near-term and long-term potential occupying the upper portion of the load. In this figure it is assumed that near-term potential will be a part of the existing system by the year 2000.

This presentation should only be considered as a rough indication of the placement of potential hydropower on the projected future load shape since the actual placement can only be determined by detailed operational studies which are clearly beyond the scope of detail utilized in the National Hydropower Study.

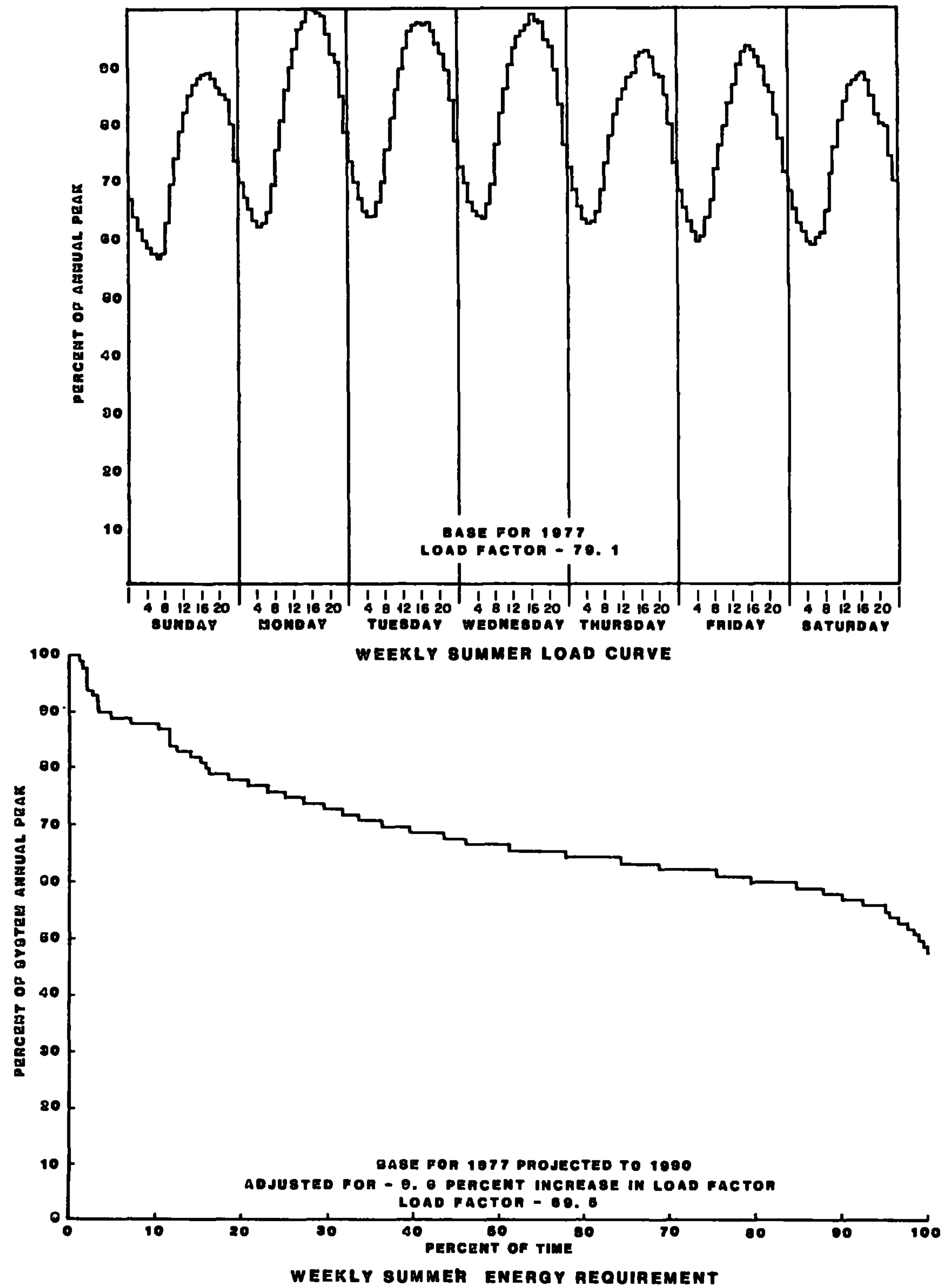
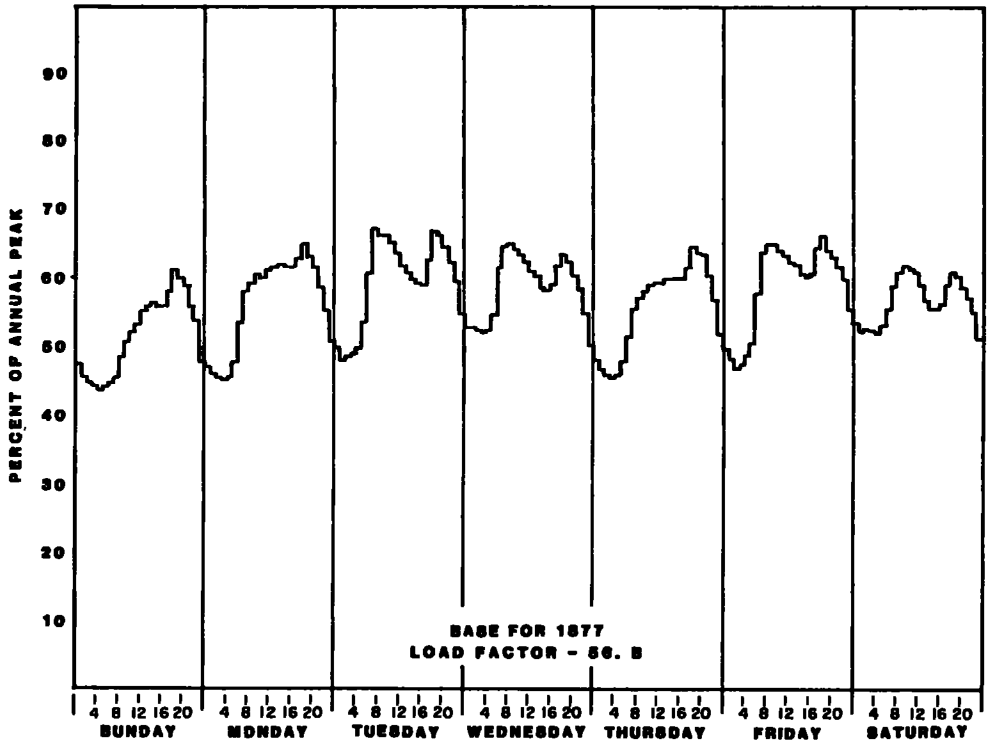
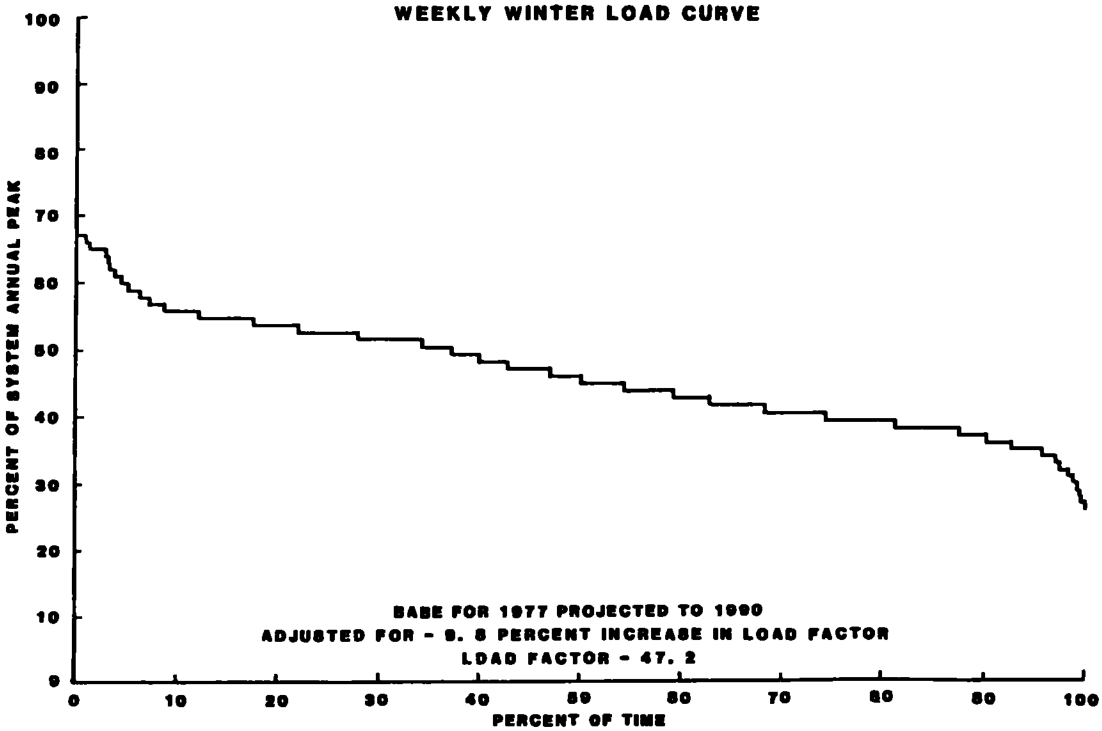


Figure 5-1

WEEKLY SUMMER LOAD CURVE AND ENERGY REQUIREMENT

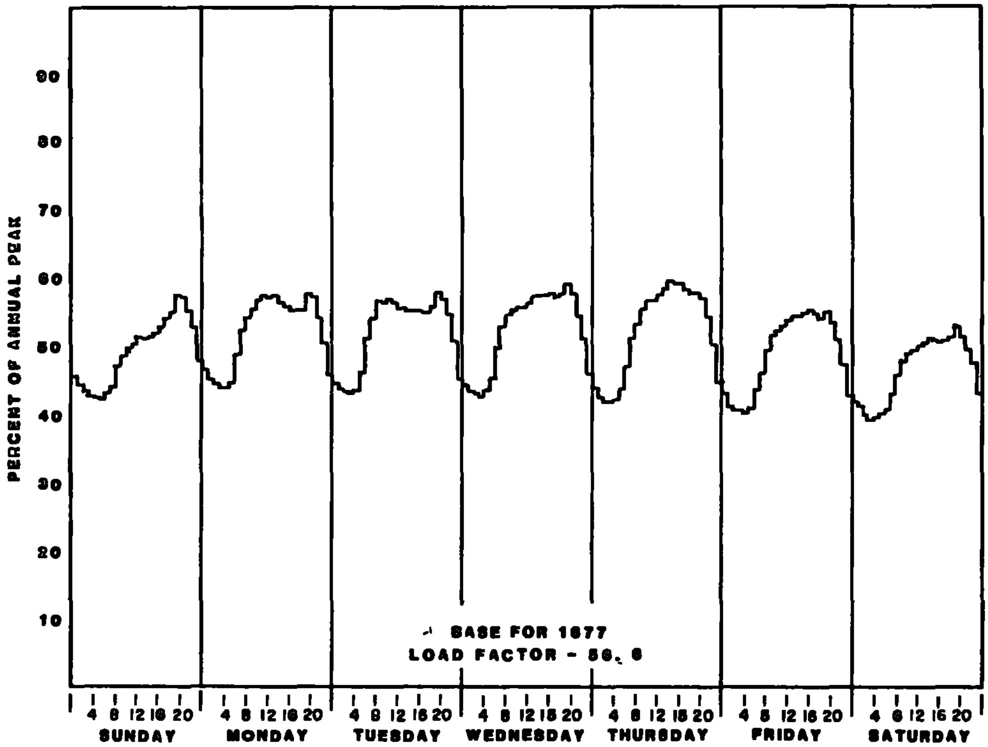


WEEKLY WINTER LOAD CURVE

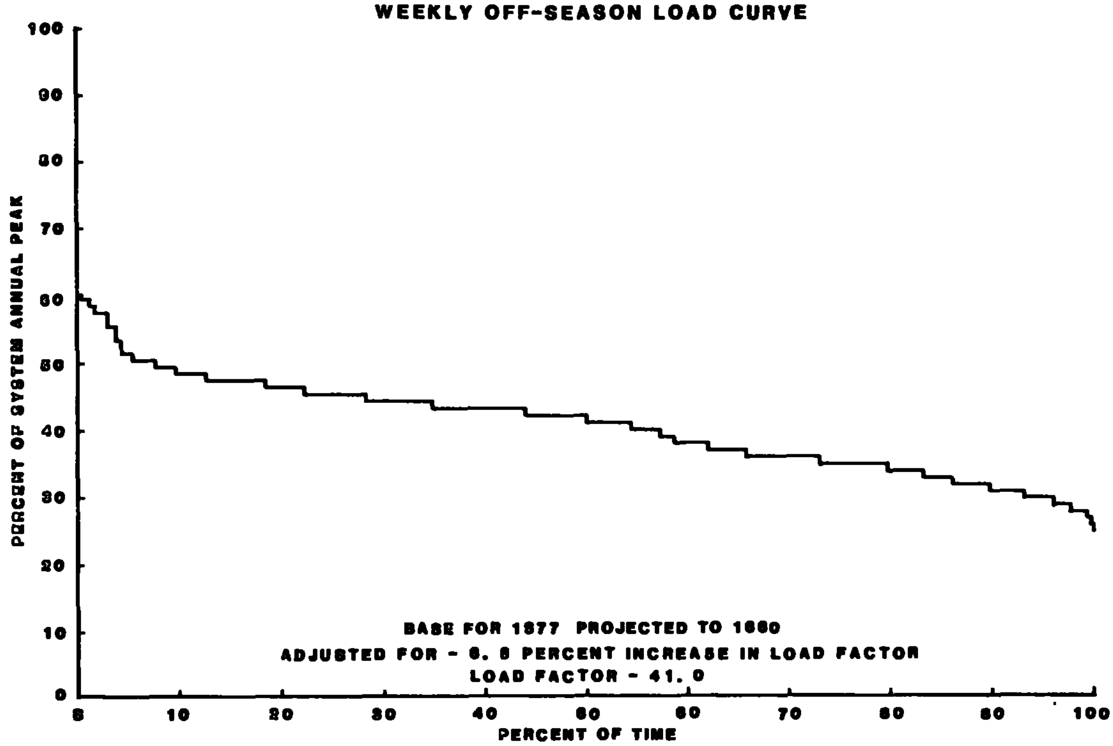


WEEKLY WINTER ENERGY REQUIREMENT

FIGURE 5-2
WEEKLY WINTER LOAD CURVE AND ENERGY REQUIREMENT



WEEKLY OFF-SEASON LOAD CURVE



WEEKLY OFF - SEASON ENERGY REQUIREMENT

FIGURE 5-3

WEEKLY OFF-SEASON LOAD CURVE AND ENERGY REQUIREMENT

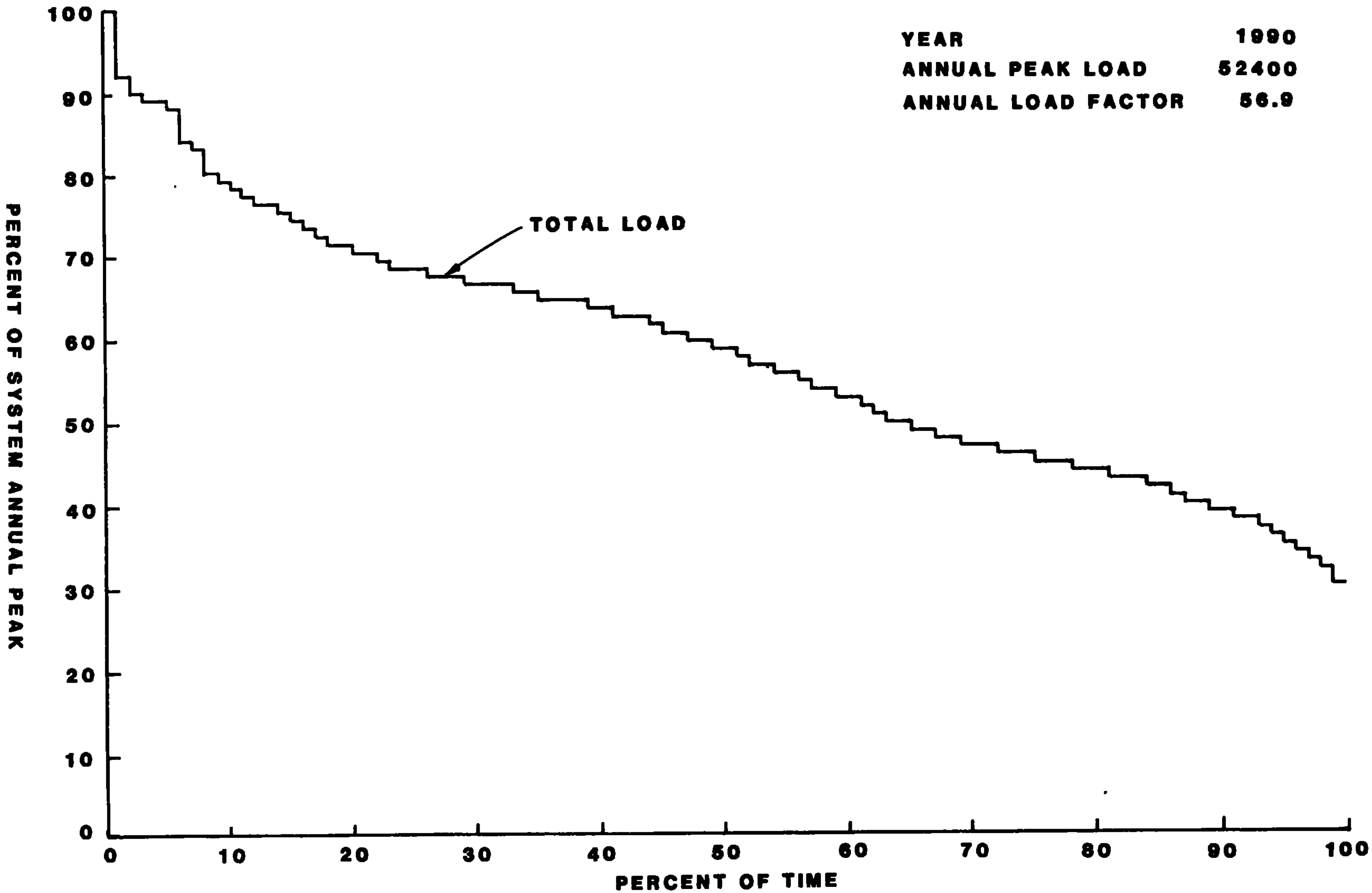


Figure 5-4
YEARLY ENERGY REQUIREMENT (LOAD SHAPE)
COMPOSITE FOR SELECTED UTILITIES IN ERCOT

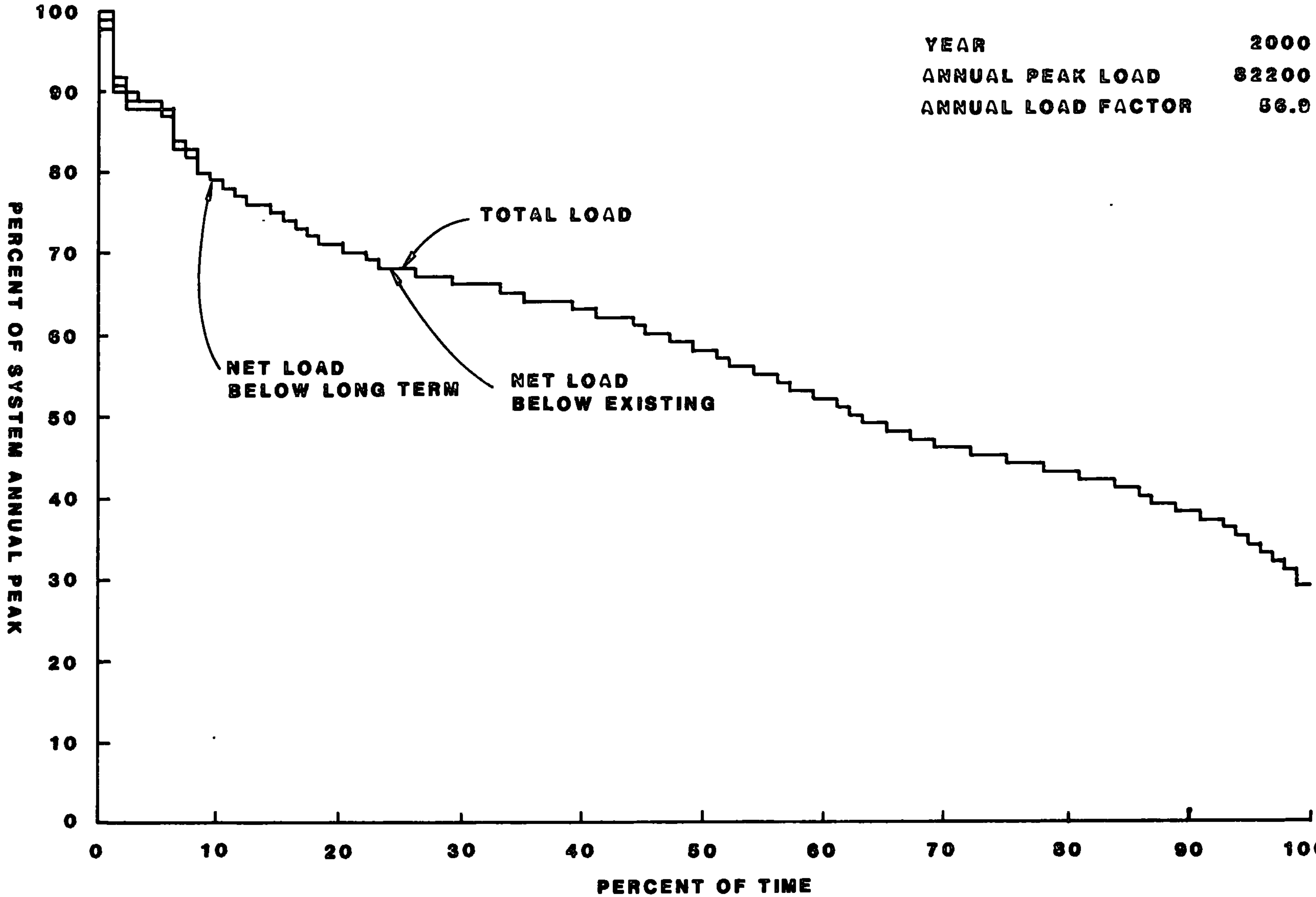


Figure 5-5
YEARLY ENERGY REQUIREMENT (LOAD SHAPE)
COMPOSITE FOR SELECTED UTILITIES IN ERCOT

5.3 PRESENTATION OF SPECIFIC PROJECT DATA

Pertinent information on all projects which passed the second stage screening is given in Attachment C to this report. Those sites which survived both phases of the stage three screening process are shown in Table 5-4. A map showing the locations of these sites accompanies this report.

Ranking numbers have been given to each of the remaining projects in order to indicate the relative unit cost of potential energy; the relative adversity of impacts associated with project development; and the relative probability of development of projects within two time frames (i.e., near-term and long-term). No projects with existing hydropower have been included in the final rankings.

The first of these rankings (the economic ranking by mills/KWH or $/MWH) was based on the assumptions that only retrofit of existing dams or additional provisions at dams currently under construction could be achieved within the next 10 years (near-term) and that potential developers would be interested in developing this resource at projects where the unit cost of energy is shown to be 50 mills/KWH or less. The selection of 50 mills/KWH is based on alternative costs of developing power in ERCOT. Attachment A shows the equivalent total power value of hydro at various capacity factors, as of January 1978. Consequently, the near-term economic ranking applies to those existing or under construction projects where the indicated cost of energy is less than 50 mill/KWH. The long-term economic ranking applies to undeveloped sites and for existing projects where the cost of retrofit is indicated to exceed 50 mills/KWH. There are 9 projects in the near-term economic ranking with numbers 1001 through 1009. There are 43 projects in the long-term economic ranking with numbers 2001 through 2043. Computer results on average annual cost and average annual energy were used in this ranking process.[13/]

The "noneconomic" ranking is essentially the same as the economic ranking. However, projects with moderate environmental or social impacts have been moved to the bottom of the near-term and long-term lists. Projects with significant impacts were screened out in the second phase of stage three. Indications of moderate impacts were given by district representatives during a project ranking workshop held in the Southwestern Division Office on 9 July 1980.

The "composite" ranking was developed during the project ranking workshop in the following manner. First, each district with projects within the SWPP region developed a district priority ranking of their projects based on economics, impacts, status of project study, and public or political interest in the particular project. A competitive process was then established where each district matched its first priority project against the others. This group of projects was discussed and a "winner" selected. The winning district then matched its second priority project against the remaining first priority projects of the other districts and a second "winner" was selected. This process continued until all projects were selected in order,

Table 5-4

SITES WITH POTENTIAL FOR HYDROPOWER DEVELOPMENT
NATIONAL HYDROELECTRIC POWER STUDY

SITE ID NUMBER	PROJECT NAME	PRIMARY COUNTY	INCREMENTAL CAPACITY (KW)	INCREMENTAL ENERGY (MWH)	INCREMENTAL COST ($/MWH)	RANKING NUMBER ERC REGION ECON	NON-ECON	COMP
TX6SWF0004	TENNESSEE COLONY DAM	ANDERSON	17900	77745	656,82	2029	2029	2023
TX6SWG0555	WEST POINT	BASTROP	22850	55354	259,61	2019	2019	2007
TXCSWF0005	BELTON DAM	BELL	16000	26920	61.247	2002	2002	1001
TXCSWF0006	STILLHOUSEHOLLOW DA M	BELL	2780	6016	48.894	1007	1006	1008
TX6SWF0014	BEE MOUNTAIN	BOSQUE	2150	6795	792,35	2032	2032	2024
TX6SWF0020	TANYARD CROSSING DAM	BURNET	3350	4550	4685.0	2041	2041	2030
TX6SWF0026	WECHES DAM	CHEROKEE	15622	49869	412,86	2024	2024	2015
TXCSWF0032	LAVON DAM	COLLIN	1080	2223	61.248	2003	2003	1011
TX6SWG0558	ALTAIR	COLORADO	14193	43492	178,60	2014	2014	2004
TX6SWG0557	COLUMBUS BEND RES	COLORADO	66222	56072	187,10	2015	2015	2005
TXCSWF3402	CANYON DAM	COMAL	6604	18631	30.818	1002	1002	1002
TX6SWF4423	AUBREY DAM	DENTON	2850	4557	3221.8	2040	2040	2029
TXCSWF0048	LEWISVILLEDAM	DENTON	2780	6750	47.700	1005	1004	1006
TX6SWG0572	CUERO 1ST STAGE	DEWITT	21043	72712	273,56	2020	2020	2008
TX6SWG0556	LA GRANGE RES	FAYETTE	106904	87487	248,67	2018	2018	2006
TX6SWF4379	RICHLAND-TEHUACANA DAM	FREESTONE	15800	23464	1068.6	2036	2036	2027
TX6SWG0575	GOLIAD RES	GOLIAD	8684	23791	750,13	2030	2030	2010
TXMSWG0075	GONZALES PROJECT NO.2960	GONZALES	0	0	0	1008	1007	1015
TXCSWG0564	LAKE HOUSTON	HARRIS	5004	15329	22.812	1001	1001	1005
TXCSWF0085	DECORDOVA BEND	HOOD	5839	19699	31.125	1003	1009	1004
TX4SWF4411	LOCK AND DAM NO.7	HOUSTON	12600	43166	115,75	2010	2012	2002
TX6SWG0582	PALMETTO BEND	JACKSON	1831	5305	1437.5	2037	2037	2019
TX6SWF4421	ROCKLAND DAM	JASPER	19307	62198	591,46	2028	2028	2022
TXCSWG0579	WESLEY E SEALE	JIM WELLS	1338	3939	43.805	1004	1003	1009
TX6SWF0105	DAM 7	KENDALL	15000	10900	845,41	2033	2033	2025
TX6SWF9014	SULPHUR BLUFF	LAMAR	1800	1790	5543.0	2042	2042	2031
TX6SWG0578	LAKE CORPUS CHRISTI	LIVE OAK	3279	7834	1890,2	2038	2038	2020
TX6SWG0577	OAKVILLE	LIVE OAK	2515	6145	763,11	2031	2031	2018
TX6SWF0115	MASON DAM	MASON	6446	16626	307,20	2022	2022	2013
TXCSWF0119	WACO DAM	MCLENNAN	4000	5407	74.695	2006	2010	1014
TX6SWF0127	CAMERON DAM	MILAM	9304	28579	527,21	2026	2026	2017
TX6SWF0132	PONTA RESERVOIR DAM	NACOGDOCHES	5316	14188	205,68	2016	2016	2011
TX6SWF0139	INSPIRATION POINT	PALO PINTO	5048	14228	241,93	2017	2017	2012
TX6SWF0138	TURKEY CREEK	PALO PINTO	5370	15067	347,68	2023	2023	2014
TX6SWF0145	HIGHTOWER	PARKER	3980	10270	588,73	2027	2027	2021
TX6SWF0149	CARL L ESTES DAM	RAINS	9718	17006	939,43	2034	2034	2035
TXCSWF0150	IRON BRIDGE DAM	RAINS	2000	1845	99.593	2009	2007	2032
TXISWA0122	RED BLUFF RESERVOIR DAM	REEVES	80	301	168,61	2013	2009	2036
TXCSWF0156	STERLING C. ROBERTSON DAM	ROBERTSON	800	919	149,20	2012	2008	2034
TX6SWF0161	HANNA DAM	SAN SABA	3600	6340	422,12	2025	2025	2016

Table 5-4 (Continued)

SITE ID NUMBER	PROJECT NAME	PRIMARY COUNTY	INCREMENTAL CAPACITY (KW)	INCREMENTAL ENERGY (MWH)	INCREMENTAL COST ($/MWH)	RANKING NUMBER ERC REGION ECON	NON-ECON	COMP
TX6SWF0162	SAN SABA	SAN SABA	3400	9155	978.72	2035	2035	2026
TXCSWF0175	EAGLE MOUNTAIN DAM	TARRANT	1400	2891	58.137	2001	2001	1012
TXCSWF0173	GRAPEVINE DAM	TARRANT	740	1860	69.464	2005	2005	1013
TX6SWF4405	BRECKENRIDGE DAM	THROCKMORTON	1340	2959	2552.9	2039	2039	2028
TX6SWF4409	PADGETT DAM	THROCKMORTON	630	1372	9811.7	2043	2043	2033
TXCSWF0184	LONGHORN DAM	TRAVIS	3293	9864	55.777	1009	1008	1016
TX6SWG0047	LOWER AUSTIN	TRAVIS	13456	35683	115.84	2011	2013	2003
TXISWF0188	INTERNATIONAL AMISTAD DAM (U	VALVERDE	80000	156000	90.270	2008	2006	1003
TX6SWG0574	CONFLUENCERES	VICTORIA	22394	66740	286.81	2021	2021	2009
TX6SWF0191	PALAFOX DAM	WEBB	22500	68100	82.831	2007	2011	2001
TXCSWF4413	GRANGER DAM	WILLIAMSON	1840	5435	48.861	1006	1005	1007
TXCSWF0197	NORTH FORKDAM	WILLIAMSON	680	1836	66.515	2004	2004	1010

Table 5-4 (Continued)

FOOTNOTES

(1) Project Identification Number

Example: TX C SWF 3402

- State Code — TX
- Type & Status Code (Table below) — C
- District Code — SWF
- Sequential Number — 3402

Status of Waterway	Run of River	Diversion	Reservoir	Reservoir with Diversion	Irrigation Canal	Pumped Storage
Existing	A	B	C	D	E	F
Existing with Power	G	H	I	J	K	L
Existing with Retired Power Plant	M	N	O	P	Q	R
Breached	S	T	U	V	W	X
Breached with Retired Power Plant	Y	Z	Ø	1	2	3
Undeveloped	4	5	6	7	8	9

(2) These estimates are based on readily available data which have generally not been verified in the field. Inasmuch as detailed studies have not been made, the potential incremental capacity and energy estimates overstate the actual power which can be developed in some cases. At existing projects, this is particularly true because of upstream diversions, releases for fish and wildlife preservation and enhancement, flood control, water supply, navigation, and recreation.

(3) Data Item: Purposes

Purpose: To identify authorized purposes at existing projects. Probable purposes at potential projects.

Source: Existing in Inventory of Dams. From available sources.

Requirements: Yes

Categories:
- I = Irrigation
- H = Hydroelectric
- C = Flood Control
- N = Navigation
- S = Water Supply
- R = Recreation
- D = Debris Control
- P = Farm Pond
- O = Other

Example: CH

(4) Data Item: Status

Purpose: Indication of project status.

Source: From available sources.

Requirement: Yes. When added to data base.

Categories:
- IS = Identified Site
- SP = Study Proposed
- SA = Authorized for Study
- FP = Feasibility Study in Progress
- SI = Study Inactive
- PA = Project Authorized
- DM = GDM in Progress
- UC = Under Construction
- OP = Project in Operation

NOTE: All dams in the Inventory of Dams were coded as OP by SWD-ADP.

Example: OP

and the order represents the composite ranking. The principal selection criterion in each successive "winner" was based on the individual project's energy production potential.

The ranking procedures were developed as a means of presenting information to potential developers of the hydropower resources in the region.

FOOTNOTES

13/ One project, Longhorn Dam, City of Austin, was placed in the near-term ranking with a cost estimate of 55.78 mills/KWH. The site was placed in the near-term ranking because of local interest expressed in the development of hydropower.

Chapter 6

PUBLIC INVOLVEMENT

Public involvement activities in ERCOT include public meetings, meetings with private and public groups, and responses to individual inquiries.

Two public meetings were held in Austin, Texas, to discuss regional aspects of the National Hydropower Study. The first public meeting was held at the Municipal Auditorium and Convention Center on 8 April 1980. Brigadier General James C. Donovan presided over the meeting. Over 1,500 notices were mailed to public and private groups known to have an interest in hydropower and/or water resources development. The purposes of the meeting were to present study progress, outline planned future efforts, and solicit public views. A total of 42 persons were at the Austin meeting. No opposition to hydropower development was expressed at the meeting. Representatives of cities and cooperative groups interested in developing specific sites raised questions concerning possible duplication of planning efforts by the Corps and them. There was also concern that nonfederal efforts to develop hydropower will be hindered if the Corps has a study authorized for the sites of interest.

The second public meeting was held at the Quality Inn in Austin, Texas, on 20 August 1980. Brigadier General Hugh G. Robinson presided at the meeting. Over 1,500 notices were also mailed for this meeting. The purposes of this meeting were to present the findings of the study and provide the public with an opportunity to let their views on hydropower development in ERCOT become a part of the public record. There were 48 persons in attendance at the meeting including Corps personnel. Attendees represented the electric power industry, elected state officials, water and power agencies of the state and federal governments, river authorities, engineering firms, and the general public.

Two persons made public statements. A spokesman for Brazos River Authority expressed concern that the use of average flow data would distort hydropower capability estimates for sites in the region. He also expressed the position of his agency on alternative water uses; specifically, that needs for other purposes, including thermal generation, had priority over hydropower needs in the Brazos River basin.

A representative of the Texas Department of Water Resources supplemented the NHS presentation with information on data regarding water resources available from his agency.

Meetings with public and private groups include meetings with state officials at College Station and at Austin, a meeting with ERCOT personnel in San Antonio, and a meeting of the American Society of Civil Engineers in Houston. The President's program, "Energy for Rural American Initiative," was also the subject of these meetings.

Inquiries concerning the NHS have been received throughout the study period. Interest has been expressed by Congressmen, energy research groups, public and private utilities, public officials, and private citizens. Most interest has been expressed relative to individual sites.

Chapter 7

INVENTORY

Initial data for sites to be included in the National Hydropower Study was collected for the Corps of Engineers district boundaries. Regional electric reliability council location was not considered in early data collection, and as a result, the number of sites originally considered in ERCOT can only be estimated. Earliest regional identification for NHS sites was reported by state. Sites within Texas were identified by five district offices: Albuquerque, Fort Worth, Galveston, New Orleans, and Tulsa. Over 4,500 sites in Texas were considered for inclusion in the National Hydropower Study.[1] Many of the sites identified in the National Inventory of Dams lacked sufficient storage or height to be included in the NHS data base, however. It is estimated that data was collected for around 1,800 sites in ERCOT for Stage 1 screening.

7.1 STAGE 1 AND 2 SCREENINGS

The purpose of the first screening was to select sites to be analyzed for physical hydropower production capability. Total sites in Texas remaining after this screening were 1,735.

The Stage 2 screening was designed to eliminate sites that were obviously uneconomic. Following this screening, a preliminary report on potential hydropower resources identified in the study was published.[14/] Table 7-1 presents data for Texas from the report. At that time, 360 sites were being considered with an estimated capacity of 2,248 MW and 5,080 GWH of energy. Potential power at 201 existing projects was shown, 197 of which have potential power of less than 25 MW. In total, 159 undeveloped sites were identified, 137 of which have potential power of less than 25 MW. Results published at this stage were considered extremely optimistic and were published to provide the public with information on the progress of the study.

7.2 STAGE 3 SCREENING

The first Stage 3 screening was reported on electric reliability council regions. Total sites remaining in the ERCOT data base after this screening were 55.[15/] This screening used more refined physical and economic data than the previous screenings. No sites with existing hydropower remained in the active inventory following this screening.

Table 7-1

PHYSICAL POTENTIAL FOR ADDITIONAL HYDROELECTRIC CAPACITY AND ENERGY DEVELOPMENT IN THE STATE OF TEXAS

HEAD IN FEET		POTENTIAL INCREMENTAL CAPACITY RANGES: .05 MW - 15 MW				15 MW - 25 MW				GREATER THAN 25 MW				TOTAL			
		EXIST INST 1 CAP	EXIST INCR 2 CAP	UNDEV POTEN 3 CAP	TOTAL INCR 4 CAP	EXIST INST 1 CAP	EXIST INCR 2 CAP	UNDEV POTEN 3 CAP	TOTAL INCR 4 CAP	EXIST INST 1 CAP	EXIST INCR 2 CAP	UNDEV POTEN 3 CAP	TOTAL INCR 4 CAP	EXIST INST 1 CAP	EXIST INCR 2 CAP	UNDEV POTEN 3 CAP	TOTAL INCR 4 CAP
0-19	NUMBER	0	18	6	24	0	0	1	1	0	0	0	0	0	18	7	25
	CAPCTY	0.0	2.5	12.1	14.7	0.0	0.0	16.9	16.9	0.0	0.0	0.0	0.0	0.0	2.5	29.0	31.6
	ENERGY	0.0	6.0	33.7	39.8	0.0	0.0	43.4	43.4	0.0	0.0	0.0	0.0	0.0	6.0	77.2	83.2
20-49	NUMBER	6	119	45	164	0	0	3	3	0	2	13	15	6	121	61	182
	CAPCTY	16.0	54.4	93.4	148	0.0	0.0	58.3	58.3	0.0	90.0	833	923	16.0	145	985	1130
	ENERGY	45.7	131	386	516	0.0	0.0	171	171	0.0	196	1994	2190	45.7	327	2551	2878
50-99	NUMBER	3	52	57	109	0	1	4	5	4	0	4	4	7	53	65	118
	CAPCTY	35.5	80.5	125	206	0.0	22.0	91.8	114	157	0.0	236	236	193	103	453	556
	ENERGY	166	163	270	433	0.0	7.1	243	250	342	0.0	480	480	508	170	992	1163
>100	NUMBER	0	7	21	28	2	0	0	0	1	2	5	7	3	9	26	35
	CAPCTY	0.0	27.2	57.2	84.4	45.0	0.0	0.0	0.0	67.5	95.4	351	446	113	123	408	530
	ENERGY	0.0	71.9	165	237	149	0.0	0.0	0.0	200	44.3	675	719	349	116	840	956
TOTAL	NUMBER	9	196	129	325	2	1	8	9	5	4	22	26	16	201	159	360
	CAPCTY	51.6	165	288	453	45.0	22.0	167	189	225	185	1420	1606	321	372	1875	2248
	ENERGY	212	372	854	1226	149	7.1	457	464	542	240	3149	3390	903	619	4461	5080

LEGEND

COLUMN 1 = EXISTING HYDROPOWER DEVELOPMENT
COLUMN 2 = ADDITIONAL POTENTIAL AT EXISTING DAMS
COLUMN 3 = UNDEVELOPED POTENTIAL
COLUMN 4 = TOTAL POTENTIAL AT ALL SITES (SUM OF COLUMNS 2 AND 3)
CAPCTY = SUM OF CAPACITIES FOR GIVEN HEAD RANGE (MEGAWATT)
ENERGY = SUM OF ENERGIES FOR GIVEN HEAD RANGE (GIGAWATT-HOUR)

Source: US Army, Corps of Engineers, IWR. National Hydroelectric Power Resources Study, Preliminary Inventory of Hydropower Resources, Volume 3, July 1979.

Stage 3, second screening, was performed by NHS staff members at Corps district offices. Available environmental, social, and marketing data for each site were collected; however, data availability varies among sites, and much of the information collected does not lend itself to quantitative analysis.

Based on available data, in-house expertise, and engineering judgment, one existing site and five undeveloped sites were removed from the inventory.

The existing site is Pat Mayse (Sanders Creek, Lamar County). Agua Verde (Rio Grande River) and four small undeveloped sites on the Pecos River were also deleted.

Three sites were added to the inventory. Two sites, Gonzales (Guadalupe River) and Longhorn (Colorado River) were identified by state and local interests. Power addition studies are underway on Gonzales. Aubrey on the Elm Fork of the Trinity was added to the inventory. More site specific analysis indicated that further consideration was warranted.

Fifty-two sites in ERCOT were retained for further study of hydropower potential. Nineteen are existing projects without power, and 33 are undeveloped sites. Sites remaining in the active inventory are shown in Table 5-4, page 5-15. More extensive data on individual sites considered in the Stage 3 screening are shown in Attachment C.

FOOTNOTES

14/ US Corps of Engineers National Hydropower Study, Preliminary Inventory of Hydropower Resources, 6 volumes, Fort Belvoir, VA, July 1979.

15/ Sites identified by the Fort Worth District and reported at the 8 April 1980 Public meeting were subsequently revised. Sites reported at the meeting that have been removed from the inventory because of the revision are H-4 and H-5 Dams, Guadalupe River; Bistone Dam, Navasota River; and Applewhite Site, Medina River. Capacity and energy estimates were revised for other sites. Three sites from SWPP (Carl L. Estes and Iron Bridge, Sabine River, and Sterling Creek, Navasota River) were moved to the ERCOT inventory. International Amistad was also erroneously omitted from the April listing.

Chapter 8

EVALUATION

The potential for developing additional conventional hydroelectric power resources within the ERCOT region is limited. As shown in the previous chapter, potential for hydropower was identified at 52 sites with an energy potential of 1242 GWH. However, the projected load shapes as illustrated in Figures 5-1 through 5-5 indicate a substantial future need for peaking power sources. The development of pumped storage hydropower projects is indicated as a reasonable option for the region. Careful analysis of the specific power demands and economic resources of individual suppliers along with siting and environmental trade offs will be required in this type of development. An evaluation of hydropower potential is presented below, considering estimated costs for development and near-term and long-term rankings. Ranking procedures are described in Chapter 5, section 5.3. There are no existing hydropower sites with additional hydropower potential in the ERCOT region.

8.1 NEAR-TERM DEVELOPMENT POTENTIAL

"Economic" Ranking

There are nine projects selected as having near-term development potential within ERCOT. This selection is based primarily on the indicated cost of the potential energy which could be developed by retrofit of existing dams. The assumption was made that retrofit of existing dams could be accomplished within 10 years and that potential developers would be interested in any project where the cost of energy production is less than 50 mills per kilowatt hour. The estimated unit cost of energy from these nine projects ranges from 22.8 mills per KWH at Lake Houston on the San Jacinto River to slightly over 50 mills per KWH at Longhorn Dam on the Colorado River.

Annual costs in terms of dollars per KW of installed capacity range from approximately $70 per KW per year to $170 per KW per year.

Total development of these nine projects would cost approximately $26 million (1978 cost data) and would create 30.6 MW of additional capacity with an average annual energy potential of 92 GWH.

"Noneconomic" Ranking

The near-term "noneconomic" ranking is essentially the same as the economic ranking except that one project (DeCordova Bend on the Brazos River) was moved to the bottom of the list. This was done because of moderate impacts associated with the development of this project. Concerns for development of hydropower potential on the Brazos River were also expressed by a spokesman from the Brazos River Authority during the public meeting of 20 August 1980.

"Composite" Ranking

During the "composite" ranking process, seven additional projects were moved to the near-term category based on district knowledge of interest for development of these sites.

The final decisions regarding development of any of the near-term potential projects, especially those projects where moderate impacts have been identified, should not be made until more detailed studies have been accomplished and trade offs inherent to their development have been carefully weighed in the public forum.

8.2 LONG-TERM DEVELOPMENT POTENTIAL

Economic Ranking

There are 43 sites indicated in the ERCOT region as having long-term development potential; 10 of these are existing projects where the estimated average cost of new energy exceeds 50 mills per KWH. The remaining 33 are undeveloped sites.

Cost of energy for the existing projects ranges from 58.13-168.61 mills per KWH. Total development of the long-term potential at nine of the existing projects is estimated to cost $23.9 million (1978 cost data) and would create 27 MW of additional capacity with an average annual energy potential of 44 GWH. Annual costs in terms of dollars per kilowatt of installed capacity range from approximately $92 per KW to $636 per KW per year.

Cost data for International Amistad, which is an existing site identified for long-term economic development potential, is excluded from the above total. Estimates from the NHS computer analysis for optimum size development differ from those for construction plans now in progress. The construction plans are based on more detailed, site specific studies which include international water rights agreements. Potential of Amistad raises the total long-term potential at existing projects to 107 MW of additional capacity and 200 GWH of average annual energy potential.

Cost of energy data for undeveloped sites within ERCOT region are misleading in that total project development costs (including dams, reservoirs, relocations, etc.) are included. Since none of the undeveloped sites in this region could be economically justified as single purpose, power only developments, the cost which might be allocated to other project purposes must be subtracted from total development costs in order to determine the actual rate of cost for energy from these sites.

Results of previous studies and judgment of field personnel have been used to decide which of the undeveloped sites should be investigated for power potential in more detailed multipurpose studies of these sites. Development of potential at designated undeveloped sites would create 466 MW of additional capacity with an average annual energy potential of 950 GWH.

"Noneconomic" and "Composite" Rankings

The noneconomic ranking of long-term development potential is essentially the same as the economic ranking except that all existing projects were moved to the top of the list.

The composite ranking of long-term potential was performed in the same manner as that for the near-term potential, giving primary consideration to the relative energy potential within district priority rankings.

8.3 SUMMARY OF HYDROPOWER POTENTIAL

Table 8-1 shows a summary of hydropower potential by the various ranking procedures. Also shown is the fuel displacement associated with annual production. Development of the sites considered in the composite ranking as likely to be developed in the near-term could displace around 0.5 million barrels of oil annually. Development of the sites in the long-term composite ranking could displace approximately 1.6 million barrels annually. Thus, development of the 52 sites identified with hydropower potential in ERCOT could displace a total of 2.1 million barrels of oil annually.

Table 8-1

HYDROPOWER POTENTIAL BY RANKINGS

Number of Sites		Capacity (MW)	Average Annual Energy (GWH)	Annual Fuel Displacement[2] (million barrels)
		ECONOMIC and NONECONOMIC RANKINGS[1]		
		Near-Term		
Existing -	9	30.6	92.0	0.15
		Long-Term		
Existing -	10	106.7	200.0	0.33
Undeveloped -	33	466.0	950.0	1.58
Subtotal	52	603.3	1242.0	2.06
		COMPOSITE RANKING		
		Near-Term		
Existing -	16	134.5	289.0	0.48
		Long-Term		
Existing -	3	2.8	3.0	0.01
Undeveloped -	33	466.0	950.0	1.58
Subtotal	52	603.3	1242.0	2.07

*Around 40,000 barrels annually.
Note: Total may not add because of rounding.

1/ Economic and noneconomic rankings are identical with respect to projects in near-term and long-term classifications; differences are in site rankings within classifications.

2/ Displacements estimated at 1 barrel oil = 600 KWH

GLOSSARY

AVERAGE LOAD - the hypothetical constant load over a specified time period that would produce the same energy as the actual load would produce for the same period.

BENEFIT-COST RATIO (B/C) - the ratio of the present value of the benefit stream to the present value of the project cost stream computed for comparable price level assumptions.

BENEFITS (ECONOMIC) - the increase in economic value produced by the hydropower addition project, typically represented as a time stream of value produced by the generation of hydroelectric power. In small hydro projects this is often limited for analysis purposes to the stream of costs that would be representative of the least costly alternative source of equivalent power.

CAPABILITY - maximum kilowatt capability of the system with all power sources available, with no allowance for outages, and with sufficient kilowatt hours to supply the requirements of the system.

CAPACITY - the maximum power output or load for which a turbine-generator station or system is rated.

CAPACITY VALUE - that part of the market value of electric power which is assigned to dependable capacity.

COSTS (ECONOMIC) - the value required to produce the hydroelectric power.

DEMAND - SEE LOAD.

DEPENDABLE CAPACITY - the load carrying ability of a hydropower plant under adverse hydrologic conditions for the time interval and period specified of a particular system load.

ENERGY - the capacity for performing work. The electrical energy term generally used is kilowatt hours and represents power (kilowatts) operating for some time (hours).

ENERGY VALUE - that part of the market value of electric power which is assigned to energy generated.

FEASIBILITY STUDY - an investigation peformed to formulate a hydropower project and definitively assess its desirability for implementation.

FEDERAL ENERGY REGULATORY COMMISSION (FERC) - an agency in the Department of Energy which licenses non-Federal hydropower projects and regulates interstate transfer of electric energy. Formerly the Federal Power Commission (FPC).

FIRM ENERGY - the energy generation ability of a hydropower plant under adverse hydrologic conditions for the time interval and period specified of a particular system load.

FOSSIL FUELS - refers to coal, oil, and natural gas.

GIGAWATT (GW) - one million kilowatts.

HEAD, GROSS (H) - the difference in elevation between the headwater surface above and the tailwater surface below a hydroelectric power plant, under specified conditions.

HYDROELECTRIC PLANT OR HYDROPOWER PLANT - an electric power plant in which the turbine-generators are driven by falling water.

INSTALLED CAPACITY - the total of the capacities shown on the nameplates of the generating units in a hydropower plant.

KILOVOLT (KV) - one thousand volts.

KILOWATT (KW) - one thousand watts.

KILOWATT HOUR (KWH) - the amount of electrical energy involved with a one kilowatt demand over a period of one hour. It is equivalent to 3,413 Btu of heat energy.

LOAD - the amount of power needed to be delivered at a given point on an electric system.

LOAD CURVE - a curve showing power (kilowatts) supplied plotted against time of occurrence and illustrating the varying magnitude of the load during the period covered.

LOAD FACTOR - the ratio of the average load during a designated period to the peak or maximum load occurring in that period.

MARGIN - difference between net system capacity and system maximum load requirements.

MEGAWATT (MW) - one thousand kilowatts.

MEGAWATT HOURS (MWH) - one thousand kilowatt hours.

NUCLEAR ENERGY - energy produced largely in the form of heat during nuclear reactions which, with conventional generating equipment, can be transferred into electric energy.

NUCLEAR POWER - power released from the heat of nuclear reactions which is converted to electric power by a turbine-generator unit.

PEAKING CAPACITY - that part of a system's capacity which is operated during the hours of highest power demand.

PEAK LOAD - the maximum load in a stated period of time.

PLANT FACTOR - ratio of the average load to the installed capacity of the plant, expressed as an annual percentage.

POWER (ELECTRIC) - the rate of generation or use of electric energy, usually measured in kilowatts.

POWER FACTOR - the percentage ratio of the amount of power, measured in kilowatts, used by a consuming electric facility to the apparent power measured in kilovolt-amperes.

POWER POOL - two or more electric systems which are interconnected and coordinated to a greater or lesser degree to supply, in the most economical manner, electric power for their combined loads.

PREFERENCE CUSTOMERS - publicly-owned systems and nonprofit cooperatives which by law have preference over investor-owned systems for the purchase of power from Federal projects.

PROJECT SPONSOR - the entity controlling the small hydro site and promoting construction of the facility.

PUMPED STORAGE - an arrangement whereby electric power is generated during peak load periods by using water previously pumped into a storage reservoir during off-peak periods.

RECONNAISSANCE STUDY - a preliminary feasibility study designed to ascertain whether a feasibility study is warranted.

SECONDARY ENERGY - all hydroelectric energy other than FIRM ENERGY.

SPINNING RESERVE - generating units operating at no load or at partial load with excess capacity readily available to support additional load.

STEAM-ELECTRIC PLANT - a plant in which the prime movers (turbines) connected to the generators are driven by steam.

SURPLUS POWER - generating capacity which is not needed on the system at the time it is available.

SYSTEM, ELECTRIC - the physically connected generation, transmission, distribution, and other facilities operated as an integral unit under one control, management, or operating superivsion.

THERMAL PLANT - a generating plant which uses heat to produce electricity. Such plants may burn coal, gas, oil, or use nuclear energy to produce thermal energy.

THERMAL POLLUTION - rise in temperature of water such as that resulting from heat released by a thermal plant to the cooling water when the effects on other uses of the water are detrimental.

TRANSMISSION - the act or process of transporting electric energy in bulk.

TURBINE - the part of a generating unit which is spun by the force of water or steam to drive an electric generator. The turbine usually consists of a series of curved vanes or blades on a central spindle.

WATT - the rate of energy transfer equivalent to one ampere under a pressure of one volt at unity power factor.

WHEELING - transportation of electricity by a utility over its lines for another utility; also includes the receipt from and delivery to another system of like amounts, but not necessarily the same energy.

ATTACHMENT A

(FERC POWER VALUES)

ATTACHMENT A

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D. C. 20426

JUN 23 1978

Mr. Augustine J. Fredrich
Director, Institute for Water Resources
Corps of Engineers
Kingman Building
Fort Belvoir, Virginia 22060

Dear Mr. Fredrich:

In reference to your letter of February 21, 1978, and in accordance with instructions received from Mr. Donald Gund of your office, our regional offices have developed preliminary generalized power values (shown in the enclosed Appendix tables) to be used in the analysis of the relative economic merits of projects for the National Hydropower Study.

The enclosed preliminary power values are developed based on a range of hydroelectric plant factors from zero to one-hundred percent, in increments of ten-percent. For each hydro capacity factor level, the individual component power values ($/kW-yr and mills/kWh) are shown in addition to an equivalent total annual value expressed both in $/kW-yr and in mills/kWh. These values are based on January 1978 cost levels and are to be applied "at-market" unless otherwise stated. Additional assumptions and rationale for the generalized power values are shown in the individual tables. These assumptions include: type of financing assumed; characteristics and costs (including fuel costs) of thermal alternatives; suggested "mix" of base-load alternatives -- for example, in areas where coal-fired steam and nuclear plants are both considered viable base-load alternatives -- and estimated pumping energy cost. The power values which are derived from base-load steam-electric alternatives reflect the added cost of environmental control facilities. The tables are arranged by regional office according to one of the following sub-groups: (1) regional electric reliability council, (2) state, and (3) power system group. A Regional Electric Reliability Council map and electric power system facilities map are also enclosed in order to identify the geographical boundaries involved.

As reflected in the enclosed tables, natural gas is considered to be an alternative fuel for peaking and intermediate duty operation in

Mr. Augustine J. Fredrich

the Anchorage area of Alaska. Alaska, however, is considered to be a different situation from the lower 48-states. Several years ago, the FPC's Bureau of Power issued instructions to its regional offices to discontinue consideration of natural gas in power value calculations for projects within the contiguous United States. The Office of Electric Power Regulation continues this policy of excluding natural gas from power value studies in the 48-states, including those states which are located in the southwestern portion of the country.

We will modify the enclosed preliminary power value data through detailed computer methodologies to reflect the final generalized power values. We anticipate that a new production costing program will be implemented for this effort prior to September 1978, the date which Mr. Gund indicated for completion of the final values. In the meantime, the enclosed values are appropriate for the preliminary screening of all hydroelectric developments (including low-head developments) within the respective study areas.

We will be happy to answer any questions regarding these values.

Sincerely,

William W. Lindsay
Director, Office of
Electric Power Regulation

Enclosures

FORT WORTH REGIONAL OFFICE

Southwest Power Pool (SWPP)

Hydro Capacity Factor %	Capacity Value ($/kW-yr)	Energy Value (mills/kWh)	Equivalent Total Power Value 1/ ($/kW-yr)	(mills/kWh)
		Combustion Turbine Alternative		
0	30.80	-	30.80	-
10	30.40	35.2	61.20	69.9
20	30.40	34.9	91.60	52.3
		Combined Cycle Alternative		
30	68.90	23.3	130.10	49.5
40	68.90	22.1	146.40	41.8
		Nuclear Alternative		
50	197.70	3.0	210.70	48.1
60	197.70	4.4	220.80	42.0
70	197.70	5.4	230.90	37.7
80	197.70	6.2	241.00	34.4
90	197.70	6.8	251.10	31.8
100	197.70	7.2	261.20	29.8
		Coal Fired Alternative		
50	125.10	12.0	177.40	40.5
60	125.10	11.9	187.70	35.7
70	125.10	11.9	197.90	32.3
80	125.10	11.9	208.10	29.7
90	125.10	11.8	218.40	27.7
100	125.10	11.8	228.60	26.1

1/ Example: Component power values of $30.40/kW-yr and 35.2 mills/kWh at 10 percent hydro capacity factor are equivalent to a total annual value of either $61.20/kW-yr or 69.9 mills/kWh (but not both).

Pumping Energy Cost 11.4 mills/kWh

ATTACHMENT A (Continued)

FORT WORTH REGIONAL OFFICE

Southwest Power Pool (SWPP)

TYPE OF ALTERNATIVE:	Coal-fired
NUMBER AND SIZE OF UNITS:	2-700 MW units
ALTERNATIVE INVESTMENT COST:	$550/kW
ALTERNATIVE HEAT RATE:	9,600 Btu/kWh
ALTERNATIVE FUEL COST:	120¢/10^6 Btu

TYPE OF ALTERNATIVE:	Nuclear
NUMBER AND SIZE OF UNITS:	2-1200 MW units
ALTERNATIVE INVESTMENT COST:	$850/kW
ALTERNATIVE HEAT RATE:	---
ALTERNATIVE FUEL COST:	$75/kW and 4.75 mills/kWh

TYPE OF ALTERNATIVE:	Combined cycle, oil-fired
NUMBER AND SIZE OF UNITS:	1-300 MW unit
ALTERNATIVE INVESTMENT COST:	$240/kW
ALTERNATIVE HEAT RATE:	9,500 Btu/kWh
ALTERNATIVE FUEL COST:	225¢/10^6 Btu

TYPE OF ALTERNATIVE:	Combustion turbine, oil-fired
NUMBER AND SIZE OF UNITS:	2-50 MW units
ALTERNATIVE INVESTMENT COST:	$160/kW
ALTERNATIVE HEAT RATE:	15,000 Btu/kWh
ALTERNATIVE FUEL COST:	225¢/10^6 Btu

TYPE OF FINANCING ASSUMED: Private (10 percent cost of money)

SUGGESTED MIX OF BASE LOAD ALTERNATIVES: 71% Coal-fired steam
29% Nuclear

ATTACHMENT B

PERTINENT CORRESPONDENCE
AND
PUBLIC VIEWS AND RESPONSES

ATTACHMENT B

PERTINENT CORRESPONDENCE
AND
PUBLIC VIEWS AND RESPONSES

TABLE OF CONTENTS

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON D C 20250

December 2 1980

Mr. Joel F. Wilson
Acting Chief, Planning Division
Southwestern Division, Corps of Engineers
U.S. Department of the Army
1200 Main Street
Dallas, Texas 75202

Dear Mr. Wilson:

Thank you for providing the opportunity to review the draft report of the National Hydroelectric Power Resources Study, Volume XXI, that discusses potential hydropower resources within the area of the Electric Reliability Council of Texas.

Noted.

We have no comments.

Sincerely,

Bob Bergland
Secretary

United States Department of Agriculture

Soil Conservation Service

Post Office Box 2323
Little Rock, Arkansas
72203

October 17, 1980

Mr. Joel F. Wilson
Acting Chief, Planning Division
Corps of Engineers
Main Tower Building
1200 Main Street
Dallas Texas 75202

Dear Mr. Wilson:

I have forwarded the draft report on the potential hydropower resources within the area of the Electric Reliability Council of Texas to Mr. George Marks, State Conservationist with the Soil Conservation Service in Temple, Texas, for review. Noted.

Thank you for the opportunity to review this draft report.

Sincerely,

M. J. Spears
State Conservationist

UNITED STATES DEPARTMENT OF COMMERCE
Economic Development Administration
Washington, D.C. 20230

NOV 3 1980

Mr. Joel F. Wilson
Acting Chief, Planning Division
Department of the Army
Southwestern Division, Corps of Engineers
Main Tower Building
1200 Main Street
Dallas, Texas 75202

Dear Mr. Wilson:

Thank you for your draft report on the potential hydropower resources within the area of the Electric Reliability Council of Texas.

We have reviewed this report, and find that the subject matter of your study has been adequately covered. We have no substantive comments to offer.

Sincerely,

GEORGE T. KARRAS
Deputy Assistant Secretary
for Operations

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VI
1201 ELM STREET
DALLAS, TEXAS 75270

October 29, 1980

Mr. Joel F. Wilson
Acting Chief
Planning Division
Southwestern Division, CDE
Main Tower Building
1200 Main Street
Dallas, Texas 75202

ATTN: SWDPL-M

Dear Mr. Wilson:

We have completed our review of the draft report on the potential hydropower resources within the area of the Electric Reliability Council of Texas (ERCOT). The report was prepared in response to Section 167 of the Water Resources Development Act of 1976. The final report onthe ERCOT area will be included in the national report that is scheduled to be published in September 1981.

The draft report on the ERCOT area primarily investigated hydroelectric power projects that showed an additional energy production potential with a corresponding reduction in fuel consumption. The report did not investigate pumped storage facilities.

The following comments are offered for your consideration:

1. The report refers to developing additional conventional hydroelectric power resources by retrofitting existing dams but how this would be done or what the environmental effects would be was not mentioned. The final report should explain if the water levels of the lakes would be raised or if the point of discharge from the dams would be moved which could change the channel downriver.

2. It would have been helpful if the report had addressed the CEQ August 11, 1980 Memorandum for Heads of Agencies concerning the need to analyze agricultural land impacts more effectively in the project planning process and under NEPA. The final report should clearly state whether or not the projects will inundate prime farmland. If farmland will be inundated, the direct and indirect effects of the proposed action should be evaluated and adverse effects avoided or minimized to the extent possible, in agreement with the CEQ Memorandum.

We appreciate the opportunity to review the draft document.

Sincerely,

Clinton B. Spotts
Regional EIS Coordinator (6ASAF)

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
WASHINGTON, D C 20410

OFFICE OF THE ASSISTANT SECRETARY
FOR COMMUNITY PLANNING AND DEVELOPMENT

IN REPLY REFER TO:

Mr. Joel F. Wilson
Acting Chief, Planning Division
Southwestern Division, Corps of Engineers
Main Tower Building
1200 Main St.
Dallas, Texas 75202

Dear Mr. Wilson:

Thank you for your draft report on the potential hydropower resources within the area of the Electric Reliability Council of Texas sent to the Secretary of HUD on October 9, 1980. I am forwarding the report to Mr. Thomas Armstrong, Regional Administrator of the Ft. Worth Office, for his information and appropriate comment. If there are specific concerns relating to potential development of these resources and project/site findings of the reports, he will respond directly to you. Noted.

Sincerely,

Richard H. Broun
Director
Office of Environmental Quality

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
FORT WORTH REGIONAL OFFICE
221 WEST LANCASTER AVENUE
P O BOX 2905
FORT WORTH, TEXAS 76113

REGION VI

October 29, 1980

IN REPLY REFER TO

Mr. Joel F. Wilson, Acting Chief
Planning Division
Southwestern Division
U.S. Army Corps of Engineers
ATTN: SWDPL-M
Main Tower Building
1200 Main Street
Dallas, Texas 75202

Dear Mr. Wilson:

This office has reviewed the Draft Regional Report for the Electric Reliability Council of Texas, Volume XXI of the National Hydroelectric Power Resources Study, transmitted by your letter of October 9.

Our comments on this Volume of the study are the same as those on Volume XX set forth in my letter of this date to Planning Division Chief Barry G. Rought. A copy of that letter is attached.

Sincerely,

Thomas J. Armstrong
Regional Administrator

Enclosure

AREA OFFICES
DALLAS, TEXAS · LITTLE ROCK, ARKANSAS · NEW ORLEANS, LOUISIANA · OKLAHOMA CITY, OKLAHOMA · SAN ANTONIO, TEXAS

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
FORT WORTH REGIONAL OFFICE
221 WEST LANCASTER AVENUE
P O BOX 2905
FORT WORTH TEXAS 76113

REGION VI

October 29, 1980

IN REPLY REFER TO

Mr. Barry G. Rought, Chief
Planning Division
Southwestern Division
U.S. Army Corps of Engineers
ATTN: SWDPL-M
Main Tower Building
1200 Main Street
Dallas, Texas 75202

Dear Mr. Rought:

This office has reviewed the Draft Regional Report for the Southwest Power Pool, Volume XX of the National Hydroelectric Power Resources Study, transmitted by your letter of October 2.

We are most enthusiastic about and highly supportive of this overall undertaking, and we agree that highest priority should be assigned to increasing the generating capacity of existing hydroelectric projects and to installing hydroelectric generators in existing reservoir projects which were constructed without power-production facilities. We are also of the opinion that high priority should be given to the installation of in-stream generating facilities at sites where impoundment is not required for power production.

For sites requiring new impoundments, we think that it is most important that a maximum effort be made to assign true and accurate values to all the factors involved in the necessary trade-off process. It is recognized that the same impoundment required for hydroelectric power production may possibly also provide benefits in the areas of flood control, municipal and industrial water supplies, water-oriented recreation, fish production, and waterfowl habitat. However, those positive or "plus" factors may in some situations be more than outweighed by such negative factors as destruction of free-flowing streams with unique and/or rare types of fauna and special recreational and scenic qualities, inundation of historic and/or scenic areas, loss of wildlife habitat and recreational lands, loss of agricultural and timber production, and disruption of established settlements. I wish to stress that we do not take a position in opposition to new impoundments, but are of the opinion that they should be subjected to a rigorous cost-benefit or trade-off assessment which takes into account both factors which can be assigned monetary values and those which cannot.

Sites considered for development would be subject to the analysis recommended.

Sincerely,

Thomas J. Armstrong
Regional Administrator

United States Department of the Interior
WATER AND POWER RESOURCES SERVICE
SOUTHWEST REGION
COMMERCE BUILDING, 714 S TYLER, SUITE 201
AMARILLO, TEXAS 79101

IN REPLY
REFER TO 720

Mr. Joel F. Wilson
Acting Chief, Planning Division
U.S. Army Corps of Engineers
Southwest Division
Main Tower Building, 1200 Main Street
Dallas, TX 75202

Dear Mr. Wilson:

We have reviewed the draft report on the potential hydropower resources within the area of the Electric Reliability Council of Texas (ERCOT), as requested by your letter of October 9, 1980. The report appears to adequately present information relative to the developable hydropower resources within the geographical boundaries of ERCOT. We would appreciate receiving a copy of the document when finalized.

Sincerely yours,

William A. Seth

William A. Seth
Regional Planning Officer

cc: Representative, Austin, Texas

United States Department of the Interior
WATER AND POWER RESOURCES SERVICE
ENGINEERING AND RESEARCH CENTER
P O BOX 25007
BUILDING 67, DENVER FEDERAL CENTER
DENVER, COLORADO 80225

IN REPLY REFER TO: D-720
125.1

NOV 12 1980

Department of the Army
Southwestern Division
Corps of Engineers
Attention: SWDPL-M
Main Tower Building
1200 Main Street
Dallas TX 75202

Subject: National Hydroelectric Power Resources Study - Regional Report - Electric Reliability Council of Texas (ERCOT)

Gentlemen:

We have reviewed the subject report as requested by your letter dated October 9, 1980. Other priorities have permitted only a cursory review of the report in the time allowed.

The report appears generally to have presented a reasonable perspective of present and future hydropower developments and potentials for the ERCOT area. On this basis we have only some general comments to make.

The regional power values presented on pages 5-8 appear to be rather conservative, but still within the range so as to yield reasonable results for this type of study.

Perhaps the weakest part of the report is the area of support for the noneconomic evaluations and ranking criteria. It appears the evaluations are too general and lack sufficient supporting data to fairly judge the merits of potential projects on this basis.

Noted.

Although the complete methodology used for power and energy calculations is not presented in the report, previous exposure to the methodology and results leads us to believe that a great deal of confidence cannot be placed in the estimates of potential capacity and energy production. We expect that our Southwest Regional Office will comment on these aspects of sites within the jurisdiction of this agency.

The methodology has been expande

Very truly yours,

Robert K. Lanky

Robert K. Lanky, Chief
Division of Planning
Technical Services

FEDERAL ENERGY REGULATORY COMMISSION

WASHINGTON 20426

In Reply Refer To:

OEPR-DHRA
Hydropower Resources Assessment
Special Studies - National
Hydroelectric Power Resources
Study - Electric Reliability
Council of Texas

Mr. Joel F. Wilson
Acting Chief, Planning Division
Department of the Army
Southwestern Division, Corps of Engineers
Main Tower Building, 1200 Main Street
Dallas, Texas 75202

DEC 1 1980

Attn: SWDPL-M

Dear Mr. Wilson:

This is in response to your letter of October 9, 1980, addressed to Chairman Curtis, requesting comments on the draft report, National Hydroelectric Power Resources Study, Regional Report, Electric Reliability Council of Texas.

Our review indicates that the economic analyses require considerable updating to reflect more current price levels and comparable financing. For example, power benefits in the report were computed utilizing generalized power values at January 1978 cost levels supplied to the Corps of Engineers by the FERC. Capacity benefits, at that time, were based on a 10 percent cost of money available in the private sector. Annual costs were determined on the basis of a 6-5/8-percent Federal interest rate. Since January 1978, energy values have escalated significantly, and capacity benefits are now computed on the basis of Federal financing (currently 7-3/8 percent). Our letter, dated April 14, 1980, to Mr. Hanchey of the Corps' Institute for Water Resources included July 1979 cost level power values based on a 7-1/8-percent Federal interest rate. We would suggest that these data be used in updating the final report. In addition, the criteria used for and the application of power benefits should be described more clearly in the report. For example, it is not clear that capacity benefits were computed on the basis of dependable capacity.

If time and funds permit, the economic analysis will be updated prior to submission of the final report to Congress.

Sincerely,

William W. Lindsay, Director
Office of Electric Power Regulation

FEDERAL ENERGY REGULATORY COMMISSION

REGIONAL OFFICE

819 Taylor Street, Room 9A05
Fort Worth, Texas 76102

November 7, 1980

In reply refer to: OEPR-FW

Mr. Barry G. Rought
Chief, Planning Division
Southwestern Division
Corps of Engineers
1200 Main Street
Dallas, Texas 75202

ATTN: SWDPL-M

Dear Mr. Rought:

In response to your letters of October 3 and 9, 1980, submitting, respectively, the Draft Report on the National Hydroelectric Power Resources Study on the Southwest Power Pool Area and on the Electric Reliability Council of Texas Area we offer the following comments.

In Table 5-1, page 5-8 the annual plant factor at zero percent should list a capacity value and a zero for the energy value. Corrected.

We also note that on Table 3-1 of the ERCOT area report the Abbott TP-3 plant is listed as being owned by the Texas Power Corporation. Our records indicate that the Guadalupe-Blanco River Authority is the owner of the Dunlap, McQueeny, Nolte, TP-4, H-4, and H-5 plants. The McQueeny plant is also known as the TP-3 plant. Corrected.

We appreciate the opportunity of reviewing the draft reports.

Sincerely,

Lenard B. Young
Regional Engineer

By [signature]
Acting

OFFICE OF THE GOVERNOR

WILLIAM P CLEMENTS, JR.
GOVERNOR

December 8, 1980

Mr. Barry G. Rought, P. E.
Chief, Planning Division, Southwestern Division
U. S. Corps of Engineers
Main Tower Building
1200 Main Street
Dallas, Texas 75202

Dear Mr. Rought:

The draft report pertaining to the Electric Reliability Council of Texas, prepared by your office, has been reviewed by the Budget and Planning Office and interested state agencies. Copies of the review comments are enclosed for your information and use. The State Environmental Impact Statement Identifier Number assigned to the project is 0-10-50-051.

The Budget and Planning Office appreciates the opportunity to review this project. If we can be of any further assistance during the environmental review process, please do not hesitate to call.

Sincerely,

F. R. Spies, Manager
General Government Section
Budget and Planning Office

mp

Enclosures: Comments by Texas Department of Water Resources
Texas Parks and Wildlife Department
Railroad Commission of Texas
State Department of Highway and Public Transportation
Texas State Soil and Water Conservation Board
General Land Office

SAM HOUSTON BUILDING • P O BOX 12428, CAPITOL STATION • AUSTIN, TEXAS 78711

OFFICE OF THE GOVERNOR

WILLIAM P CLEMENTS, JR
GOVERNOR

October 31, 1980

TRANSMITTAL MEMORANDUM

TO: Review Participants

DATE COMMENTS DUE TO BUDGET AND PLANNING OFFICE: 11/21/80

Aeronautics Commission
X Air Control Board
_ Animal Health Commission
Bureau of Economic Geology
X Coastal and Marine Council
Department of Agriculture
Department of Health
X Department of Highways and Public Transportation
X Department of Water Resources
_ Texas Forest Service
X General Land Office
Historical Commission

_ Industrial Commission
X Parks and Wildlife Department
X Public Utilities Commission
✓X Railroad Commission
X Soil and Water Conservation Board
X Texas Energy and Natural Resources Advisory Council
_ Governor's Office of Regional Development

[X] Draft EIS [ ] Other EIS Number D-10-50-0?1

Project Title Draft Study: Hydroelectric Power Resources

Electric Reliability Council

Originating Agency U.S. Dept. of Army, Corps of Engineers

Pursuant to the National Environmental Policy Act of 1969, Office of Management and Budget Circular A-95, and the Texas Policy for the Environment (1975), the Governor's Budget and Planning Office is responsible for securing the comments and views of local and State agencies during the environmental impact statement review process.

Enclosed for your review and comment is a copy of the above cited document. This Office solicits your comments and asks that they be returned on or before the above due date. You may find the questions, listed on the reverse side, useful in formulating your comments.

For questions on this project, contact Ward Goessling at (512) 475-6021.

Please address your agency's formal comments to: Mr. Paul T. Wrotenbery, Director
Governor's Budget and Planning Office
Attention: General Government Section
P.O. Box 12428
Austin, Texas 78711

Suggested Questions to be Considered by Reviewing Agencies:

1. Does the proposed project impact upon and is it consistent with the plans, programs and statutory responsibilities of your agency?

2. What additional specific effects should be assessed?

3. What additional alternatives should be considered?

4. What better or more appropriate measures and standards should be used to evaluate environmental effects?

5. What additional control measures should be applied to reduce adverse environmental effects or to avoid or minimize the irreversible or irretrievable commitment of resources?

6. How serious would the environmental damage from this project be, using the best alternative and control measures?

7. What specific issues require further discussion or resolution?

8. Does your agency concur with the implementation of this project?

As a part of the environmental impact statement review process, the Budget and Planning Office forwards to the originating agency all substantive comments which are formally submitted. If, after analyzing this document, you conclude that substantive comments are unnecessary, you may wish to so indicate by checking the box below and forwarding the form to this office. This type of response will indicate receipt of this document by your agency and that no formal response will be prepared.

[X] No Comment.

Jim B. Claudt

Name and Title of Reviewing Official

Railroad Commission of Texas

Agency

REC... 1980 ADMINISTR...

OFFICE OF THE GOVERNOR

WILLIAM P CLEMENTS, JR.
GOVERNOR

October 31, 1980

TRANSMITTAL MEMORANDUM

TO: Review Participants

DATE COMMENTS DUE TO BUDGET AND PLANNING OFFICE: 11/21/80

- _ Aeronautics Commission
- X Air Control Board
- _ Animal Health Commission
- _ Bureau of Economic Geology
- X Coastal and Marine Council
- _ Department of Agriculture
- _ Department of Health
- X Department of Highways and Public Transportation
- X Department of Water Resources
- _ Texas Forest Service
- X General Land Office
- _ Historical Commission
- _ Industrial Commission
- X Parks and Wildlife Department
- X Public Utilities Commission
- X Railroad Commission
- X Soil and Water Conservation Board
- X Texas Energy and Natural Resources Advisory Council
- _ Governor's Office of Regional Development

[X] Draft EIS [ ] Other ____________ EIS Number 0-ID-50-051

Project Title Draft Study: Hydroelectric Power Resources Electric Reliability Council

Originating Agency U.S. Dept. of Army, Corps of Engineers

Pursuant to the National Environmental Policy Act of 1969, Office of Management and Budget Circular A-95, and the Texas Policy for the Environment (1975), the Governor's Budget and Planning Office is responsible for securing the comments and views of local and State agencies during the environmental impact statement review process.

Enclosed for your review and comment is a copy of the above cited document. This office solicits your comments and asks that they be returned on or before the above due date. You may find the questions, listed on the reverse side, useful in formulating your comments.

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Please address your agency's formal comments to: Mr. Paul T. Wrotenbery, Director
Governor's Budget and Planning Office
Attention: General Government Section
P.O. Box 12428
Austin, Texas 78711

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As a part of the environmental impact statement review process, the Budget and Planning Office forwards to the originating agency all substantive comments which are formally submitted. If, after analyzing this document, you conclude that substantive comments are unnecessary, you may wish to so indicate by checking the box below and forwarding the form to this office. This type of response will indicate receipt of this document by your agency and that no formal response will be prepared.

[X] No Comment.

Marcus L. Yancey Jr.
Name and Title of Reviewing Official
Marcus L. Yancey, Jr.
Deputy Engineer-Director, 11-12-80

State Department of Highways and Public Transportation
Agency

Suggested Questions to be Considered by Reviewing Agencies:

1. Does the proposed project impact upon and is it consistent with the plans, programs and statutory responsibilities of your agency?

2. What additional specific effects should be assessed?

3. What additional alternatives should be considered?

4. What better or more appropriate measures and standards should be used to evaluate environmental effects?

5. What additional control measures should be applied to reduce adverse environmental effects or to avoid or minimize the irreversible or irretrievable commitment of resources?

6. How serious would the environmental damage from this project be, using the best alternative and control measures?

7. What specific issues require further discussion or resolution?

8. Does your agency concur with the implementation of this project?

As a part of the environmental impact statement review process, the Budget and Planning Office forwards to the originating agency all substantive comments which are formally submitted. If, after analyzing this document, you conclude that substantive comments are unnecessary, you may wish to so indicate by checking the box below and forwarding the form to this office. This type of response will indicate receipt of this document by your agency and that no formal response will be prepared.

[X] No Comment.

Name and Title of Reviewing Official

GENERAL LAND OFFICE
Agency

Approved:
Mike Hightower, Director
Coastal Division
Land Resources Program

RECEIVED
DEC 1 1980
Budget & Planning

TEXAS DEPARTMENT OF WATER RESOURCES
1700 N. Congress Avenue
Austin, Texas

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Harvey Davis
Executive Director

TEXAS WATER COMMISSION
Felix McDonald, Chairman
Dorsey B. Hardeman
Joe R. Carroll

RECEIVED
NOV 21 1980
Budget/Planning

November 20, 1980

Mr. Paul T. Wrotenbery, Director
Governor's Budget and Planning Office
Attention: General Government Section
P. O. Box 12428
Austin, Texas 78711

Dear Mr. Wrotenbery:

The National Hydroelectric Power Resource Study, Volume XXI Draft Report (Electric Reliability Council of Texas Region), published by the U.S. Army Corps of Engineers has been reviewed by the staff of the Texas Department of Water Resources. Specific comments and concerns pertaining to the content of the report are presented below:

Chapter II. The economic analysis of the region is based on a 1972 OBERS Series E projection set. The problems inherent in using these outdated data should be clearly stated in the report. Also, the residential electrical energy use distribution patterns indicated in the last column of Table 2-5 on Page 2-15 should be footnoted to indicate that these were taken from a multi-regional study and are applicable to more than the Electric Reliability Council of Texas Region of the United States.

Chapter V. In developing the methodology for evaluating potential projects, water rights were not considered. Likewise, at new reservoir sites, it was assumed that existing unimpounded flow patterns would still exist after impoundment. Also, possible direct diversions from the reservoirs were not taken into account. These three considerations have significant impact on the viability of a hydroelectric power project, yet these issues were not addressed. We realize that it is impossible to consider all of these factors in detail in such an analysis and do not propose that the methodology be changed. Nonetheless, the Texas Department of Water Resources considers it to be of great importance that these issues and their implications be more clearly addressed in the final reports. Failure to do so would be a serious omission.

On Page 5-3, second paragraph, we question the validity of the methodology used to estimate flows in streams where drainage areas and flow data were not given. Although we realize this assumption was used only in the preliminary screening, it is not accurate for areas of the United States such as Texas. On pages 5-7 and 5-9 and 5-10, which present preliminary cost data for single power units, we note that the draft study does not indicate if these data include cost for pen stocks, tail races, switching yards, or other facilities that must also be built. The costs which are included in these data should be clearly stated.

Chapter VII. We believe that it is necessary to stress that many of the undeveloped sites presented in this report may never be built, and that many of the sites included are alternate sites for other projects on the list. We wish to again stress that water rights were not addressed in the methodology for arriving at these estimates.

We appreciate the opportunity to review this document. We again emphasize that the assumptions of the study pertaining to water rights, hydrology, and the cost analysis should be clearly stated. We hope that these comments will be helpful.

Sincerely yours,

Harvey Davis
Executive Director

TEXAS
PARKS AND WILDLIFE DEPARTMENT

COMMISSIONERS

PERRY R BASS
Chairman, Fort Worth

JAMES R PAXTON
Vice Chairman, Palestine

PEARCE JOHNSON
Austin

CHARLES D TRAVIS
EXECUTIVE DIRECTOR

4200 Smith School Road
Austin, Texas 78744

COMMISSIONERS

JOE K FULTON
Lubbock

EDWIN L COX, JR
Dallas

W B OSBORN JR
Santa Elena

November 24, 1980

Mr. Paul T. Wrotenbery, Director
Governor's Budget and Planning Office
Attention: General Government Section
P. O. Box 12428
Austin, Texas 78711

Re: Draft Study: Hydroelectric Power Resources, Volume XXI

Dear Mr. Wrotenbery:

The referenced study was recently provided to this Agency from the U. S. Army Corps of Engineers, and the attached comments were provided to that agency for their consideration.

The opportunity to coordinate with you on this matter is appreciated.

Sincerely,

CHARLES D. TRAVIS
Executive Director

CDT:JDR:bdj

Attachment

NOV 14 1980

Mr. Joel F. Wilson
Acting Chief, Planning Division
Department of the Army
Southwestern Division, Corps of Engineers
Main Tower Building, 1200 Main Street
Dallas, Texas 75202

Re: National Hydroelectric Power Resources Study,
Draft Report (SWDPL-M)

Dear Mr. Wilson:

The referenced document was reviewed by this agency and the following comments are offered for your consideration.

This agency can appreciate the need for energy generation from hydropower projects such as those discussed in this document. This agency is also vitally interested in the preservation of the fisheries resources of the State's streams and rivers. It is believed that, with proper coordination, both objectives can be achieved in a satisfactory manner, and a discussion of such coordination would make a worthwhile addition to this document. Of particular importance for the protection of fisheries resources is the quality of water released (e.g., hypolimnetic water can create a hazard to fish) and the quantity and timing of water releases that will maintain downstream fisheries. The pattern of brush and tree clearing in the reservoir site should also be an important ingredient of early coordination.

Noted.

This agency will be happy to provide assistance in early planning and coordination on any of these specific projects.

Sincerely,

CHARLES D. TRAVIS
Executive Director

CDT:JDR:dsb
SIGNED AND DISPATCHED ________ 19 _____

PWD 482 (Rev 2/78) 6000

BLCLIVEL

NOV 21 1980

Budget/Planning

TEXAS STATE SOIL AND WATER CONSERVATION BOARD

1002 First National Building
P O Box 658
Temple Texas 76501
Area Code 817 773 2250

November 19, 1980

Mr. Paul T. Wrotenbery, Director
Governor's Budget and Planning Office
Attention: General Government Section
411 West 13th Street
Austin, Texas 78701

Dear Mr. Wrotenbery:

We have reviewed the draft environmental impact statement for the Draft Study: Hydroelectric Power Resources, Electric Reliability Council prepared by the U.S. Department of the Army, Corps of Engineers.

We offer no comment on the statement.

Sincerely yours,

A. C. Spencer
Executive Director

ACS/JMM/vd

BRAZOS RIVER AUTHORITY

4400 COBBS DRIVE P O BOX 7555 TELEPHONE AREA CODE 817 776-1441
WACO, TEXAS 76710

November 6, 1980

Department of the Army
Southwestern Division, Corps of Engineers
Main Tower Building, 1200 Main Street
Dallas, Texas 75202

Attention: SWDPL-M

Gentlemen:

Reference is made to letter from Mr. Joel F. Wilson, Acting Chief, Planning Branch, dated 9 October 1980, with which he forwarded for our comment a draft dated September 1980 of Volume XXI, Regional Report, Electric Reliability Council of Texas, National Hydroelectric Power Resources Study. Following are our comments.

Table 5-4 on pages 5-19 and 5-20 of the draft report lists seven existing reservoirs and seven undeveloped sites in the Brazos River Basin as "Sites With Potential for Hydropower Development". Use of the criteria and procedures described in the draft report in evaluating the seven existing reservoirs and seven undeveloped sites listed in the Brazos Basin is completely unrealistic and results in greatly exaggerating their potential for hydropower development.

The Brazos River Authority was created by the Texas Legislature in 1929 and is the agency of the State of Texas with responsibility for developing, conserving and making available for beneficial use the surface water resources of the entire Brazos River Basin. In meeting this responsibility, the Authority has planned, financed, constructed, owns and operates three major water supply reservoirs in the Brazos Basin. The Authority has also cooperated with the U.S. Army Corps of Engineers in development of multi-purpose reservoirs throughout the basin in order to have the right to use the conservation storage space in such reservoirs for water supply purposes.

Two of the seven existing Brazos Basin reservoirs listed in Table 5-4 as having hydropower potential, Lakes Granbury and Limestone, are entirely owned by the Brazos River Authority. The other five are owned by the United States and operated by the Corps of Engineers, but by agreeing to pay all costs associated with the inclusion of conservation storage space in each of these projects the Authority has acquired the right to use such space for water supply purposes. Under permits granted by the State of Texas, the Authority has the right to store State water in each of these reservoirs and to use them in a basin-wide surface water supply system.

The entire long-term dependable yield of the Authority's entire system, including all of the seven reservoirs listed in Table 5-4, is committed to meeting present and future water needs under existing water supply contracts. Part, and in some cases all, of the dependable yield of each reservoir is committed to uses in the immediate vicinity of the reservoir upstream of the dam. Water thus committed will not be passed through the dam and would not be available for hydroelectric power generation. Commitments to downstream needs will be met by operating the Authority's reservoirs to supplement unregulated streamflow. When unregulated flow is in excess of all permitted downstream uses, including those to which water from storage is committed, no release from storage will be made. When release from storage is required to meet downstream commitments, the release will be made from the reservoir or reservoirs which, from a hydrologic standpoint, are in the best condition to supply the water at that time.

Accordingly, there will be extended periods when no water will be released from conservation storage in the Authority's reservoir system, and the only water passing the dam would be flood flows, which are infrequent and of short duration, and low inflows that are passed through the reservoir for the benefit of downstream water rights holders but that are too small to be of use for the generation of hydroelectric power. Even streamflow records immediately downstream of reservoirs that have been in place for several years do not accurately reflect future release patterns. The reservoir system is still in development, and much of the water committed under contracts is for future use, with only a relatively small portion of the water committed having been put to actual use so far. With completion of the system and full use of committed water, it is to be expected that release patterns will differ radically from historical streamflows. It is therefore apparent that use of historical streamflows, as outlined in the description of methodology in Chapter 5 of the report, as a basis for evaluating hydroelectric potential at one of the Authority's water supply reservoirs will give a highly distorted picture and greatly exaggerate the potential for hydropower development.

It is agreed that significant changes in streamflow patterns not considered in the analysis would invalidate estimates of hydropower potential.

The methodology is also faulty in regard to the assumption that is apparently made that a power head adequate for power generation will always be available. These are water supply reservoirs, and during the design critical drouth period, they will be drawn down essentially to the bottom of the conservation pool in normal operation to meet water supply commitments. Therefore, during any extended drouth period, the level of water in the lake will be for much of the time below the stage necessary for practical power generation. It is

The methodology does not contain the assumption that a power head adequate for power generation will always be available. When the sequential routing option was used, no releases for hydropower beyond dependable capacity was made if the reservoir storage was at or above the top of the conservation (power) pool.

therefore apparent that the assumption of continuous existence of an "average net power head" in the methodology for the studies has resulted in indicating a much greater potential for hydropower development than actually exists.

It is recommended that, before putting the draft report in final form, consideration be given to the facts summarized above and that the draft report be modified as necessary to reflect the above summarized facts.

We appreciate your giving us the opportunity to comment on this draft report.

Sincerely,

Carson H. Hoge

CARSON H. HOGE
Assistant General Manager

CHH:gls

TMPA

Serving the cities of Bryan Denton, Garland & Greenville

October 16, 1980

B-6200
ERCOT
National Hydroelectric
Power Resources Study

Mr. Joel F. Wilson
Acting Chief, Planning Division
Department of the Army
Southwestern Division, Corps of Engineers
Main Tower Building, 1200 Main Street
Dallas, Texas 75202

Dear Mr. Wilson:

Please be advised that we have no substantive comments to the above captioned draft report other than to support the observations on Page 6-2 that the Brazos River basin water use would be more productive for thermal generation rather than hydropower.

Noted.

Sincerely,

Larry C. Hearn

Larry C. Hearn, P. E.
Director
Engineering & Operations

jk

Texas Municipal Power Agency 600 Arlington Downs Tower Arlington, Texas 76011 (817) 461-4400

ATTACHMENT C

(DETAILED DATA ON ERCOT SITES IN NHS)

ATTACHMENT C

FOOTNOTES

(1) **Project Identification Number**

```
         Example:  TX  C  SWF  3402
       State Code──┘   |   |     └──Sequential Number
Type & Status Code─────┘   └────────District Code
 (Table below)
```

Status of Waterway	Run of River	Diversion	Reservoir	Reservoir with Diversion	Irrigation Canal	Pumped Storage
Existing	A	B	C	D	E	F
Existing with Power	G	H	I	J	K	L
Existing with Retired Power Plant	M	N	O	P	Q	R
Breached	S	T	U	V	W	X
Breached with Retired Power Plant	Y	Z	0	1	2	3
Undeveloped	4	5	6	7	8	9

(2) These estimates are based on readily available data which have generally not been verified in the field. Inasmuch as detailed studies have not been made, the potential incremental capacity and energy estimates overstate the actual power which can be developed in some cases. At existing projects, this is particularly true because of upstream diversions, releases for fish and wildlife preservation and enhancement, flood control, water supply, navigation, and recreation.

(3) Data Item: Purposes

Purpose: To identify authorized purposes at existing projects. Probable purposes at potential projects.

Source: Existing in Inventory of Dams. From available sources.

Requirements: Yes

Categories:
- I = Irrigation
- H = Hydroelectric
- C = Flood Control
- N = Navigation
- S = Water Supply
- R = Recreation
- D = Debris Control
- P = Farm Pond
- O = Other

Example: CH

(4) Data Item: Status

Purpose: Indication of project status.

Source: From available sources.

Requirement: Yes. When added to data base.

Categories:
- IS = Identified Site
- SP = Study Proposed
- SA = Authorized for Study
- FP = Feasibility Study in Progress
- SI = Study Inactive
- PA = Project Authorized
- DM = GDM in Progress
- UC = Under Construction
- OP = Project in Operation

NOTE: All dams in the Inventory of Dams were coded as OP by SWD-ADP.

Example: OP

ATTACHMENT C

SITE ID NUMBER ACTV. INV. (Footnote 1)	PROJECT NAME / PRIMARY CO. / OWNER	NAME OF STREAM	LATITUDE / LONGITUDE / DR. AREA (D M.M) (D M.M) (SQ.MI)	PROJ.PURP. / STATUS / AVF. Q (CFS) (Footnote 3 &4)	DAM HT / MX.STOR. / PHR. HD. (FT) (AC FT) (FT)	EXIST.CAP. / INC. CAP. / TOT. CAP. (MW) (MW) (MW)	EXIST.ENRG / INC.ENERGY / TOT.ENERGY (MWH) (MWH) (MWH) (Footnote 2)	ANUL. COST / ENERGY COST (1000 $) ($/MWH)	ERC ECONOMIC (SEQUENCE RANK)	ERC NONECONOMIC (SEQUENCE RANK)	ERC COMPOSITE (SEQUENCE RANK)
TXGSHP0004	TENNESSEE COLONY DAM		31 50.0	CSHR	124.0	0	0	51064	2029		
2	ANDERSON	TRINITY RIVER	95 50.9	OP	6910000	17900	77705	696.82		2029	
	DAEN SWF		12302	3170.0	79.9	17900	77705				2023
TXGSHG0999	WEST POINT		30 2.2	HISPC	99.0	0	0	18378	2019		
2	BASTROP	COLORADO RIVE	97 11.9	FP	1930000	22850	55354	259.61		2019	
	UNKNOWN		27705	1585.9	62.9	22850	55354				2007
TXCSHP0005	BELTON DAM		31 6.0	C S R	192.0	0	0	1608.7	2002		
2	BELL	LEON RIVER	97 28.4	OP	1876700	16000	26920	61.247		2002	
	DAEN SWF		3560	663.0	115.8	16000	26920				1001
TXCSHP0006	STILLHOUSEHOLLOW DA M		31 1.9	CSR	200.0	0	0	298.15	1007		
2	BELL	LAMPASAS RIVE	97 31.9	OP	1013300	2780	6016	48.098		1006	
	DAEN SWF		1318	300.0	123.8	2780	6016				1008
TXGSHP0018	BEE MOUNTAIN		32 12.0	IHS	100.0	0	0	5388.0	2032		
2	BOSQUE	BRAZOS RIVER	97 36.2	SI	0	2150	6795	792.35		2032	
			25455	-987.9	90.9	2150	6795				2024
TXGSHP0020	TANYARD CROSSING DAM		30 59.0	CSRH	235.0	0	0	21316	2041		
2	BURNET	COLORADO RIVE	98 26.9	SI	6296100	3350	4550	4685.0		2041	
	DAEN SWF		18918	-370.1	209.2	3350	4550				2030
TXGSHP0024	WECHES DAM		31 35.0	CSH	129.0	0	0	20589	2024		
2	CHEROKEE	NECHES RIVER	95 11.4	IS	3442100	15622	49869	412.86		2024	
	DAEN SWF		1886	-1426.7	96.9	15622	49869				2015
TXCSHP0032	LAVON DAM		33 1.9	CSR	81.0	0	0	136.15	2003		
2	COLLIN	EAST FORK OF	96 28.9	OP	921200	1080	2223	61.248		2003	
	DAEN SWF		770	460.0	58.9	1080	2223				1011
TXGSHG0998	ALTAIR		29 39.9	HISR	39.0	0	0	7768.2	2018		
2	COLORADO	COLORADO RIVE	96 27.2	FP	181965	14193	43492	178.60		2018	
	UNKNOWN		28230	2230.5	46.0	14193	43492				2004

ATTACHMENT C (continued)

SITE ID NUMBER ACTV. INV.	PROJECT NAME PRIMARY CO. -NAME OF STREAM OWNER	LATITUDE LONGITUDE DR. AREA (D M.M) (D M.M) (SQ.MI)	PROJ.PURP. STATUS AVE. Q (CFS)	DAM HT MX.STOR. PWR. HD. (FT) (AC FT) (FT)	EXIST.CAP. INC. CAP. TOT. CAP. (KW) (KW) (KW)	EXIST.ENRG INC.ENERGY TOT.ENERGY (MWH) (MWH) (MWH)	ANUL. COST ENERGY COST (1000 $) ($/MWH)	ERC ECONOMIC ERC NONECONOMIC ERC COMPOSITE (SEQUENCE RANK) (SEQUENCE RANK) (SEQUENCE RANK)
TX6SWG0587 2	COLUMBUS BEND RES COLORADO - COLORADO RIVE BUREAU OF REC	29 50.0 96 45.0 29180	MISR FP 2234.5	60.0 608666 51.0	0 66222 66222	0 56072 56072	10891 187.10	2015 2015 2005
TXCSWF3402 2	CANYON DAM COMAL - GUADALUPE RIV DAEN SWF	29 52.0 98 11.9 1432	CSR OP 387.0	224.0 1129300 158.8	0 6604 6604	0 18631 18631	574.19 30.818	1002 1002 1002
TX6SWF4423 2	AUBREY DAM DENTON - ELM FORK OF T DAEN SWF	33 21.3 97 3.2 692	CSR DM -249.1	127.0 1931900 97.4	0 2850 2850	0 4557 4557	14684 3221.8	2040 2040 2029
TXCSWF0048 2	LEWISVILLEDAM DENTON - ELM FORK OF T DAEN SWF	33 3.9 97 1.0 1600	CSR OP 663.0	125.0 2082800 76.9	0 2780 2780	- 0 6750 6750	321.97 47.700	1005 1004 1006
TX6SWG0572 2	CUERO 1ST STAGE DEWITT - GUADALUPE RIV BUREAU OF REC	29 8.4 97 20.0 4900	MCRS FP 2024.5	103.0 1650000 80.9	0 21043 21043	0 72712 72712	19891 273.56	2020 2020 2008
TX6SWG0556 2	LA GRANGE RES FAYETTE - COLORADO RIVE UNKNOWN	29 54.2 96 52.9 27550	MISR FP 2184.5	87.0 2010000 79.7	0 106904 106904	0 87487 87487	21755 248.67	2018 2018 2006
TX6SWF8379 2	RICHLAND-TEHUACANA DAM FREESTONE - RICHLAND AND TARRANT COUNTY WCSIDND 1	31 57.1 96 5.9 2300	S FP -1352.5	90.0 2082000 69.9	0 15800 15800	0 23464 23464	25075 1068.6	2036 2036 2027
TX6SWG0575 2	GOLIAD RES GOLIAD - SAN ANTONIO R UNKNOWN	29 38.4 97 26.0 3921	MSR FP 641.5	127.0 2117000 110.6	0 8684 8684	0 23791 23791	17846 750.13	2030 2030 2010
TXMSWG0075 0	GONZALES PROJECT NO.2960 GONZALES - GUADALUPE RIV CITY OF GONZALES	29 29 23 97 27 18 3450	H OP 0	15.0 0 0	0 1140 1140	0 6800 6800	~~0~~ 3.0 3.0	1008 1007 1015

ATTACHMENT C (continued)

SITE ID NUMBER / ACTV. INV.	PROJECT NAME / PRIMARY CO. - NAME OF STREAM / OWNER	LATITUDE (D M.M) / LONGITUDE (D M.M) / DR. AREA (SQ.MI)	PROJ.PURP. / STATUS / AVE. Q (CFS)	DAM HT (FT) / MX.STOR. (AC FT) / PWR. HD. (FT)	EXIST.CAP. (KW) / INC. CAP. (KW) / TOT. CAP. (KW)	EXIST.ENRG. (MWH) / INC.ENERGY (MWH) / TOT.ENERGY (MWH)	ANNL. COST (1000 $) / ENERGY COST ($/MWH)	ERC ECONOMIC (SEQUENCE RANK) / ERC NONECONOMIC (SEQUENCE RANK) / ERC COMPOSITE (SEQUENCE RANK)
TXCSWG0564	LAKE HOUSTON	29 55.1	S	64.0	0	0	389.69	1001
2	HARRIS - SAN JACINTO R	95 7.8	OP	153785	5004	15329	22.812	1001
	HOUSTON	2828	1792.5	39.3	5004	15329		1005
TXCSWF0085	DECORDOVA BEND	32 20.7	IS	84.0	0	0	613.12	1003
2	HOOD - BRAZOS RIVER	97 42.7	OP	293750	5839	19698	31.125	1009
	BRAZOS RIVER AUTHORITY	24691	-1381.1	65.4	5839	19698		1004
TXGSWF0411	LOCK AND DAM NO.7	31 22.7	NM	50.0	0	0	9996.8	2010
2	HOUSTON - TRINITY RIVER	95 40.6		0	12600	43166	115.75	2012
	DAEN SWF	13680	-5761.9	39.9	12600	43166		2002
TXGSWG0592	PALMETTO BEND	28 52.9	S	55.0	0	0	7627.2	2037
2	JACKSON - NAVIDAD RIVER	96 34.7	SI	329300	1831	5305	1037.5	2037
	BUREAU OF REC	1004	731.0	43.5	1831	5305		2019
TXGSWF0421	ROCKLAND DAM	31 1.3	HCSR	106.0	0	0	36788	2028
2	JASPER - NECHES RIVER	94 22.9	BI	5074600	19307	62198	591.46	2028
	DAEN SWF	3557	-2274.9	74.9	19307	62198		2022
TXCSWG0579	WESLEY E SEALE	28 2.4	R	54.0	0	0	172.55	1004
2	JIM WELLS - NUECES RIVER	97 51.8	OP	308700	1338	3939	43.805	1003
	LNRWSD	16656	864.7	41.7	1338	3939		1009
TXGSWF0105	DAM 7	29 52.9	HCSR	195.0	0	0	9215.0	2033
2	KENDALL - GUADALUPE RIV	98 31.9	BI	630000	15000	10900	845.91	2033
	GUADALUPE-BLANCO R AUTH	1124	-272.3	167.8	15000	10900		2025
TXGSWF9014	SULPHUR BLUFF	33 25.6	S	60.0	0	0	9920.8	2042
2	LAMAR - SULPHUR RIVER	95 26.0	IS	1060035	1800	1790	5543.0	2042
	TWDB	1026	945.0	17.9	1800	1790		2031
TXGSWG0578	LAKE CORPUS CHRISTI	28 2.1	HSR	115.0	0	0	14808	2038
2	LIVE OAK - NUECES RIVER	97 52.1	FP	1900000	3279	7834	1890.2	2038
	CITY OF CORPUS CHRISTI	16660	865.0	107.6	3279	7838		2029

ATTACHMENT C (continued)

SITE ID NUMBER ACTV. INV.	PROJECT NAME PRIMARY CO. - NAME OF STREAM OWNER	LATITUDE (D M.M) LONGITUDE (D M.M) DR. AREA (SQ.MI)	PROJ.PURP. STATUS AVE. Q (CFS)	DAM HT (FT) MX.STOR. (AC FT) PWR. HD. (FT)	EXIST.CAP. (KW) INC. CAP. (KW) TOT. CAP. (KW)	EXIST.ENRG (MWH) INC.ENERGY (MWH) TOT.ENERGY (MWH)	ANLL. COST (1000 $) ENERGY COST ($/MWH)	ERC ECONOMIC (SEQUENCE RANK) ERC NONECONOMIC (SEQUENCE RANK) ERC COMPOSITE (SEQUENCE RANK)
TX6SWG0577	OAKVILLE	28 26.3	HSR	57.0	0	0	4689.7	2031
2	LIVE OAK - NUECES RIVER	98 7.5	PP	176000	2515	6145	763.11	2031
	UNKNOWN	15630	867.2	48.0	2515	6145		2018
TX6SWF0115	MASON DAM	30 39.9	CSRH	196.0	0	0	5107.6	2022
2	MASON - LLANO RIVER	99 15.0	SI	1057700	6446	16626	307.20	2022
	DAEN SWF	3127	-854.9	123.3	6446	16626		2013
TXCSWF0119	WACO DAM	31 36.0	CSR	140.0	0	0	403.91	2006
2	MCLENNAN - BOSQUE RIVER	97 13.0	OP	828300	4000	5407	74.695	2010
	DAEN SWF	1670	845.0	84.9	4000	5407		1014
TX6SWF0127	CAMERON DAM	30 46.9	CSRH	119.0	0	- 0	15067	2026
2	MILAM - LITTLE RIVER	97 1.0	IS	3033800	9304	28579	527.21	2026
	DAEN SWF	7008	-1848.9	78.9	9304	28579		2017
TX6SWF0132	PONTA RESERVOIR DAM	31 43.0	CSH	104.5	0	0	2918.3	2016
2	NACOGDOCHES - ANGELINA RIVE	94 58.0	IS	0	5316	14188	205.68	2016
	DAEN SWF	1251	-730.3	41.9	5316	14188		2011
TX6SWF0139	INSPIRATION POINT	32 41.4	IMCR	80.0	0	0	3442.4	2017
2	PALO PINTO - BRAZOS RIVER	98 7.4	SI	205000	5048	14228	241.93	2017
		23231	-1031.7	58.9	5048	14228		2012
TX6SWF0138	TURKEY CREEK	32 48.7	IMCS	81.0	0	0	5238.5	2023
2	PALO PINTO - BRAZOS RIVER	98 12.5	SI	159000	5370	15067	347.68	2023
		23113	-1026.5	58.9	5370	15067		2014
TX6SWF0145	HIGHTOWER	32 34.5	IMCS	75.0	0	0	6046.3	2027
2	PARKER - BRAZOS RIVER	97 49.4	SI	520000	3980	10270	588.73	2027
		24393	-1083.4	58.9	3980	10270		2021
TX6SWF0149	CARL L ESTES DAM	32 43.0	CSR	103.5	0	0	15976	2034
2	RAINS - SABINE RIVER	95 37.0	DM	1151300	9718	17006	939.43	2034
	DAEN SWF	1128	-926.6	53.9	9718	17006		2035

ATTACHMENT C (continued)

SITE ID NUMBER ACTV. INV.	PROJECT NAME PRIMARY CO. -NAME OF STREAM OWNER	LATITUDE LONGITUDE DR. AREA (D M.M) (D M.M) (SQ.MI)	PROJ.PURP. STATUS AVE. Q (CFS)	DAM HT MX.STOR. PWR. HD. (FT) (AC FT) (FT)	EXIST.CAP. INC. CAP. TOT. CAP. (KW) (KW) (KW)	EXIST.ENRG INC.ENERGY TOT.ENERGY (MWH) (MWH) (MWH)	ANUL. COST ENRGY COST (1000 $) ($/MWH)	ERC ECONOMIC ERC NONECONOMIC ERC COMPOSITE (SEQUENCE RANK) (SEQUENCE RANK) (SEQUENCE RANK)
TXCSWF0150	IRON BRIDGE DAM	32 48.7	IRS	85.0	0	0	183.82	2009
2	RAINS - SABINE RIVER	95 54.9	DP	1810000	2000	1845	99.593	2007
	SABINE RIVER AUTHORITY	756	=829.1	58.9	2000	1845		2032
TXISWA0122	RED BLUFF RESERVOIR DAM	31 58.0	IWO	106.0	0	0	50.880	2013
2	REEVES - PECOS RIVER	103 58.5	DP	805000	80	301	168.61	2009
	RED BLUFF WATER CON DIST	20720	=289.6	90.2	80	301		2036
TXCSWF0186	STERLING C. ROBERTSON DAM	31 19.7	SI	60.0	0	0	137.23	2012
2	ROBERTSON - NAVASOTA RIVE	96 19.0	UC	85P603	800	919	149.20	2008
	BRAZOS RIVER AUTH	678	=302.3	39.9	800	919		2030
TX6SWF0161	HANNA DAM	31 22.9	M	105.0	0	0	2676.9	2029
2	SAN SABA - COLORADO RIVE	98 50.0	IS	300000	3600	6340	822.12	2029
	LOWER COLORADO RIVERAUT	25757	-629.0	102.8	3600	6340		2016
TX6SWF0162	SAN SABA	31 7.7	SC	230.3	0	0	8961.0	2035
2	SAN SABA - SAN SABA RIVE	98 59.1	SI	1190000	3400	9155	970.72	2035
		2760	-262.8	166.8	3400	9155		2026
TXCSWF0175	EAGLE MOUNTAIN DAM	32 52.2	SIR	85.0	0	0	168.10	2001
2	TARRANT - WEST FORK TRI	97 29.7	DP	958250	1400	2891	58.137	2001
	TARRANT COWCID 1	1970	-268.8	87.9	1400	2891		1012
TXCSWF0173	GRAPEVINE DAM	32 58.0	CSR	137.0	0	0	129.20	2005
2	TARRANT - DENTON CREEK	97 3.0	DP	758800	780	1860	69.464	2005
	DAEN SWF	695	193.0	83.9	780	1860		1013
TX6SWF8805	BRECKENRIDGE DAM	33 0.0	CSRH	199.0	0	0	7558.1	2039
2	THROCKMORTON- CLEAR FORKBRA	99 20.0	IS	2112900	1380	2959	2552.9	2039
	DAEN SWF	3830	-235.6	138.8	1380	2959		2028
TX6SWF8809	PADGETT DAM	33 18.9	CSRH	120.0	0	0	13461	2043
2	THROCKMORTON- BRAZOS RIVER	98 57.5	IS	3137800	630	1372	9811.7	2043
	DAEN SWF	15211	-869.0	63.9	630	1372		2033

ATTACHMENT C (continued)

SITE ID NUMBER ACTV. INV.	PROJECT NAME PRIMARY CO. -NAME OF STREAM OWNER	LATITUDE (D M.M) LONGITUDE (D M.M) DR.AREA (SQ.MI)	PROJ.PURP. STATUS AVE. Q (CFS)	DAM HT (FT) MX.STOR. (AC FT) PWR. HD. (FT)	EXIST.CAP. (KW) INC. CAP. (KW) TOT. CAP. (KW)	EXIST.ENRG (MWH) INC.ENERGY (MWH) TOT.ENERGY (MWH)	ANUL. COST (1000 $) ENERGY COST ($/MWH)	ERC ECONOMIC (SEQUENCE RANK) ERC NONECONOMIC (SEQUENCE RANK) ERC COMPOSITE (SEQUENCE RANK)
TXCSWF0184	LONGHORN DAM	30 15.0	O	0	0	0	550.18	1009
9	TRAVIS - COLORADO RIVE	97 42.7	OP	6850	3293	9864	55.777	1008
	CITY OF AUSTIN TEXAS	38510	-2567.8	9.9	3293	9864		1016
TX6SWG0047	LOWER AUSTIN	30 10.9	MISR	53.0	0	0	4133.8	2011
2	TRAVIS - COLORADO RIVE	97 26.3	FP	138000	13456	35683	115.84	2013
	UNKNOWN	26070	-1533.9	43.5	13456	35683		2003
TXISWF0188	INTERNATIONAL AMISTAD DAM (U	29 27.0	C I H R	285.0	0	0	5470.7	2008
2	VALVERDE - RIO GRANDE	101 3.5	OP	5658600	80000	156000	90.270	2006
	IBWC	126423	-1057.0	218.4	80000	156000		1003
TX6SWG0574	CONFLUENCERES	28 35.0	MSR	55.0	0	0	19102	2021
2	VICTORIA - GUADALUPE RIV	96 55.2	FP	1100000	22394	66740	286.81	2021
	UNKNOWN	10128	3506.3	48.4	22394	66740		2009
TX6SWF0191	PALAFOX DAM	27 39.9	H	70.0	0	0	5640.7	2007
2	WEBB - RIO GRANDE	99 41.0	IS	0	22500	68100	82.831	2011
		130600	-8091.7	65.9	22500	68100		2001
TXCSWF0413	GRANGER DAM	30 42.1	CSR	115.0	0	0	265.56	1006
2	WILLIAMSON - SAN GABRIEL R	97 19.7	UC	579900	1840	5435	48.881	1005
	OAEN SWF	709	309.7	63.9	1840	5435		1007
TXCSWF0197	NORTH FORKDAM	30 39.9	CSR	162.0	0	0	122.12	2008
2	WILLIAMSON - NORTH FORKOF	97 43.5	UC	220100	680	1836	66.515	2008
	OAEN SWF	246	-99.5	91.9	680	1836		1010

NHS MAPS

Two maps are inserted into the adjacent pocket. One is an index map and one is a site location map. The primary purpose of the index map is to show the National Electric Reliability Council (NERC) regions, the Corps of Engineers division and district boundaries, and Corps office locations. A separate regional report and accompanying site location map has been prepared for each of the NERC regions depicted on the index map.

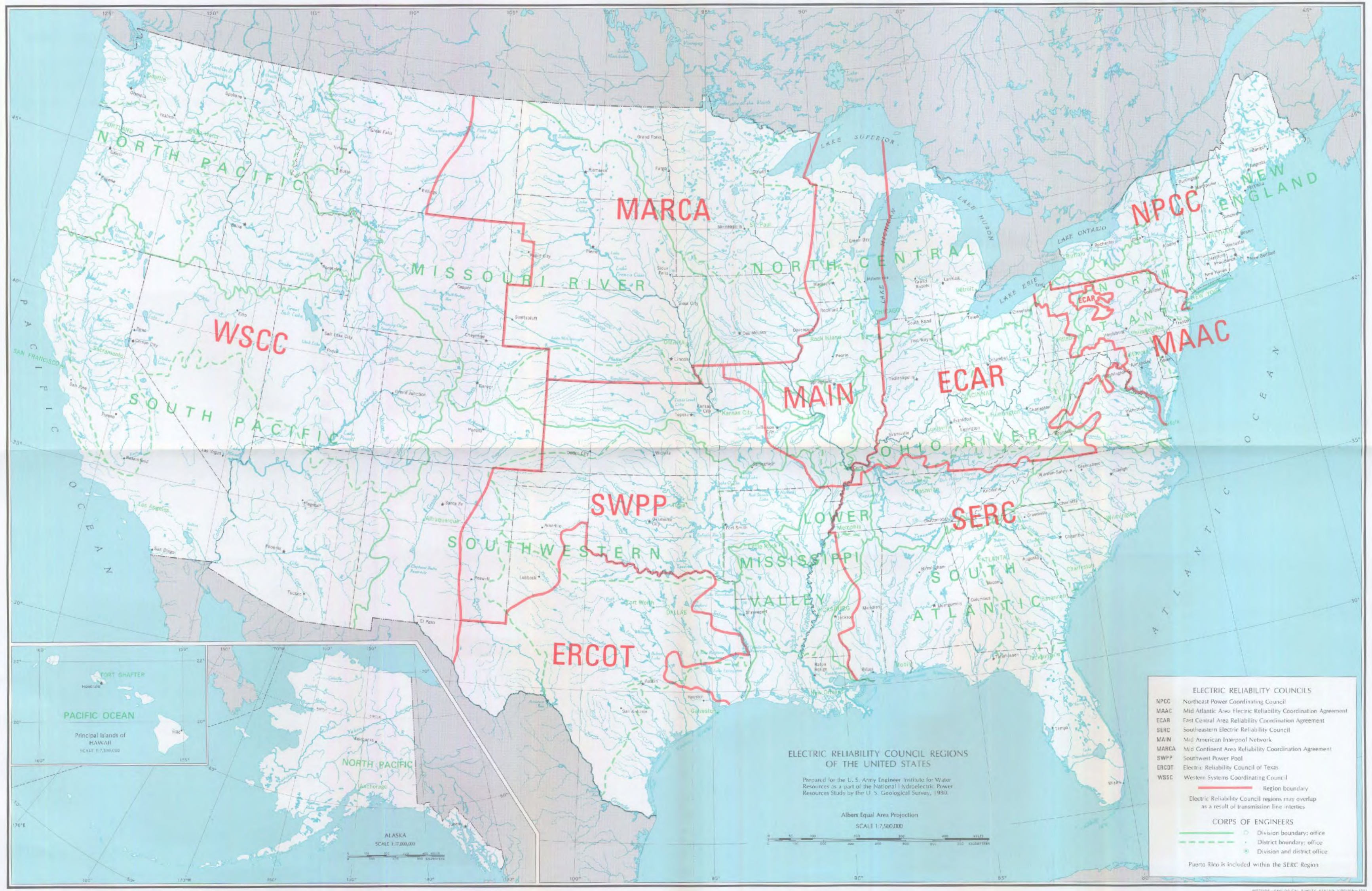
The second map shows existing and potential hydroelectric site locations for the subject region and is intended to provide general information to the reader about the sites. The size of a project is depicted by the diameter of the circle and the type of project by color. Each site symbol on the map is labeled with a four digit number which corresponds to a ten character National Hydroelectric Power Resources Study site identification code. Each part of the 10 character ID code helps to narrow down the source of information for that site. For example, a typical site identification code is shown below:

```
            O R   A   N P P   9 9 9 9
               |  |     |        |
      State ---   |     |         ---- Site ID Number
Type of Project --       ------ Corps Division and District
```

Consequently, for more information about a site, one needs to determine from the map a site's state and county, the Corps division and district, and the four digit number. With the site ID number, the site can then be located in the list of sites in the regional report or in Volume XII of the NHS final report. If more detailed information is desired, the appropriate Corps division and/or district office may be contacted.

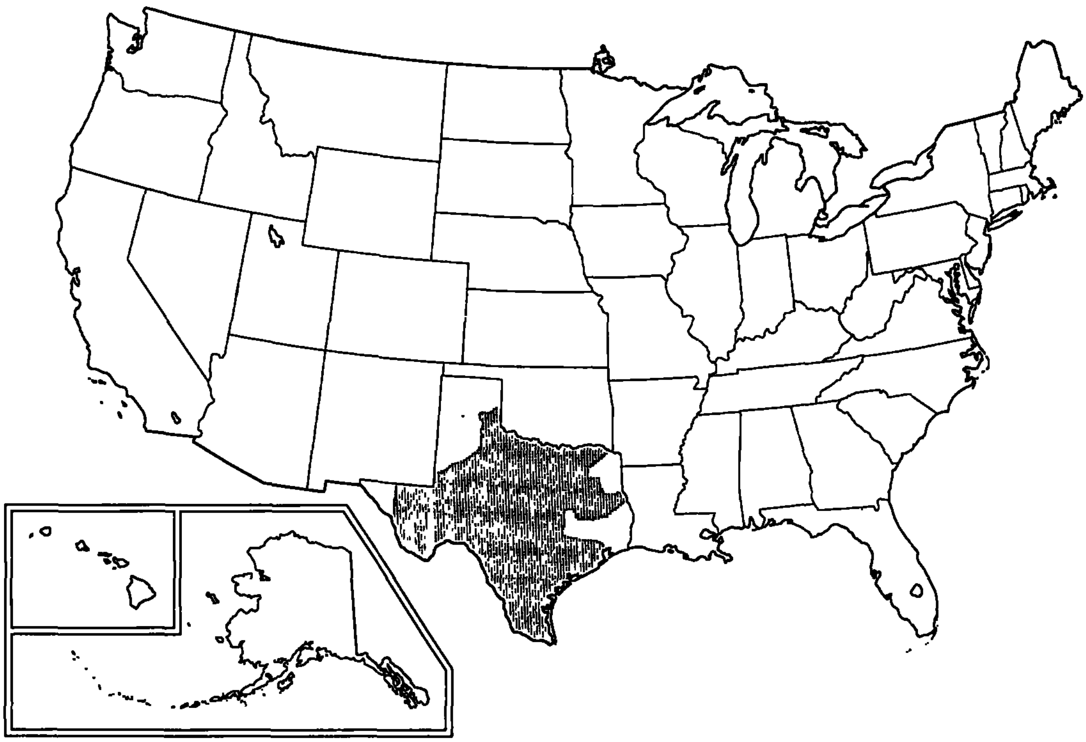
NATIONAL HYDROELECTRIC POWER RESOURCES STUDY

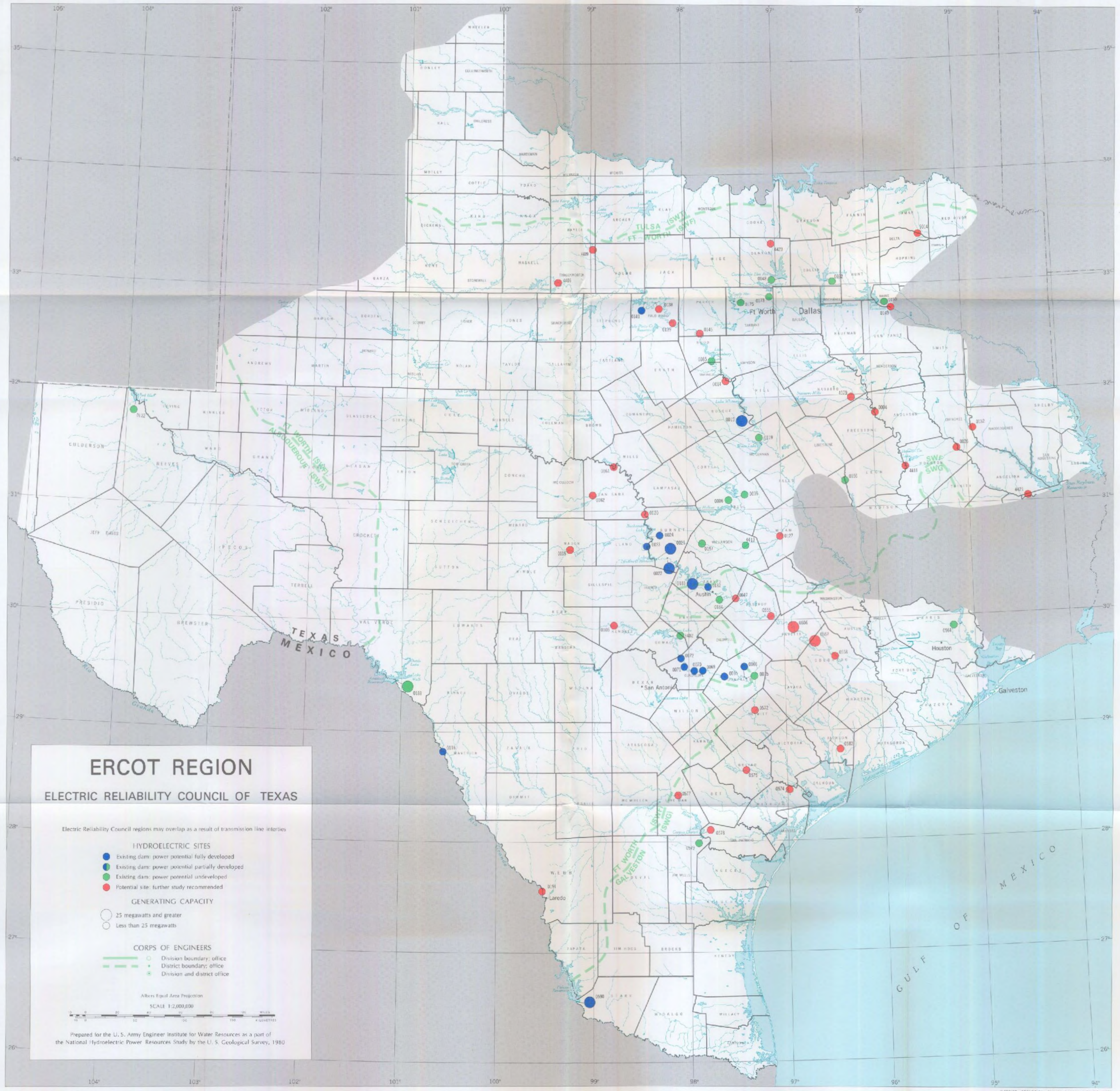
INDEX TO NATIONAL ELECTRIC RELIABILITY COUNCIL REGIONS


ELECTRIC RELIABILITY COUNCIL REGIONS OF THE UNITED STATES
Prepared for the U. S. Army Engineer Institute for Water Resources as a part of the National Hydroelectric Power Resources Study by the U. S. Geological Survey, 1980.
Albers Equal Area Projection
SCALE 1:7,500,000
WSCC
MARCA
MAIN
ECAR
NPCC
MAAC
SWPP
SERC
ERCOT
NORTH PACIFIC
SOUTH PACIFIC
MISSOURI RIVER
NORTH CENTRAL
NEW ENGLAND
OHIO RIVER
SOUTHWESTERN
LOWER MISSISSIPPI VALLEY
SOUTH ATLANTIC
PACIFIC OCEAN
ATLANTIC OCEAN
ELECTRIC RELIABILITY COUNCILS
NPCC Northeast Power Coordinating Council
MAAC Mid Atlantic Area Electric Reliability Coordination Agreement
ECAR East Central Area Reliability Coordination Agreement
SERC Southeastern Electric Reliability Council
MAIN Mid American Interpool Network
MARCA Mid Continent Area Reliability Coordination Agreement
SWPP Southwest Power Pool
ERCOT Electric Reliability Council of Texas
WSSC Western Systems Coordinating Council
Region boundary
Electric Reliability Council regions may overlap as a result of transmission line interties
CORPS OF ENGINEERS
Division boundary; office
District boundary; office
Division and district office
Puerto Rico is included within the SERC Region

NATIONAL HYDROELECTRIC POWER RESOURCES STUDY

ELECTRIC RELIABILITY COUNCIL OF TEXAS (ERCOT)




ERCOT REGION
ELECTRIC RELIABILITY COUNCIL OF TEXAS
Electric Reliability Council regions may overlap as a result of transmission line interties
HYDROELECTRIC SITES
Existing dam: power potential fully developed
Existing dam: power potential partially developed
Existing dam: power potential undeveloped
Potential site: further study recommended
GENERATING CAPACITY
25 megawatts and greater
Less than 25 megawatts
CORPS OF ENGINEERS
Division boundary; office
District boundary; office
Division and district office
Albers Equal Area Projection
SCALE 1:2,000,000
MILES
KILOMETRES
Prepared for the U. S. Army Engineer Institute for Water Resources as a part of the National Hydroelectric Power Resources Study by the U. S. Geological Survey, 1980
TEXAS
MEXICO
GULF OF MEXICO
Ft Worth
Dallas
Austin
San Antonio
Houston
Galveston
Laredo