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WASTEWATER MANAGEMENT PLAN. COLORADO RIVER AND TRIBUTARIES, TEX--ETC(U)
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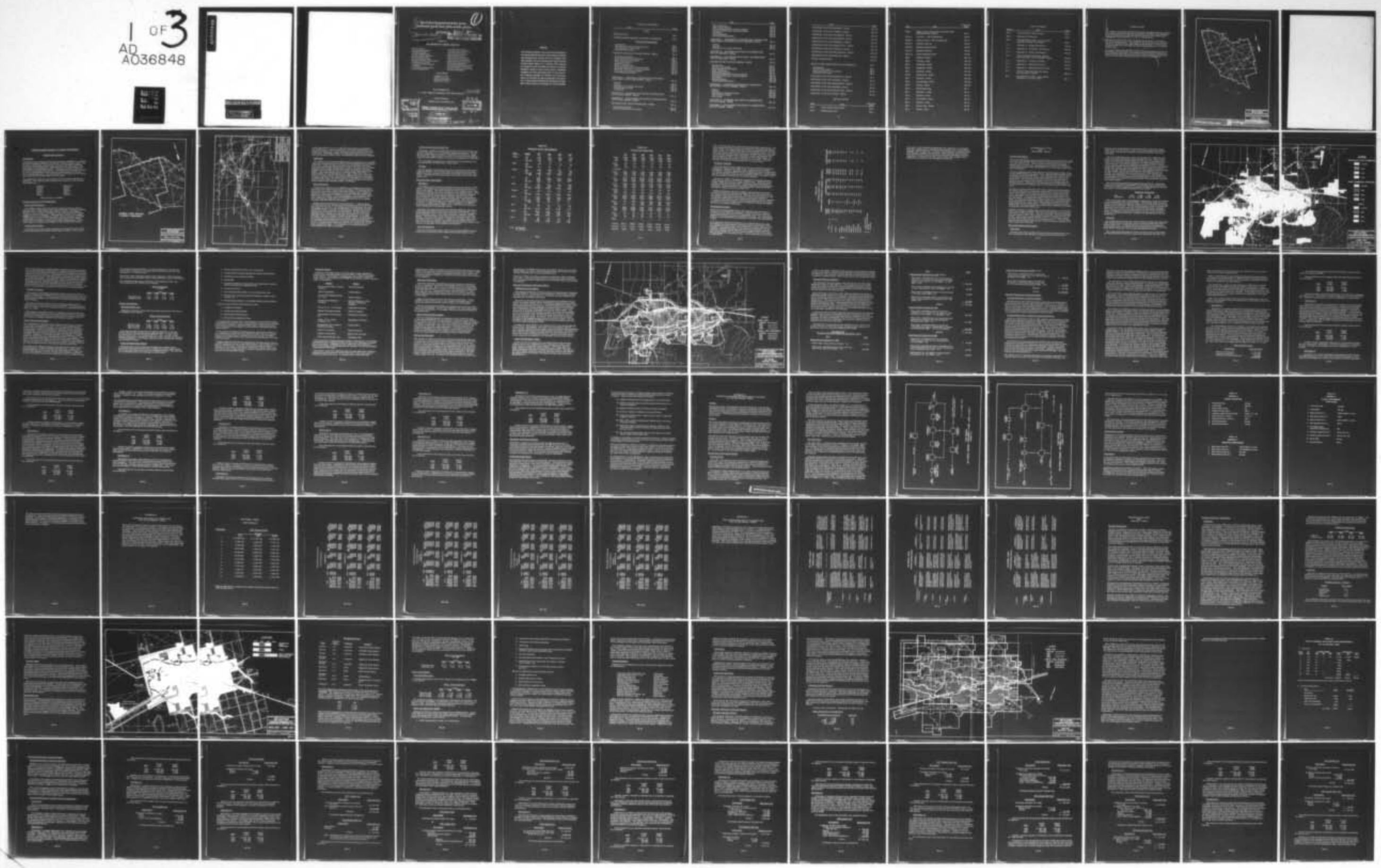

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(6) WASTEWATER MANAGEMENT PLAN.

COLORADO RIVER AND TRIBUTARIES, TEXAS.

VOLUME V. Upper Basin

Areawide Plan.

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(1)

Prepared by

THE GOVERNOR'S PLANNING COMMITTEE

Office of the Governor
Texas Water Development Board
Texas Water Quality Board
Texas Water Rights Commission
Texas Parks and Wildlife Department
Railroad Commission of Texas
Texas State Department of Health
Texas State Soil and Water Conservation Board
U. S. Department of the Interior
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U. S. Environmental Protection Agency
Farmers Home Administration
Lower Colorado River Authority
Colorado River Municipal Water District
Central Colorado River Authority
Upper Colorado River Authority
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Central Texas Council of Governments
Concho Valley Council of Governments
Houston-Galveston Area Council
Permian Basin Regional Planning Commission
South Plains Association of Governments
West Central Texas Council of Governments
Nine General Public Members

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Congressman John Young
Congressman Omar Burleson
Congressman O. C. Fisher

Study Management By

U. S. ARMY CORPS OF ENGINEERS, FORT WORTH DISTRICT

(12) 255p.

Consulting Engineers

TURNER, COLLIE & BRADEN, INC.

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PREFACE

The information presented in this volume consists of background and technical data that were used in the formulation of the Wastewater Management Plan, Colorado River and Tributaries, Texas, dated September 1973, which was approved by the Environmental Protection Agency Region VI on 4 December 1973. These data are intended for use by the affected communities in the basin as background material for future planning actions in wastewater management and other water quality fields. For those communities considering application for treatment works construction grants, this information can serve as a data base for the preparation of material required in Sections 201 and 208 of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500).

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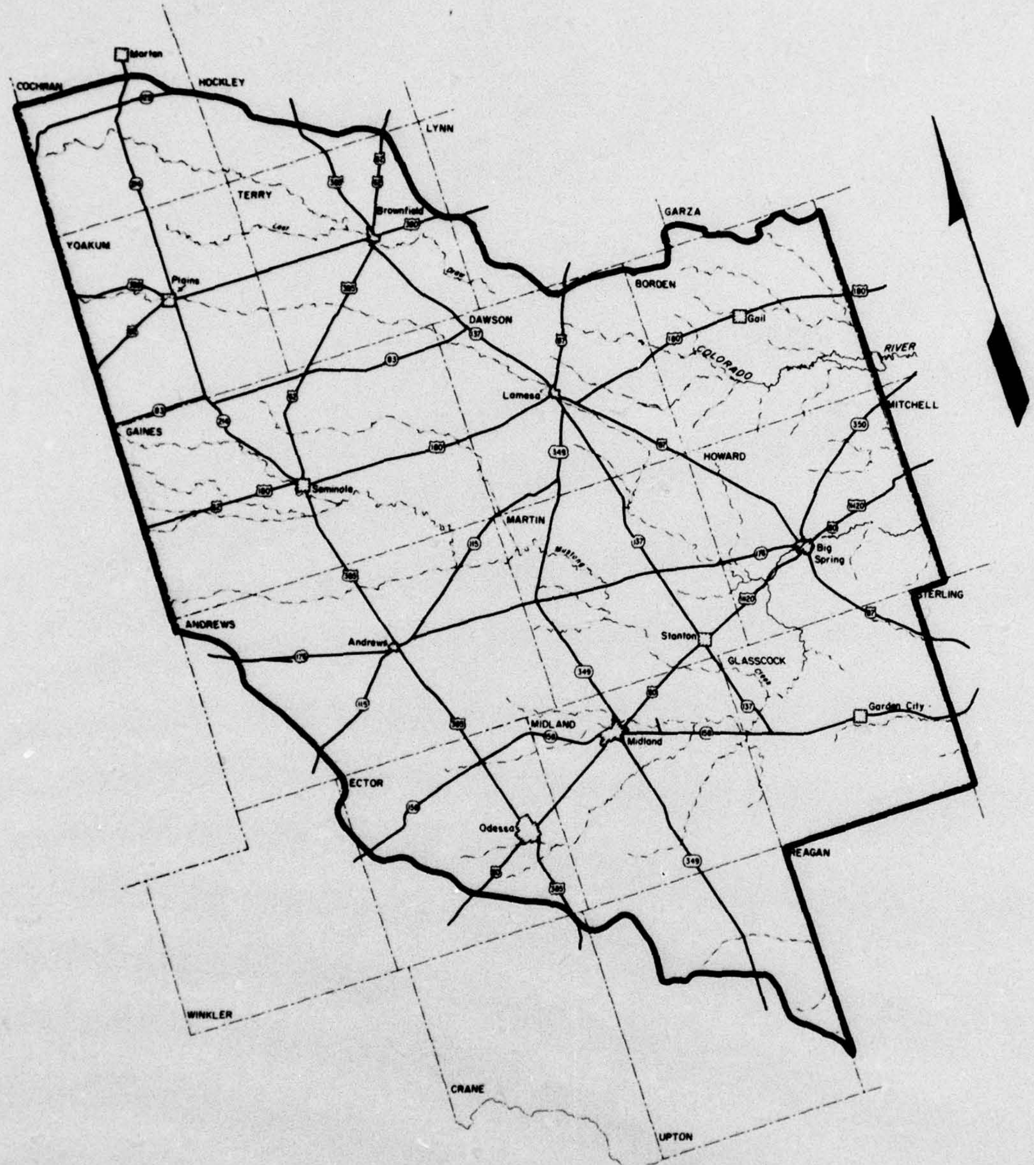
INTRODUCTION

This volume of the Colorado River Wastewater Management Study contains the areawide planning documents pertaining to the Upper Basin Planning Area and prepared in conjunction with the Colorado River Wastewater Management Plan, Volumes I, II, III, IV and Summary.

During the course of the study, the Basin was divided for convenience into three planning areas. The results of the study efforts for the three areas are contained in the Upper Basin Areawide Plan, Central Basin Areawide Plan and Lower Basin Areawide Plan (Volumes V, VI and VII, respectively).

This Upper Basin Areawide Plan contains those documents prepared for the planning jurisdictions of the Permian Basin Regional Planning Commission and the South Plains Association of Governments. The general area covered by this planning document is shown on Plate UB-1.



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

UPPER BASIN
PLANNING AREA

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PERMIAN BASIN REGIONAL PLANNING COMMISSION

General Characteristics

Introduction.

The Permian Basin Regional Planning Commission (PBRPC) is composed of fourteen member and three non-member counties in West Texas. For purposes of this study, only the nine counties of the PBRPC planning area within the Colorado River Basin boundary will be discussed. The Commission was established in 1971 to plan and coordinate activities and efforts in regional development. The PBRPC has no statutory authority, but is instrumental in formulating recommendations for the welfare of the planning area. The main functions of this body are the review and coordination of planning efforts in the region.

The PBRPC also lists five school districts and six special districts as members. The counties in this planning area which lie in the Colorado River Basin are:

Andrews	Glasscock
Borden	Howard
Crane*	Martin
Dawson	Midland
Ector	Upton
Gaines	Winkler*

*Non-members of PBRPC

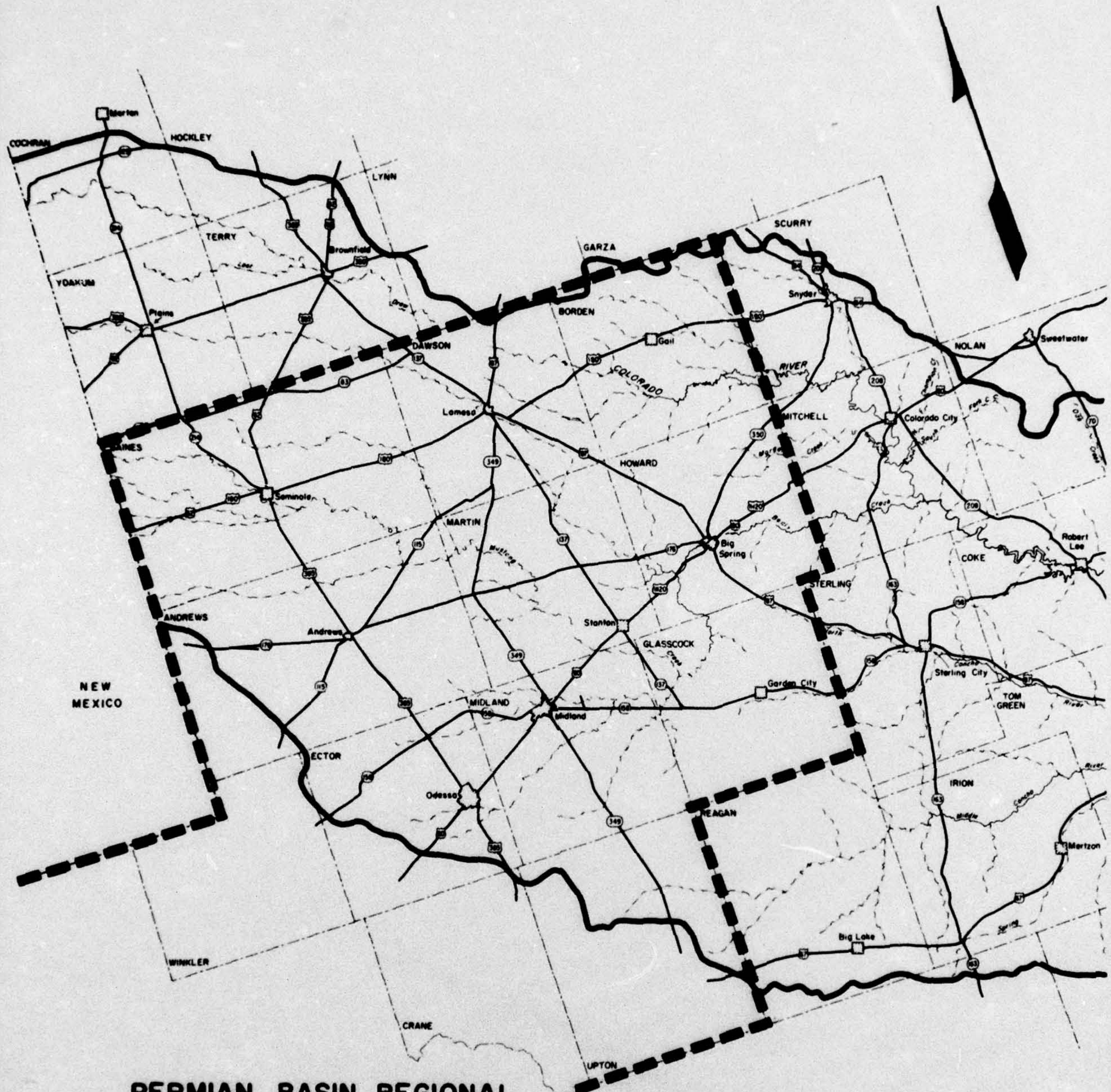
Physical Description of Planning Area.

Study Area Delineation.

The PBRPC region in the Colorado River Basin covers an area of approximately 10,000 square miles and includes all of Andrews, Borden, Dawson, Ector, Gaines, Glasscock, Howard, Martin, and Midland Counties. Also included in the Basin is the northeastern half of Upton County which lies in the Basin. Geographically, most of the in-Basin PBRPC area is in the High Plains region, with the exception of Borden and Glasscock Counties. The former is found in the Lower Plains region while the latter is located in the Edwards Plateau area. Plate PB-A shows the relation of the PBRPC to the Colorado River Basin.

Climate Descriptions.

The study area's mean annual temperature averages from 60° to 64°F and the mean annual precipitation totals about 16 inches. Mean annual



PERMIAN BASIN REGIONAL PLANNING COMMISSION

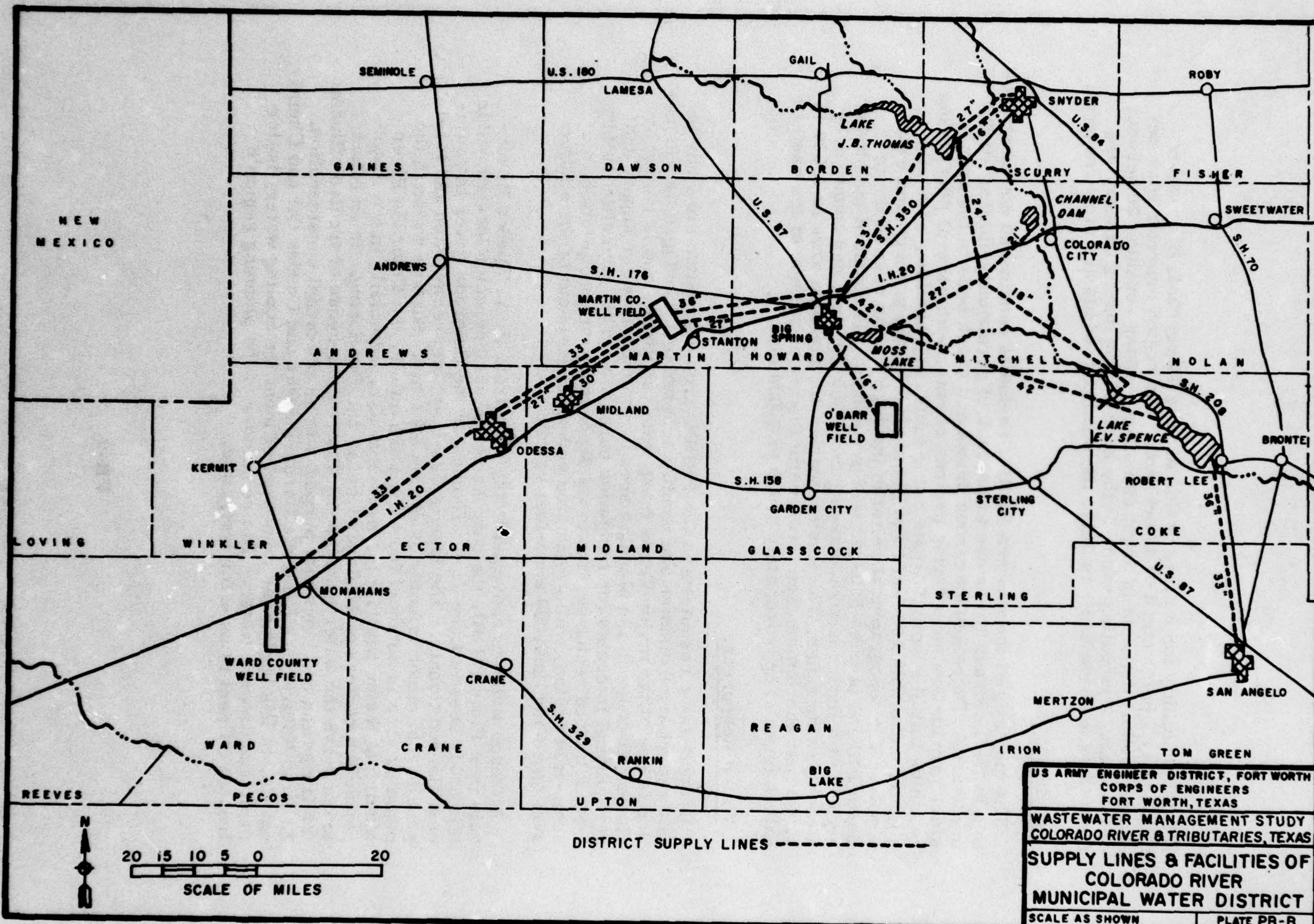
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

PBRPC STUDY AREA

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

PLATE: PB-A


SEMINOLE
U.S. 180
LAMESA
GAIL
ROBY
SNYDER
U.S. 84
LAKE
J.B. THOMAS
27"
16"
GAINES
DAWSON
BORDEN
SCURRY
FISHER
NEW
MEXICO
CHANNEL
DAM
SWEETWATER
U.S. 87
33"
S.H. 350
24"
21"
COLORADO
CITY
S.H. 70
ANDREWS
S.H. 176
I.H. 20
27"
18"
MARTIN CO.
WELL FIELD
36"
27"
42"
BIG
SPRING
STANTON
MOSS
LAKE
33"
ANDREWS
MARTIN
HOWARD
MITCHELL
NOLAN
30"
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MIDLAND
16"
42"
S.H. 208
O'BARR
WELL
FIELD
LAKE
E.V. SPENCE
BRONTE
ODESSA
KERMIT
S.H. 158
ROBERT LEE
33"
I.H. 20
GARDEN CITY
STERLING
CITY
36"
LOVING
WINKLER
ECTOR
MIDLAND
GLASSCOCK
COKE
U.S. 87
33"
MONAHANS
STERLING
WARD COUNTY
WELL FIELD
CRANE
SAN ANGELO
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MERTZON
REAGAN
WARD
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SCALE OF MILES
DISTRICT SUPPLY LINES
US ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
SUPPLY LINES & FACILITIES OF
COLORADO RIVER
MUNICIPAL WATER DISTRICT
SCALE AS SHOWN
PLATE PB-B

relative humidity for 6 a.m. in this area is 70 percent, decreasing to a yearly 6 p.m. mean of 40 percent. The region experiences a net annual evaporation rate of about 60 inches, having sunshine 70 percent of the year. Prevailing winds in the High Plains during January are from the southwest while in July, the southeast winds are most frequent.

Hydrology.

The majority of the western PBRPC region is considered non-contributing to the Colorado River due to the lack of perennially-flowing streams in the area. There are numerous draws and creek beds in the area which provide drainage during periods of rain, with several playa lakes retaining initial runoff. Ground water tables are shallow, with only slightly more than 100 feet from the surface to the underground water supply. The topographical relief in the High Plains area of the in-Basin PBRPC is from 500-900 feet per county. The rest of the study area is of a flatter nature, varying from 300-500 feet per county over a county-wide range. The western half of the planning area is 3,000 to 4,000 feet above mean sea level, while the major portion of the eastern half is found at approximately 2,000 to 3,000 feet.

Water Resources.

Ground water resources in the PBRPC area designated for study in this report are extensive and readily accessible. The Ogallala Formation is one of the major Texas fresh water aquifers, and is tapped by almost all cities in the planning area for municipal water supply and agricultural interests for irrigation purposes. This formation suffers from a lack of recharge, due to its dependency on precipitation in a semi-arid region, while estimated perennial yield out of the aquifer averages about 200,000 acre-feet yearly.

Although water is conveyed to the area from E. V. Spence Reservoir (see Plate PB-B), the only source of surface water located within this study area is Lake J. B. Thomas on the Colorado River in southeast Borden County. The lake is dependent on precipitation and local runoff from minor tributaries for its contents. Surface water in the planning area is obtained from the Lake owner, the Colorado River Municipal Water District for municipal use, especially in the major population centers of Midland, Odessa and Big Spring. In an effort to conserve the water resource of this region, reuse of treated effluent for irrigation and industrial purposes is an important consideration. El Paso Natural Gas Products Co. in Odessa, and Cosden Oil and Chemical Co. in Big Spring use municipal effluent for cooling water, boiler feed, and process water. The remainder of the planning region's treated effluent is used for irrigation.

Present and Projected Water Use.

Municipal, industrial and agricultural water use for the study area has been projected by the Texas Water Development Board. The projection methodology is presented in Appendix A of Volume II, Basin Plan Appendix. Expressed in acre-feet, the projected water requirements for the PBRPC in-Basin study area are presented in Table PB-1.

The individual municipal water requirements are presented in the city presentations included later in this report.

Geology.

Surface geology in the study area is from the Pliocene, Miocene and Oligocene Epochs. Soils in this region are generally neutral sands, sandy loams and clay loams with some very shallow calcareous clay loams. Individual soils are discussed in the write-up for each metropolitan area.

Socio-Economic Description.

Population.

The PBRPC and the local city governments have the function of planning for, protecting and maintaining both the population and environment of the region. The many aspects that affect people's lives, their values and behavior have to be considered in any planning effort. Thus, the primary variable that must be weighed in any program designed for the future has to be the number of people that the project will serve or affect. Once this variable has been defined, the guidelines for the scope of the project have been established. This task was performed by the TWDB through the methodology explained in Appendix A of Volume II, Basin Plan Appendix. Their findings for the PBRPC study area are illustrated in Table PB-2, which shows the urban and rural populations for the planning period.

Individual metropolitan and non-metropolitan population figures are individually discussed in the specific municipal presentations. The large population centers in the study area which have been designated as metropolitan areas for this study are Odessa, Midland, and Big Spring. These and other urban areas will be covered in detail in the following sections of this report. In general, the larger urban areas are found in areas of extensive petroleum activity and development, while the purely agricultural regions are characterized by smaller trade centers and generally rural population distributions.

Land Use Analysis.

Land use for the three major cities in the in-Basin PBRPC jurisdictional area is illustrated on the respective land-use maps for each

TABLE PB-1

PROJECTED WATER REQUIREMENTS

County	Function	1970	1980	1990	2020
Andrews	Mun.	2,432	2,677	2,829	3,162
	Ind.	1,157	1,785	2,059	3,032
	Agri. (GW)	1,198	571	0	0
Borden	Mun.	125	137	143	138
	Ind.	0	0	0	0
	Agri. (GW)	377	179	0	0
Dawson	Mun.	2,026	2,084	2,051	1,788
	Ind.	39	47	48	52
	Agri. (GW)	42,085	33,604	25,900	7,830
	(SW)	23	0	0	0
Ector	Mun.	14,658	18,056	21,324	32,792
	Ind.	4,584	6,773	8,282	15,032
	Agri. (GW)	2,406	1,141	0	0
Gaines	Mun.	2,272	2,224	2,215	2,006
	Ind.	465	459	502	653
	Agri. (GW)	146,835	126,903	108,780	32,886
Glasscock	Mun.	105	125	141	183
	Ind.	0	0	0	0
	Agri. (GW)	34,185	28,586	23,506	20,943
Howard	Mun.	6,780	7,905	8,814	11,368
	Ind.	2,490	3,158	3,596	5,317
	Agri. (GW)	1,255	595	0	0
	(SW)	124	0	0	0
Martin	Mun.	496	528	553	582
	Ind.	6	6	6	6
	Agri. (GW)	29,187	19,320	10,360	3,132
Midland	Mun.	12,473	14,046	15,148	17,721
	Ind.	670	865	989	1,474
	Agri. (GW)	33,429	22,517	12,601	5,292
Upton	Mun.	49	48	42	27
	Ind.	188	204	212	212
	Agri.	5,438	6,109	6,723	6,480

NOTE: ***GW = Groundwater***
SW = Surface Water

TABLE PB-2

POPULATION PROJECTIONS

	1970	1980	1990	2000	2010	2020
Andrews	10,359	10,880	11,380	11,880	12,180	12,380
Urban	8,625	8,780	8,970	9,140	9.150	9,070
Rural	1,734	2,100	2,410	2,740	3,030	3,314
Borden	860	870	870	870	780	780
Urban	0	0	0	0	0	0
Rural	860	870	870	870	780	780
Crane (U&R)	0	0	0	0	0	0
Dawson	16,434	15,250	14,260	13,080	11,890	10,800
Urban	11,559	10,910	10,270	9,480	8,680	7,940
Rural	4,875	4,340	3,990	3,600	3,210	2,860
Ector	91,700	105,190	121,080	137,160	154,240	172,320
Urban	78,383	91,510	105,240	119,100	133,820	149,350
Rural	13,317	13,680	15,840	18,060	20,420	22,970
Gaines	11,593	11,400	11,300	10,900	10,600	10,100
Urban	5,007	5,130	5,230	5,180	5,180	5,080
Rural	6,586	6,270	6,070	5,720	5,420	5,020
Glasscock	1,155	1,200	1,300	1,400	1,500	1,500
Urban	0	0	0	0	0	0
Rural	1,155	1,200	1,300	1,400	1,500	1,500
Howard	37,796	40,400	43,400	45,800	48,100	50,100
Urban	28,753	32,050	34,670	36,850	38,970	40,890
Rural	9,061	8,350	8,730	8,950	9,030	9,210
Martin	4,771	4,800	4,900	4,900	4,800	4,800
Urban	0	0	2,640	2,790	2,900	3,070
Rural	4,771	4,800	2,260	2,110	1,900	1,730
Midland	65,433	68,700	72,400	75,100	77,400	79,100
Urban	59,463	62,340	65,310	67,360	69,020	70,130
Rural	5,970	6,360	7,090	7,740	8,380	8,970
Upton	270	240	200	160	130	110
Urban	0	0	0	0	0	0
Rural	270	240	200	160	130	110
Winkler	0	0	0	0	0	0
Total COG	240,371	258,930	281,090	301,250	321,620	341,990
Total Urban	191,772	210,720	232,330	249,900	267,720	285,530
Total Rural	48,599	48,210	48,760	51,350	53,900	56,460

city. Over the study area, land use is predominantly agricultural, with ranching and farming activities maintained over and around oil operations. While the in-Basin study area consists of approximately 10,000 square miles, only about 100 of these are occupied by cities. The vastness and extent of agricultural land usage and open space is illustrated by the fact that approximately 764 square miles in the planning area were irrigated in 1970, even though the lack of available water resources restricts that practice somewhat in the region. Industrial land use is confined to the peripheries of the major cities.

Economic Analysis.

Oil is the chief economic support for the area, although agriculture, consisting of sorghum and cotton crops, ranks high as a secondary contributor. Industry, especially that in Odessa, employs a high number of residents in its petrochemical and refining complexes. Economically, the area is basically sound, but new markets must be cultivated to diversify the economic structure as oil reserves dwindle.

The area is readily accessible by a network of excellent highways connecting the cities in the in-Basin PBRPC area. Midland's major airport, along with several county, municipal and private airports, provide aerial access to the area. Railway service is provided by the Atchinson, Topeka and Santa Fe Railroad and the Texas and Pacific Railroad to major points in the study area.

Growth potential for the area is slight, unless improved recovery methods are devised to boost the oil industry, and a diversification of the economic base can be achieved. The lack of water resources must be considered as a deterrent to growth as much as the decline of employment possibilities. While automation causes many farm workers to migrate to the urban centers, the demands placed on the metropolitan services must be handled in such a manner as to obtain the highest return for the resource allocated.

Existing Waste Loads.

Within the following PBRPC plans, the projected waste loadings as furnished by the TWQB are presented. Those projections, based on census populations and not service populations, were to be used with judgment for planning purposes throughout the study. The methodology utilized in those projections is presented in the Basin Plan Appendices, Volume

In an attempt to develop an estimate of the existing influent and effluent loadings for each municipal treatment facility in the Basin, available published sampling data, field visitations, and prior reports were examined. Estimated treatment reductions were developed, and the resultant estimated effluent loadings are the best available approximations of the loadings that would be exerted on Basin waters if the facilities discharged to a receiving stream. These estimates are presented in Table PB-3.

TABLE PB-3

EXISTING WASTE LOADS

PERMIAN BASIN REGIONAL PLANNING COMMISSION

City		Estimated Population Served	Discharge	Estimated Influent Loading			Estimated Treatment Reduction	Estimated Effluent Loading	
				Flow mgd	BOD lb./day	TSS lb./day		BOD lb./day	TSS lb./day
BIG SPRING	TF	34,000	Yes	2.35	3,380	1,770	65% / 22%	1,180	1,370
	HP	7,000	No	0.50	720	380	77% / 10%	170	340
MIDLAND	M	59,500	No	4.30	8,600	10,160	90% / 85%	860	1,520
	A	Unknown	No	0.14	230	290	80% / 80%	50	60
ODESSA		78,000	No	6.20	12,500	14,700	93% / 88%	880	1,760
ANDREWS		8,000	No	0.80	1,360	1,600	85% / 85%	200	240
LAMESA		11,400	Yes	0.60	1,900	1,700	80% / 80%	380	340
GOLDSMITH		387	No system	0.03	70	80	–	–	–
SEAGRAVES		2,400	No	0.20	200	220	85% / 85%	30	30
SEMINOLE		5,000	No	0.43	610	470	62% / 74%	230	120
GARDEN CITY		286	No system	0.02	50	60	–	–	–
COAHOMA		1,200	No	0.10	180	210	70% / 40%	50	120
SAND SPRINGS		903	No system	0.08	150	180	–	–	–
STANTON		2,000	No	0.17	180	270	68% / 77%	40	60

TF – Trickling Filter Process
HP – Hays Process–Activated Sludge
M – Main Plant
A – Airport Plant

Very little of the available sampling data was consistent or reasonable; therefore, judgment was required in many instances as to what influent loadings could be expected. Treatment reductions were calculated where possible from available data; however, where lacking, the reductions were estimated with typical efficiencies tempered with known operating conditions. As stated previously, with no other data available, best judgment was required in the loadings and estimates.

METROPOLITAN PLAN
FOR
BIG SPRING, TEXAS

Physical Description.

The City of Big Spring is an incorporated home rule municipality located in the central portion of Howard County at the intersection of I. H. 20, U.S. 80, and U. S. 87. The city limits of Big Spring encompass approximately 8,200 acres. Big Spring is the county seat of Howard County and is located within the jurisdiction of the Permian Basin Planning Commission.

The City, situated on the divide between the High Plains of West Texas and the Rolling Plains, has grown in the valley formed by Beals Creek, a tributary of the Colorado River. The major portion of the City lies on the southern bank of the Creek and is bounded on the south by an escarpment. The northern portion of the City is on the low side of Beals Creek and slopes more gradually toward the tributary than the southern portion. Drainage for the southern section of Big Spring is predominantly to the northeast while the northern section drains to the south.

The City is entirely underlain by the Potter-Mansker soil association. The Potter soils have a calcareous, sandy loam to clay loam surface, 4 to 10 inches thick, over white or pinkish-white caliche several feet thick. The caliche is semi-hard in the upper part and becomes soft and chalky below. The terrain is gently sloping to hilly, with 2 to 20 percent slopes. Permeabilities range from 0.8 to 2.5 inches per hour. There are moderate limitations on septic tanks due to the permeability of the soil; however, there may be some danger of flooding due to the shallow depth of the caliche layer. Sewage lagoons have severe limitations due to the permeability of the soil and the probability of seepage through the calcareous substratum.

Mansker soils have a friable loam to clay loam surface, 4 to 10 inches thick, over friable, granular, clay loam with small calcium carbonate concretions in the lower part. The soil is strongly calcareous throughout with a nearly white, thick horizon of calcium carbonate at 12 to 20 inches. The terrain is gently sloping with one to five percent slopes. Permeabilities range from 0.8 to 2.5 inches per hour. This soil type imposes the same limitations on septic tanks and sewage lagoons as the above-mentioned Potter soil.

Social and Economic Description.

Population.

The area, now known as Howard County, first attracted settlers who were interested in the abundance of good grazing land found there.

Ranches were established near sources of water, and cattle raising became the chief occupation. Later, when homesteading was allowed, large areas of range were cleared, and cotton and other crops were cultivated.

The City of Big Spring first came into prominence in 1880 when the Texas and Pacific Railroad was built through the town. Shortly afterwards, the Texas and Pacific Railway shops were constructed and became one of the City's major industries. In 1900 the population was 1,255; however, by 1930 the population increased to 13,735. This increase was motivated by the extension into Howard County of the Howard-Glasscock oil field. The City continued to grow steadily through the years, with the population increasing by 13,944 people between the years of 1950 to 1960. By the end of that decade, the population stood at 31,230. This rapid increase was due, in part, to the construction of Webb Air Force Base, 1.8 miles west of the City. The small decline between 1960-70 was due to the phasing back of Webb AFB and the related services, along with normal attrition of the permanent and semi-permanent populace.

The 1970 Census population for Big Spring was 28,735. Population projections developed by the TWDB for use in this study indicate that a moderate increase in population is expected for Big Spring over the next fifty years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	28,735	32,050	34,670	40,890

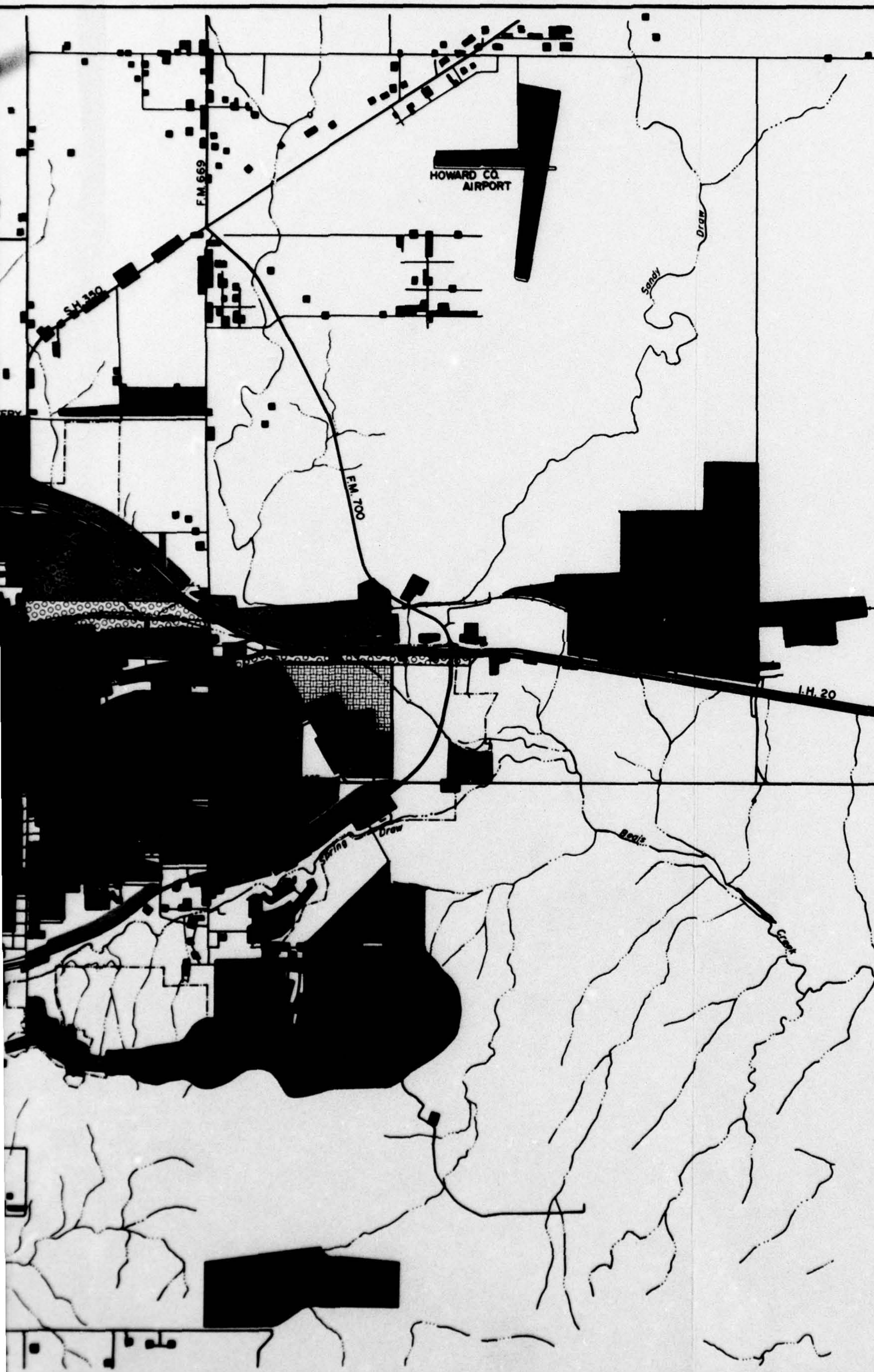
The current population of Big Spring is comprised of 78 percent whites, 16 percent Spanish, and 5 percent Negro. The median annual income of families and unrelated individuals in the City is $7,974 while the average annual income is $9,013. The low income section of town is located predominantly north of the Texas and Pacific Railroad tracks, although there are some areas in the central portion of town which are deteriorating. According to mean annual incomes, the low income section is primarily inhabited by Negroes, although some Spanish-Americans do reside there.

Land Use.

An existing land-use map was compiled from an aerial photo dated May 1968, along with some assistance from preliminary USGS quad sheets dated October 1971. Projected land use was based on the population growth projected by the TWDB and the present growth trends of the City. Plate PB-B-1 illustrates the existing and projected land use.

The commercial and industrial areas are heavily concentrated along the Texas and Pacific Railroad tracks which transverse the City in an


F.M. 87
U.S.
BIG SPRING
STATE
HOSPITAL
CEMETERY
S.H. 350
F.M. 669
Fourmile
Lake
Marsh
Onemile
Lake
Beals
Creek
TEXAS AND PACIFIC RAILWAY
I.H. 20



LEGEND

RESIDENTIAL / LIGHT COMMERCIAL

- EXISTING
- 1980
- 1990
- 2020

HEAVY COMMERCIAL / INDUSTRIAL

- EXISTING
- 1980
- 1990
- 2020

PUBLIC

- EXISTING
- 1980
- 1990
- 2020

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

LAND USE
CITY OF BIG SPRING

TURNER, COLLIE & BRADEN, INC. — HOUSTON / PORT ARTHUR

SCALE: 1" = 4000' | PLATE: PB-B-1

2

east to west direction. Cosden Refinery and other chemical and petroleum products manufacturing plants are located to the east of the City. Commercial and industrial growth is expected to continue its expansion north of the railroad tracks. Paralleling the commercial areas to the north and south are the residential sectors, although the southern sector is considerably larger. The residential areas are projected to extend farther to the southeast and southwest. Public land areas are scattered throughout the City, although the largest area is to the west of town where Big Spring State Park and Webb Air Force Base are located. Small open-space areas are scattered throughout the City; however, the primary concentration is along the periphery of the developed areas.

Economic Analysis.

The economy of Big Spring is based primarily on the chemical and petroleum products manufacturers, the railroad, medical services, and Webb Air Force Base. The Big Spring State Hospital and the Veterans' Administration Hospital are located here, along with the Howard County Junior College.

The 1969 average per capita income for Big Spring was $2,674, while the value for the State of Texas was $2,810. This would indicate that the economy of the area would probably have less potential than the State as a whole.

Big Spring is accessible by two U.S. highways and is served by the Texas and Pacific Railroad and the Howard County Airport. The anticipated growth potential for the City is good due to its accessibility and the presence of adequate industrial and economic activity.

Water Resources and Supply.

The Colorado River Municipal Water District is the primary supplier of raw water for Big Spring. Lake J. B. Thomas, located on the Colorado River southwest of Snyder, is the major source, although a limited supply of water is obtained from Moss Creek Lake southeast of Big Spring. Ground water supplies, consisting of two wells with pumping capacities of 275 gpm and 125 gpm, are utilized for standby purposes. Adjacent to S.H. 350 and north of Big Spring is a 15 mg reservoir which holds water obtained from Lake J. B. Thomas. This water is transported through a 27-inch line to the water treatment plant, while water from Moss Creek Lake is delivered to the treatment plant by a 14-inch line. The well water is, however, released directly into the distribution system in the southern section of the City.

According to the "Water and Sanitary Sewage System Improvements" report published in 1960 by Forrest and Cotton, Inc., Lake J. B. Thomas supplies 14.0 mgd, Moss Creek Lake supplies 1.5 mgd, and the well field supplies 3.5 mgd. Storage for the system is provided by three clearwell reservoirs with capacities of 2.5, 2.5, and 0.5 mgd;

six elevated-ground reservoirs, five with capacities of 1.0 mgd each and one with a capacity of 0.25 mgd; and two elevated reservoirs with capacities of 1.5 and 0.25 mgd.

The surface water undergoes typical water treatment, while the ground water needs only chlorination before being released for public consumption.

The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Projections
(in mgd)

	Year 1970	1980	1990	2020
Municipal Use	4.81	5.86	6.61	8.76
Industrial Use	2.06	2.61	2.96	4.40

Waste Load Analysis.

Municipal Waste Load.

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

Waste Load Projections

	Year 1970	1980	1990	2020
Flows in mgd	2.44	2.72	2.94	3.47
BOD in lb/day	4,880	5,770	6,240	7,770
TSS in lb/day	5,750	6,730	7,630	9,400

Self-reporting data indicate that the average daily flow to the Big Spring sewage treatment facility was approximately 3.18 mgd during the period from July 1971 through June 1972. Also, a study of Big Spring's wastewater treatment facilities by Freese, Nichols and Endress, Consulting Engineers, Fort Worth, dated July 1971, indicated an average flow of about 2.85 mgd.

Urban and Agricultural Runoff.

Big Spring lies entirely within the drainage area of Beals Creek. Stormwater discharges into the stream include any urban runoff in addition to any agricultural runoff from surrounding farmland. The following are the principal sources of pollutants in urban runoff.

1. Street and parking lot litter, oil, and grease.

2. Animal and bird wastes deposited on impervious surfaces.

3. Fertilizers from lawns and parks.

4. Pesticides.

5. Suspended solids from excavation and construction activities and from unpaved and unplanted areas.

6. Leaves and grass.

7. Air pollutants which settle or are washed out by rain.

8. Unauthorized waste discharges into gutters, streets, storm sewers, etc.

9. Overflowing manholes in overloaded sanitary sewer systems.

Sources of agricultural runoff pollution include:

1. Inorganic fertilizers.

2. Animal and poultry wastes.

3. Insecticides and herbicides.

4. Silt and other suspended solids.

Concentrations of pollutants in runoff depend on the amounts available to be washed away by rain, time interval between rains, and the intensity and duration of rainfall. Existing studies seem to indicate that urban runoff is generally much higher in concentration of pollutants than agricultural runoff.

In the semi-arid regions around Big Spring, stormwater pollution is not a significant problem due to low annual rainfall rates and a general absence of flowing streams. Rainfall is often in the form of sudden annual storms which create more problems with flooding than with pollution from runoff.

Updated detailed information on Big Spring's drainage system was not available during the course of this study; however, all drainage from the City is to Beals Creek. In general, the primary means of interior drainage are open ditches and natural tributaries to Beals Creek, with some storm sewers being utilized for interior drainage in high-density commercial and residential areas.

Industrial Wastes.

Industries in the Big Spring area which might produce significant wastes to the treatment system are listed below, along with the nature of the industry. According to available data, there are no industrial waste control orders issued by the TWQB to any industry within a 20-mile radius of Big Spring.

Industry	Nature
Big Spring Tortilla & Tamale Factory	Food Processing
Cabot Corporation	Carbon Black
Cactus Paint Manufacturing Co., Inc.	Paint Products
Cosden Oil & Chemical Company	Styrene Monomer, Polystyrene, Automotive Gasoline
Grace, W. R., & Company	Anhydrous Ammonia
Hubbard Packing Company	Meat Processing
International Technovation, Inc.	Polystyrene Products
Janes, R. E., Gravel Company, Inc.	Aggregates and Sands
Richardson, Sid, Carbon & Gasoline Company	Carbon Black
Skelly Oil Company	Natural Gasoline
Sulpetro Corporation	Sulfur from sour gas
Fiber Glass Systems, Inc.	Fiberglass Pipe

No information concerning quantity, quality, pretreatment, and disposal of wastewater which might be produced in any of the industries was available for this study. Although it is very likely that some industrial waste is discharged to the Big Spring sewer system, no data are available concerning such discharge.

Stormwater runoff from industrial sites can pose significant problems. Containment and treatment of runoff would vary in each case, and are probably nonexistent in some. A detailed study of each particular industrial site would be necessary to truly understand the nature and magnitude of this problem, and such is beyond the scope of this report. Solid wastes from these industries are generally handled onsite, taken to the municipal landfill for disposal, or utilized by local farmers for fertilizer where adaptable.

Municipal Solid Waste.

Solid waste disposal in Big Spring presently consists of disposal in an 18-acre sanitary landfill which is located just north of the sewage treatment plant site. An old 15-acre landfill, which is no longer used, is located approximately 0.4 mile north of the intersection of Birdwell Lane with I. H. 20. A proposed 20-acre sanitary landfill is located just northeast of the intersection of West I. H. 20 with the Texas and Pacific Railroad and is also located just north of the saltwater marsh in this region.

Surface water flows away from the old and present sites. Neither landfill is located within a wet or dry-weather streambed; thus, no significant pollution of surface waters results from the landfills.

Both the old and present landfills are underlain by a hard clay which has a low permeability. The low permeability of the clay should significantly limit any pollution which might result from leachate seeping into the ground water.

Water Treatment Plant Wastes.

The City of Big Spring owns and operates a water treatment plant located approximately 0.25-mile northwest of the intersection of Birdwell Lane and F.M. 700. No information on quantity, quality and method of disposal of wastewater from the treatment plant was available during the course of this study. Since there is no individual permit for the treatment and disposal of this wastewater, it is anticipated that the method of disposal is one which requires no discharge, or the wastewater may be discharged to the sanitary sewer to be subsequently treated and discharged under the sewage treatment plant permit.

Waste Load Allocation.

The concept of waste load allocation is based on dividing the assimilative capacity of a particular stream among the waste producers in such a manner that the total waste load on the stream will not exceed its ability to renew and maintain itself at the desired quality level. Since there are no perennial streams in the Big Spring area, any wastewater effluent discharged to a waterway becomes the stream flow under low flow conditions; and, therefore, under a strict allocation methodology, stream quality standards would become effluent standards. For this reason, wastewater restrictions for Big Spring are and will remain effluent quality criteria. At present, the limiting effluent criterion for

Big Spring is the TWQB requirement that effluent contain not more than 20 ppm BOD_5 and 20 ppm Total Suspended Solids with at least 1.0 mg/1 chlorine residual after 20-minute detention time.

Under PL 92-500, secondary treatment of wastewater will be adequate until 1983, at which time application of the best practicable waste treatment technology will be required toward the ultimate goal of no discharge of pollutants.

Municipal Wastewater Collection System.

Existing Collection System.

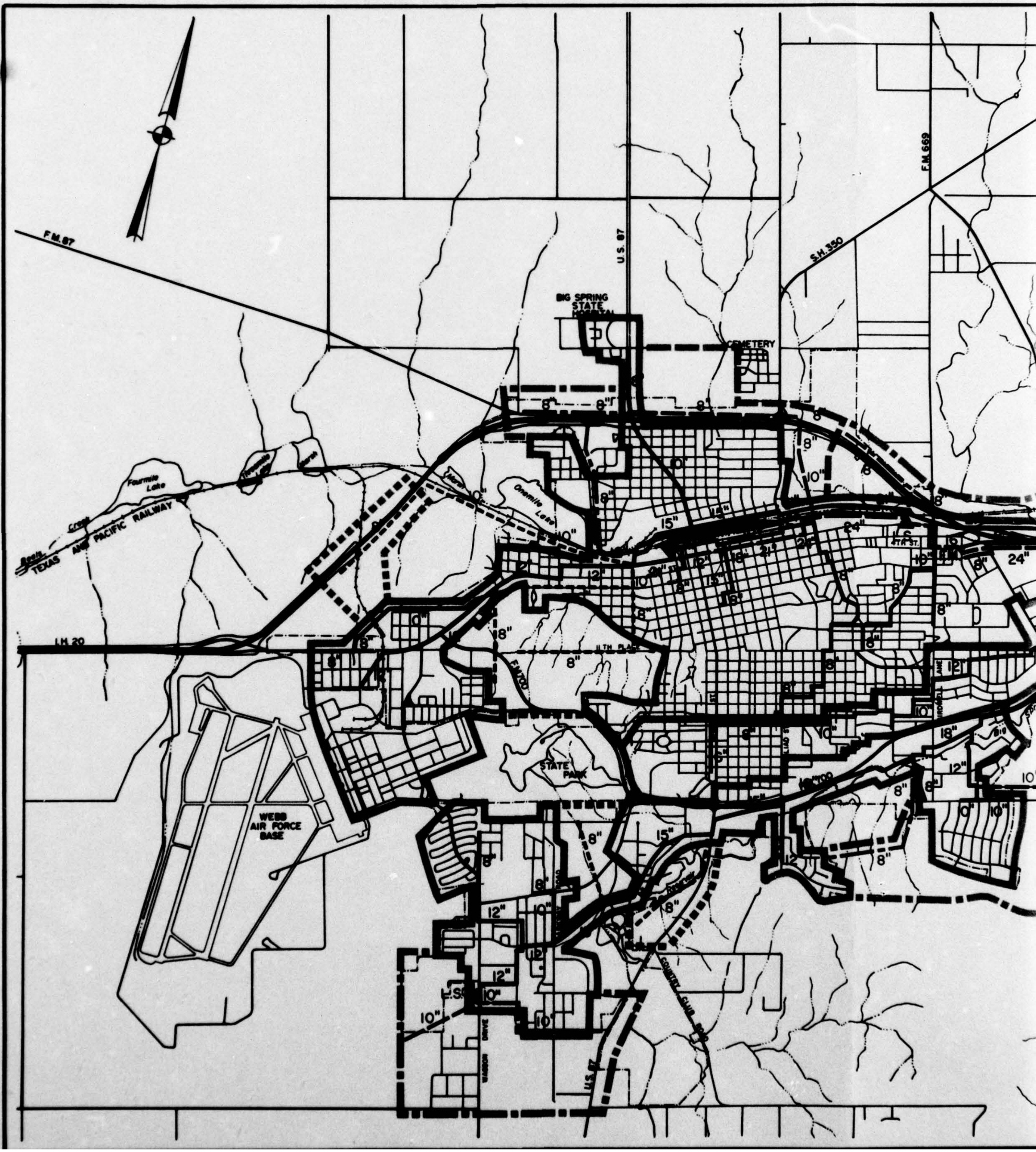
The existing wastewater collection system for Big Spring is illustrated on Plate PB-B-2. The service area boundaries, major mains, outfalls and line sizes are shown; however, for clarity, the small laterals and submains are not shown on the plate.

The most recent study of the collection system was published in May 1960 in the report entitled "Water and Sanitary Sewage System Improvements" by Forrest and Cotton, Inc., Consulting Engineers, Dallas, Texas. This included development of design criteria, performance analysis of the existing lines, recommendation of remedial steps to correct problems, and delineation of proposed lines to meet future needs. City officials have provided information to update the report to the present so that the analysis of the existing system could be used for this study. Since the study was made, the City has made corrections in some of the major problem areas. At present, there seems to be no severe problems in the Big Spring sanitary sewer collection system, with the exception of the problem of substantial infiltration of saline water into the north outfall along Beals Creek.

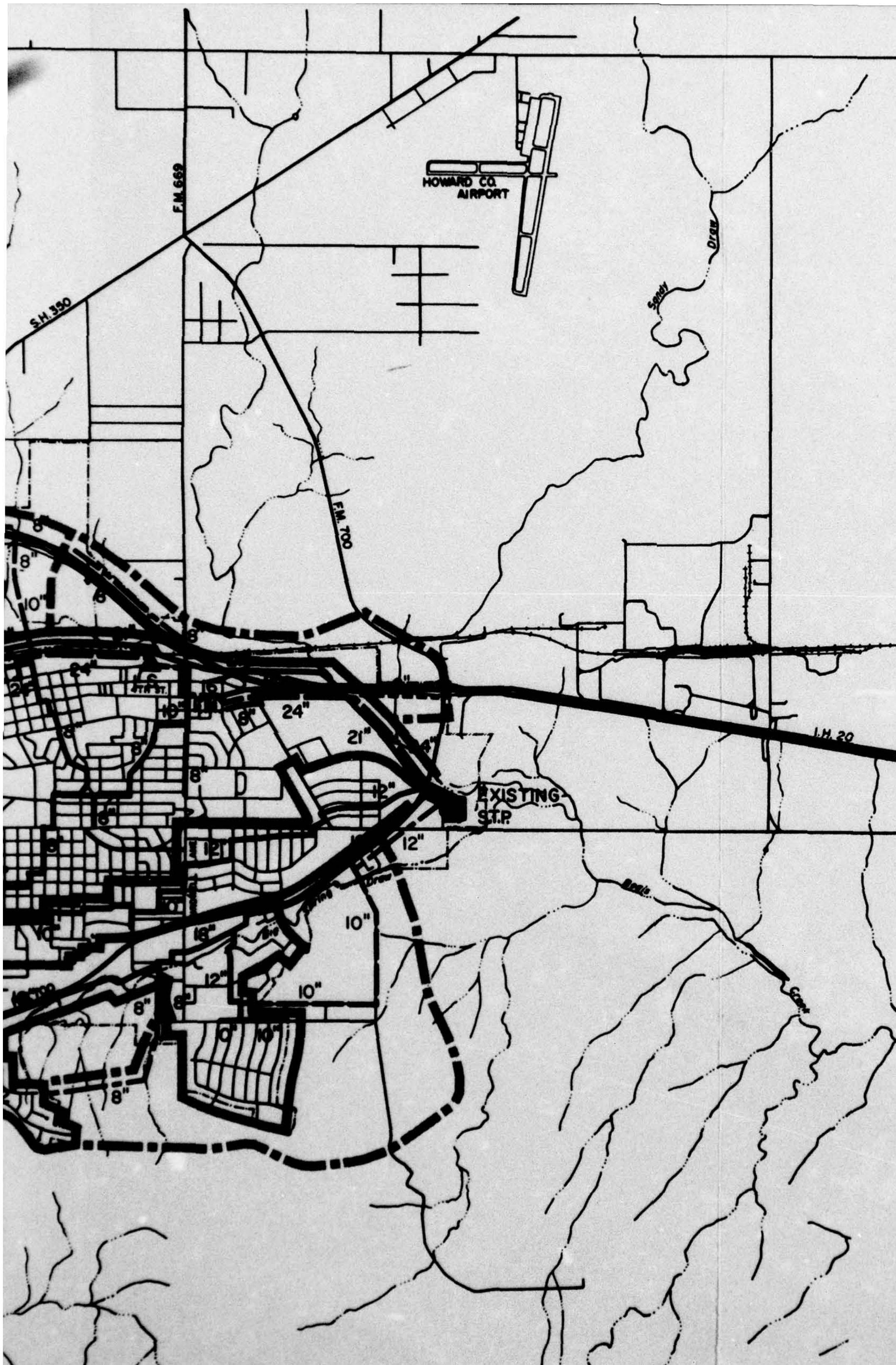
As shown on Plate PB-B-2, the existing service area was divided into three sectors: the northern, the central, and the southern sectors. A review of the outfall sewers and major mains indicated that they apparently have adequate capacity to carry existing and future loads, with the exception of the 18-inch outfall to the plant from the southern service area which will become overloaded in its lower reaches if and when the projected residential development in the southeast sector of town occurs.

Areas Utilizing Septic Tanks.

As best can be determined from the updated sewer map and other reports, there are no significant areas of Big Spring proper where septic tanks are utilized for waste disposal. There are, however, some scattered residences which do utilize septic tanks both in the lightly-developed areas and in outlying areas of the City. No information was available during the course of this study which would indicate any significant local problems resulting from septic tank use in the Big Spring area.



F.M. 87
U.S. 87
S.H. 350
F.M. 669
BIG SPRING STATE HOSPITAL
CEMETERY
TEXAS AND PACIFIC RAILWAY
Fourmile Lake
Onemile Lake
I.H. 20
11TH PLACE
STATE PARK
WEBB AIR FORCE BASE
COUNTRY CLUB ROAD
WASSON DRIVE
U.S. 87



LEGEND

SEWER LINES

EXISTING
1980
1990
2020

SERVICE AREA BOUNDARIES

EXISTING
1980
1990
2020

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

BIG SPRING
SANITARY SEWER

TURNER, COLLIE & BRADEN, INC. — HOUSTON / PORT ARTHUR

SCALE: 1" = 4000' | PLATE: PB-B-2

Some of the lightly-developed areas at present are projected to further develop in the future. When such development occurs and sewer service is warranted, then extension of sewer services to these areas will make it possible to abandon septic tanks therein and tie into the sanitary sewer.

Proposed Collection System.

The proposed collection system improvements for the City of Big Spring are shown on Plate PB-B-2. The proposed lines were determined with regard to the sewer report mentioned previously and are based primarily on the land use and population projections developed for this study and covered previously.

Since the scope of the study of the collection system was limited to analyzing existing mains and outfalls and to project only mains and outfalls as needed to serve either existing or anticipated future developed areas, the proposed lines consist of two relief sewers and several main sewers. The description of these sewer lines and their corresponding construction cost, including engineering and contingencies, are given in the following table. The laterals which would be required to collect the sewage from the projected service areas and carry it to the mains were not studied, and thus are not presented herein nor are cost estimates provided for such laterals.

It should be noted that these proposed improvements are for planning purposes only and are not intended to be fixed in regard to size and location. Since many of the proposed lines are intended to serve areas projected for future development, they will not be constructed until sufficient development is anticipated or occurs in a specific area to warrant sewer service to that area.

It should also be noted that the cost estimates do not include costs for the reduction of infiltration in the existing system, which is required by a directive from the TWQB and PL 92-500.

Cost Estimates
Proposed Collection System for Big Spring, Texas

Item	Cost
Improvements Projected by 1980	
Relief sewer along 4th Street (6000' - 10")	$ 86,000
Main sewer extending service to the area just north of the State Park (9500' - 8")	108,000

Item	Cost
Improvements Projected by 1980 (Cont'd)	
Main sewer extending service to the projected industrial area along the railroad spur to Webb AFB and just south of I.H. 20 (4200' - 8" and 8000' - 10")	$ 163,000
Main sewer extending service along I.H. 20 from the 24" outfall east to F.M. 700 (2500' - 8")	28,000
Main sewer extending service to area just south of the State Park (3000' - 8")	34,000
Main sewer extending service to projected commercial area along U.S. 87 south of F.M. 700 (4500' - 8")	51,000
Subtotal	$ 470,000
Improvements Projected by 1990	
Main sewer extending service to projected industrial area north of I.H. 20 near S.H. 350 and east U.S. 87 (8400' - 8" and 2000' - 10")	125,000
Main sewer extending service to projected residential area south of F.M. 700 and east of Birdwell Lane (7800' - 10")	113,000
Main sewer extending service to projected residential area west of Wasson Drive in Southwest Big Spring (3000' - 10" and lift station)	116,000
Subtotal	$ 354,000
Improvements Projected by 2020	
Main sewer extending service to projected industrial area north of I.H. 20 and west of U.S. 87 (8500' - 8")	$ 97,000
Main sewer extending service to projected commercial-industrial area north of I.H. 20 and just west of Birdwell Lane (4700' - 8")	54,000
Relief sewer for 18" outfall to treatment plant paralleling F.M. 700 (3000' - 12")	54,000

Improvements Projected by 2020 (Cont'd)

Main sewer extending service to projected residential area south of F.M. 700 and west of Birdwell Lane (5800' - 8")	$ 66,000
Main sewer extending service to projected developed area between Wasson Drive and U.S. 87 in southwest Big Spring (5200' - 10")	75,000
Subtotal	$ 346,000
TOTAL	$1,170,000

Municipal Wastewater Treatment System.

Existing Wastewater Treatment System.

Big Spring's sewage treatment facility is located on the south bank of Beals Creek about 0.3 mile east of the intersection of F.M. 700 and Eleventh Place, as shown on Plate PB-B-2. The treatment facility consists of two plants: the older Hays plant is of the activated-sludge type, and the other plant is of the trickling-filter type. A detailed description of the components of the plants and the status of performance, operation, and maintenance is given in Appendix A of this section.

Proposed Wastewater Treatment Facility Alternatives.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. Since the stream segment into which the Big Spring plant discharges is classified as effluent limiting the treatment facilities will have to meet, as a minimum, the phased implementation requirements of the law. All effluent from the Hays plant is currently utilized for industrial reuse. It is the current interpretation of the law that total reuse of effluent, such that no pollution of surface or ground water resources results from such practice, is in compliance with the law. The industry reusing the effluent currently provides in-plant treatment of the effluent before utilizing it for boiler feed and process water.

It is therefore recommended that the effluent from the Hays plant continue to be utilized for industrial reuse as long as the demand exists. It should be noted that as an alternative disposal method which would meet the requirements of the law, the Hays plant could be abandoned with the flow routed to the adjacent main plant. Expansion of the main plant to treat this additional flow would cost about $124,000, including engineering and contingencies.

The effluent from the trickling filter plant is presently unsuitable for industrial reuse as a result of the presence of chlorides; therefore, the effluent is presently discharged to Beals Creek. It is the present interpretation of the law that the level of discharge constituents that will be utilized to define secondary treatment will not be attainable by the trickling filter process currently employed by Big Spring, and the City will be required to implement a higher level of waste treatment prior to 1977.

The efficiency of the trickling filter facility presently is considerably below the efficiency which is characteristic of such type of installations. As stated by Freese, Nichols and Endress, Consulting Engineers, Fort Worth, in their 1971 report on Big Spring's wastewater treatment facilities, the present trickling filter inefficiencies appear to be caused by both a high concentration of heavy metals and chlorides in the wastewater.

As a first step to improving the quality of effluent from the trickling filter plant, it is recommended that the necessary action be taken to substantially reduce or eliminate toxic substances in the waste. In order to reduce or eliminate the heavy metals, particularly chromium, it is recommended that the source of the heavy metals be located and action be taken to correct such discharge either by requiring pretreatment at the source or elimination of any discharge of wastewater containing high concentrations of heavy metals to the sanitary sewer.

In an attempt to reduce the volume of chlorides which are carried down Beals Creek during infrequent rains, the Colorado River Municipal Water District has begun a program to drain the highly saline playa lakes west of the City. Dewatering of the lakes will eliminate a substantial source of conservative minerals that are presently carried down Beals Creek, eventually into freshwater reservoirs operated by the District. As a possible side benefit, it is hoped that the surface pumping and well-pointing during the continuing playa lake draining program will lower the water table sufficiently to reduce or eliminate the present infiltration problem experienced in the sewer main along Beals Creek.

On June 17, 1971, the TWQB directed the City of Big Spring to file an application for an amended permit which would require a higher effluent quality. The Board also required the City to set forth specific plans for controlling ground water infiltration, which is believed to be the principal source of chlorides in the wastewater. No information concerning what steps might have already been taken by the City to control ground water infiltration was available for the study. However, it is recommended that any necessary action which has not already been initiated be taken as soon as possible, in order to reduce the chloride concentrations to eliminate any adverse effects on the biological treatment process. It is not certain whether reduction of chlorides could produce an effluent suitable for industrial reuse; however, it is recommended that an investigation be made to determine the practicality of producing an effluent suitable for industrial reuse. If this venture would be practical, it should be considered as an alternative to the following alternatives to meet the requirements of the law. Delivery of additional water to the refinery could reduce the refinery's need for fresh water which it presently receives from the City, which receives raw water from the local water supply district.

Prior to presentation of the proposed wastewater treatment facility alternatives for the Main plant, it should be noted that proposed collection system costs are common to each alternative, and these costs are therefore repeated for all alternatives.

For Big Spring, a total of twelve alternative wastewater treatment schemes were investigated during the conduct of this study. These twelve alternatives were evaluated and four alternatives were selected as the most viable alternatives. All of the twelve alternatives will meet the treatment requirements of PL 92-500. A discussion of the four most viable alternatives is presented, followed by a discussion of the eight remaining alternatives.

Also, more detailed information on treatment components, flow diagrams, and anticipated treatment efficiencies is presented in Volume III, Technical Appendix.

Alternative 1.

Alternative 1 includes modification and expansion of the existing 2.8 mgd trickling-filter plant by 1975 to a 3.5-mgd activated-sludge plant capable of providing conventional biological treatment. The total cost for these improvements is estimated to be $1,118,000, including engineering and contingencies. Total operation and maintenance costs are estimated to be $115,000 annually. By 1983, a means of disposal whereby no discharge would be made to a receiving stream would be implemented. This means of disposal could be either industrial reuse or tertiary treatment through irrigation, or a combination of both of these methods.

For land disposal, the spray irrigation of grassland and cropland is recommended. This could be accomplished by contracting with local farmers for the retention and irrigation of all effluent. Such a contract between the City and the landowner(s) would set forth the mutually-agreeable terms for payment of cost for constructing, operating, and maintaining the system. A cost estimate, including engineering and contingencies, for the construction of a 320-acre spray irrigation facility by 1983 is given on the following page. This facility should handle up to 3.5 mgd average flow, at a maximum average application rate of 4 inches per week and a minimum holding capacity equal to 45 days at 3.5 mgd.

1983 Irrigation Costs

Description	Estimated Cost
100-acre holding pond	$ 437,000
Irrigation equipment	1,013,000
420 acres of land @ $250/acre	105,000
	$1,555,000

The associated annual operation and maintenance costs are estimated to be about $120,000.

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$470,000	$9,400
1990	354,000	7,100
2020	346,000	6,900

Further economic analysis of Alternative 1 is presented in Appendix B of this section. Alternative 1 was also subjected to an evaluation analysis. Results of that analysis are shown in Appendix C of this section.

Alternative 2.

Alternative 2 includes utilization of the existing 2.8-mgd trickling-filter plant with inclusion of any maintenance, replacement, and expansion by 1975 which may be deemed necessary to operate and maintain the facility to the satisfaction of the regulatory agencies. The cost of these improvements is estimated to be about $150,000, with associated operation and maintenance costs of $115,000 annually. Also by 1975, the means of disposal could be industrial reuse if the effluent is suitable, or land disposal by spray irrigation, or a combination of both of these methods. The cost of spray irrigation would be the same as for Alternative 1, a capital cost of $1,555,000, with associated operation and maintenance costs of $120,000.

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$470,000	$9,400
1990	354,000	7,100
2020	346,000	6,900

Further economic analysis of Alternative 2 is presented in Appendix B of this section. Alternative 2 was also subjected to an evaluation analysis. Results of that analysis are shown in Appendix C of this section.

Alternative 3.

Alternative 3 includes modification and expansion of the existing trickling-filter plant by 1975 such that it would be converted to a 3.5-mgd activated sludge plant capable of providing conventional secondary treatment. Tertiary treatment consisting of nitrification, chemical addition, total filtration, denitrification, activated carbon treatment and aeration of the effluent would also be included.

The total cost for the above improvements is estimated to be $4,225,000, including enginering and contingencies. Total operation and maintenance costs are estimated to be $511,000 annually.

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$470,000	$9,400
1990	354,000	7,100
2020	346,000	6,900

Further economic analysis of Alternative 3 is presented in Appendix B of this section Alternative 3 was also subjected to an evaluation analysis. Results of that analysis are shown in Appendix C of this section.

Alternative 4.

Alternative 4 includes modification and expansion of the existing trickling-filter plant by 1975 to a 3.5-mgd activated-sludge plant capable of providing conventional secondary treatment. The total cost of these improvements is estimated to be $1,118,000, including engineering and contingencies. Total operation and maintenance costs are estimated to be $115,000 annually. By 1983, partial tertiary treatment consisting of nitrification, chemical addition, and partial filtration would be added at an estimated cost of $740,000, including engineering and contingencies. The annual operation and maintenance of these partial tertiary treatment additions is estimated to be $200,000. By 1985, further tertiary treatment in the form of total filtration and denitrification would be added at an estimated cost of $680,000, including engineering and contingencies. The annual operation and maintenance for the 1985 additions is estimated to be $90,000.

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$470,000	$9,400
1990	354,000	7,100
2020	346,000	6,900

Further economic analysis of Alternative 4 is presented in Appendix B of this section. Alternative 4 was also subjected to an evaluation analysis. Results of that analysis are shown in Appendix C of this section.

The aforementioned four alternatives were selected as the most viable, cost-effective alternatives. The additional eight alternatives investigated, but not selected for further refinement, are presented below. All of these alternatives will meet the requirements of PL 92-500 and were considered for immediate (1975) implementation.

Alternative 5.

Alternative 5 includes modification and expansion of the existing trickling-filter plant by 1975 to a 3.5-mgd trickling-filter plant capable of providing conventional biological treatment. Tertiary treatment consisting of nitrification, chemical addition, total filtration, denitrification, activated carbon treatment and aeration of the effluent would also be included. The total cost for the above improvements is estimated to be $6,796,000, including engineering and contingencies. Total operation and maintenance costs are estimated to be $434,000 annually.

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$470,000	$9,400
1990	354,000	7,100
2020	346,000	6,900

Further economic analysis of Alternative 5 is presented in Appendix B of this section. Alternative 5 was not selected for further refinement because this alternative was not one of the most cost-effective alternatives.

Alternative 6.

Alternative 6 includes construction of a new 3.5-mgd physical-chemical plant by 1975 to provide conventional secondary and full tertiary treatment. The total cost for the above improvements is estimated to be $2,982,000, including engineering and contingencies. Total operation and maintenance costs are estimated to be $511,000 annually.

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$470,000	$9,400
1990	354,000	7,100
2020	346,000	6,900

Further economic analysis of Alternative 6 is presented in Appendix B of this section. Alternative 6 was not selected for further refinement because abandonment of the existing facilities would be required, this alternative was not one of the most cost-effective alternatives, O&M costs are greater than for biological treatment processes, large quantities of non-renewable resources (chemicals) would be required, and large volumes of chemical sludges would present handling and disposal problems.

Alternative 7.

Alternative 7 includes modification and expansion of the existing trickling-filter plant by 1975 such that it would be converted to a 3.5-mgd activated-sludge plant capable of providing conventional secondary treatment, followed by total reuse of all effluent through spray irrigation of farmland. The total cost for upgrading the plant and irrigation facilities is estimated to be $2,673,000, including engineering and contingencies. Total operation and maintenance costs are estimated to be $235,000 annually.

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$470,000	$9,400
1990	354,000	7,100
2020	346,000	6,900

Further economic analysis of Alternative 7 is presented in Appendix B of this section. Alternative 7 was not selected for further refinement because extensive modification of the existing trickling-filter process would be required, and the alternative was not one of the most cost-effective alternatives.

Alternative 8.

Alternative 8 includes modification and expansion of the existing trickling-filter plant by 1975 to a 3.5-mgd trickling filter plant capable of providing conventional biological treatment, followed by total reuse of the effluent through spray irrigation of farmland. The total cost for this alternative is estimated to be $2,738,000, including engineering and contingencies. The total operation and maintenance costs are estimated to be $222,000 annually.

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$470,000	$9,400
1990	354,000	7,100
2020	346,000	6,900

Further economic analysis of Alternative 8 is presented in Appendix B of this section. Alternative 8 was not selected for further refinement because this alternative was not one of the most cost-effective alternatives.

Alternative 9.

Alternative 9 includes construction of a new 3.5-mgd physical-chemical plant by 1975 capable of providing conventional secondary treatment, followed by total reuse of the effluent through spray irrigation of farmland. The total cost of this alternative is estimated to be $2,560,000, including engineering and contingencies. Total operation and maintenance costs are estimated to be $310,000 annually.

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$470,000	$9,400
1990	354,000	7,100
2020	346,000	6,900

Further economic analysis of Alternative 9 is presented in Appendix B of this section. Alternative 9 was not selected for further refinement because extensive abandonment of the existing facilities would be required, this alternative was not one of the most cost-effective alternatives, O&M costs are greater than for biological treatment processes, large quantities of non-renewable resources (chemicals) would be required, and the large volumes of chemical sludges would present handling and disposal problems.

Alternative 10.

Alternative 10 includes modification and expansion of the existing trickling filter plant by 1975 such that it would be converted to a 3.5-mgd activated-sludge plant capable of providing conventional secondary treatment, followed by the overland runoff method of tertiary treatment of all effluent. The total cost for this alternative is estimated to be $3,593,000, including engineering and contingencies, with the total operation and maintenance costs estimated to be $260,000 annually.

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$470,000	$9,400
1990	354,000	7,100
2020	346,000	6,900

Further economic analysis of Alternative 10 is presented in Appendix B of this section. Alternative 10 was not selected for further refinement because this alternative was not one of the most cost-effective alternatives.

Alternative 11.

Alternative 11 includes modification and expansion of the existing trickling-filter plant by 1975 to a 3.5-mgd trickling-filter plant capable of providing conventional biological treatment, followed by the overland runoff method of tertiary treatment of all effluent. The total cost for this alternative is estimated to be $3,658,000, including engineering and contingencies. Total operation and maintenance costs are estimated to be $247,000 annually.

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$470,000	$9,400
1990	354,000	7,100
2020	346,000	6,900

Further economic analysis of Alternative 11 is presented in Appendix B of this section. Alternative 11 was not selected for further refinement because this alternative was not one of the most cost-effective alternatives.

Alternative 12.

Alternative 12 includes construction of a new 3.5-mgd physical-chemical plant by 1975, capable of providing conventional secondary treatment, followed by the overland runoff method of tertiary treatment of all effluent. The total cost for this alternative is estimated to be $3,480,000, including engineering and contingencies. Total operation and maintenance costs are estimated to be $337,000 annually.

Cost estimates for the proposed collection system improvement are as follows:

Date	Capital Cost	Annual O&M
1980	$470,000	$9,400
1990	354,000	7,100
2020	346,000	6,900

Further economic analysis of Alternative 12 is presented in Appendix B of this section. Alternative 12 was not selected for further refinement because this alternative was not one of the most cost-effective alternatives, O&M costs are greater than for biological treatment processes, large quantities of non-renewable resources (chemicals) would be required, and large volumes of chemical sludges would present handling and disposal problems.

Conclusion and Recommendation.

Alternative 1 appears to be the best plan for Big Spring because it meets the treatment requirements of PL 92-500; it is one of the most cost-effective alternatives; during public workshop, this plan was selected by participating local interests; and the method of disposal returns wastes to the soil, thereby complying with the national goal of no discharge of critical pollutants by 1985. It is therefore recommended that all steps necessary to implement the Alternative 1 plan be undertaken.

Continuing Responsibility.

The planning and construction of wastewater treatment facilities is only one small part of the overall treatment scheme. The application of good operation, maintenance, and control techniques are essential for proper wastewater management. The most advanced equipment available is useless if it is improperly operated or poorly maintained. As an example of the optimum care required, a modern secondary treatment facility in the 2 to 4-mgd range would employ as many as one superintendent, four operators, one maintenance man, and one laborer, to provide around-the-clock attendance. Land disposal facilities for Big Spring would require another three to five employees, and conventional tertiary treatment could require even more.

Every operative function in a treatment plant which involves a variable treatment mode, is based on a daily sampling testing and recording program. Typical tests and frequencies include:

(1) Sludge measurements in settling tanks on each shift daily.

(2) Settleable solids volume and pH measurements daily for influent and effluent.

(3) Effluent stability tests on 24-hour composite samples.

(4) Chlorine residual of effluent on each shift daily.

(5) Total and volatile solids, volatile acids, and pH of digested sludge as needed.

(6) BOD, TSS, and pH of influent and effluent daily on 24-hour composite sample.

(7) Dissolved oxygen measurement on influent, effluent, and receiving stream above and below the discharge point five days per week.

(8) For activated sludge plants, DO of mixed liquor and sludge volume index on each shift daily.

In addition to providing a record of treatment efficiency, regular sampling and testing programs aid in early detection and correction of operational malfunctions in a treatment plant.

When land disposal of effluent is utilized, an additional sampling program is usually required to monitor ground water quality in the area around the disposal site. This usually consists of a series of wells surrounding the site, from which periodic samples are drawn. Such monitoring is just one more means of maintaining the careful surveillance necessary for sound wastewater management.

In metropolitan areas like Big Spring, high concentrations of population and industry have increased both the quantity and strength of wastewater to be handled. Traditionally, wastewater handling has consisted of the minimum treatment necessary to prevent public health hazards, but new environmental priorities and increased public awareness of water quality problems have lent increased weight to the argument for responsible wastewater management -- not just to meet government requiremnts, but also to protect the environment.

APPENDIX A
MUNICIPAL WASTEWATER TREATMENT FACILITIES
CITY OF BIG SPRING, TEXAS

Preface.

During the course of investigation for the Colorado River Wastewater Management Study, all municipal wastewater facilities within the Basin were visited by the study staff. In addition, operational specialists were directed to investigate the treatment facilities located within the metropolitan areas. The following text represents a summary of that operational report.

General.

The City of Big Spring operates two wastewater treatment plants which are located adjacent to each other off U.S. Highway 80. The location of both plants is shown on Plate PB-B-2. The main treatment plant is a two-stage, high-rate trickling filter plant, which receives waste from the area north of the City and from the downtown business district. A high chloride content, due to infiltration, makes the effluent from this plant unsuitable for industrial use.

The smaller Hays process plant receives waste from the western and southern part of town. The entire effluent from this plant is sold to Cosden Oil and Chemical Company. The trickling filter plant is at present required by the TWQB to produce an effluent with a quality not exceeding 20 mg/1 BOD_5, 20 mg/1 suspended solids, and a residual chlorine concentration not less than 1 mg/1 after 20 minutes detention time. In addition, the City is required to set forth plans to control ground water infiltration into the sanitary sewer system and to apply for an amendment to the existing Waste Control Order.

Description of Existing Facilities.

The Hays Plant.

Until 1962, all wastewater was treated at the activated sludge plant. This plant, which was originally constructed in 1943 and expanded in 1951 to its current stated capacity of one mgd, used a modified activated sludge process known as the Hays process. This process involves staged, diffused aeration, and contactor plates.

The basis for design adopted by the U.S. Army during World War II was as follows: primary sedimention providing 2-1/2 hours detention time, primary aeration tanks with contactor plates providing 156 sq ft of area per pound off BOD applied daily, intermediate sedimention for 1-1/2 hours, secondary aeration identical to primary aeration, and final sedimentation for 2-1/2 hours.

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The first stage is the sedimentation section. The sewage then flows into the primary aeration tank in which the contactor plates are placed in such a way that the sewage alternately flows over and under them. Bacterial growth developed on the contactor plates stabilizes the organic content of the waste. Intermediate sedimentation, followed by the second aeration stage and final sedimentation, complete the treatment.

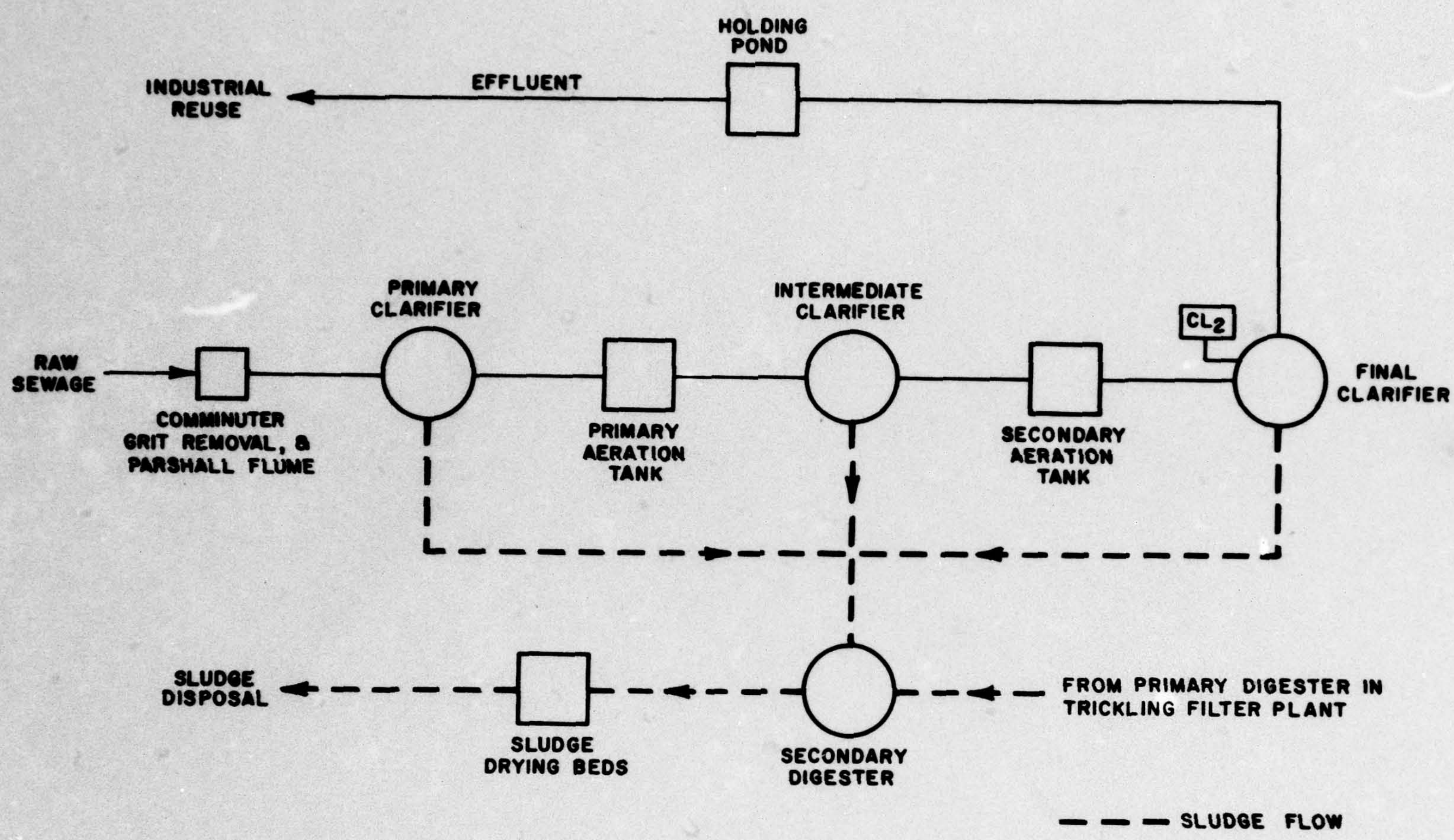
In this particular plant, as shown in Figure A-1, sewage flows by gravity through an entrance structure which contains a comminuter, a grit remover and a Parshall flume. From here, it passes through the Hays biological treatment unit previously described and on to the Cosden pond. Sludge is wasted to the secondary digester and ultimately to the sludge drying beds. A chlorine line was recently installed in the incoming sewer in an attempt to alleviate problems caused by accumulation of hyrogen sulfide.

This plant was out of service for several years and the basins were at one time used for sludge storage. This caused extensive damage to equipment, in particular to the air diffusion system. Reconstruction was performed by the operating staff. At present, the plant is in poor condition mechanically and operationally. This, however, seems no detriment to industrial utilization, and the entire effluent from this plant is pumped to a collection pond from which it is once again pumped, on demand, to Cosden Oil and Chemical Company. Here, it is retreated and used as boiler feedwater. There is no discharge from this plant since, until now, industrial demand has exceeded supply.

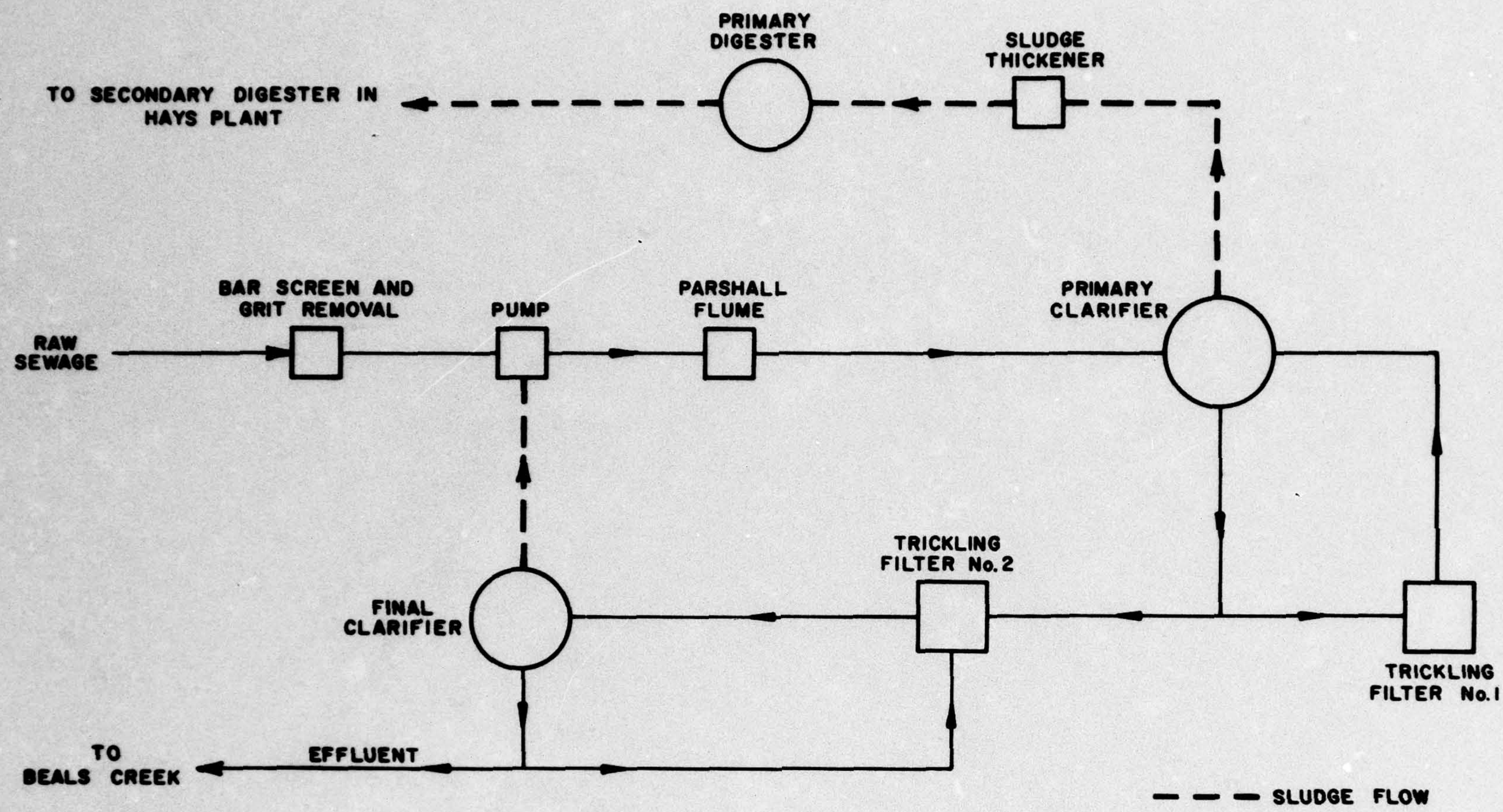
The Main Plant.

The main plant, a trickling filter installation with a design capacity of 2.8 mgd, was constructed in 1962. It utilizes a two-stage, high-rate process, with a series-parallel flow pattern as shown in Figure A-2. The plant receives approximately 83 percent of the City's raw sewage, amounting to an average daily flow of 2.34 mgd, with a low flow rate of 1.2 mgd and a recorded high flow rate of 10 mgd during wet weather.

Incoming sewage passes through a mechanical bar screen and a Parshall flume, then flows by gravity to the primary clarifier. Primary clarifier underflow is returned to the primary digester, while the overflow is split in a distribution box with part of the flow going to Trickling Filter No. 1 and part to Filter No. 2. Effluent from both filters then flows to a pump station. From here, the effluent from Filter No. 1 is recirculated to the distribution box ahead of the primary clarifier, while the effluent from Filter No. 2 is pumped to the final clarifier. Underflow from this clarifier is returned to the head of the plant, while the overflow is in part returned to the division box for Filter No. 2. The remainder of the effluent is discharged into the drainage ditch and thence into Beals Creek. The recirculation flow scheme is shown in Figure A-2. Also, a list of design parameters, predicted



FLOW DIAGRAM
BIG SPRING SEWAGE TREATMENT PLANT (HAYS PLANT)
FIGURE A-1



FLOW DIAGRAM
BIG SPRING SEWAGE TREATMENT PLANT (TRICKLING FILTER PLANT)
FIGURE A-2

performance and actual performance is shown in Tables A-1, A-2, and A-3, respectively.

The plant has been the subject of recent inquiries by the TWQB. Although the trickling filter plant is in good mechanical condition, several operational problems prevail which preclude an effluent of a sustained quality within the bounds of the permit criteria. Factors causing problems are suspected high levels of heavy metals such as chromium, due to cooling tower water discharges into the sewer system, as well as fluctuating chloride concentrations due to infiltration. The latter renders the plant effluent unsuitable for industrial use. Clarifiers show carry-over of fines, and the aerobic digester is unsatisfactory. Occasional high concentrations of chromium have been found in the digester sludge.

The wastewater treatment department now has eight persons employed, including a chemist, two licensed operators, and two laborers, providing 24-hour coverage. The evening and late night shifts are manned by a single operator for both plants, which is below the minimum recommended; however, the proximity of the two plants and lack of discharge from the Hays plant may make this arrangement acceptable.

Capital Improvements.

Expenditures currently planned by the City include monies required for installation of a suitable chlorine contact basin and improvements to the mechanical bar screen. For the collection system, expenditures are required to define and alleviate infiltration, the rebuilding of a lift station, and the installation of several manholes. Monies currently allocated for this fiscal year (1973) include $400,000 for the collection system and $3,000 for the treatment system. There is ample room for expansion of current facilities; however, since the present facility has not been paid for, issuance of more bonds for waste treatment is unlikely in view of current population figures.

Conclusions.

In the past, high concentrations of heavy metals such as chromium have occasionally resulted in problems in the biological process. The City now has an ordinance prohibiting the disccharge of cooling tower water into the sewer system. This ordinance should be enforced more strictly to eliminate toxic, heavy metal concentrations.

Infiltration should be eliminated if possible. This will result in better effluent quality suitable for industrial consumption and will reduce extremes in chloride concentrations and hydraulic loading on the plant. A TWQB letter of June 23, 1971, directed the City to "describe steps to be taken to eliminate this (infiltration) problem."

TABLE A-1

APPENDIX A

DESIGN PARAMETERS

1.	Influent Flow Rate	2.8 mgd
2.	Influent BOD	200 mg/l
3.	Depth Primary Clarifier	8 ft.
4.	Diameter Primary Clarifier	100 ft.
5.	Hydraulic Loading of Primary Clarifier	713 gal. / ft.^{2} / day
6.	Depth Filters No. 1 and No. 2	4 ft. - 6 in.
7.	Diameter Filters No. 1 and No. 2	100 ft.
8.	Primary Recirculation	2.8 mgd
9.	Secondary Recirculation	2.8 mgd

TABLE A-2

APPENDIX A

PREDICTED PERFORMANCE

1.	BOD Load on Filter No. 1	1.29 lbs. BOD/cu. yd./day
2.	BOD Load on Filter No. 2	1.47 lbs. BOD/cu. yd./day
3.	BOD of Effluent Filter No. 1	14.5 mg/l
4.	BOD of Effluent Filter No. 2	20.5 mg/l

TABLE A-3

APPENDIX A

ACTUAL PERFORMANCE

(12 Mo. Average)

1.	Influent Flow Rate	2.35 mgd
2.	Influent BOD	172 mg/l
3.	BOD Load Filter No. 1	2.02 lbs. BOD/cu. yd./day
4.	BOD Removal Filter No. 1	27.4%
5.	BOD Load Filter No. 2	2.92 lbs. BOD/cu. yd./day
6.	BOD Removal Filter No. 2	38.4%
7.	% of Design Capacity (Actual Flow / Design Flow)	84%
8.	Hydraulic Loading Filter No. 1	13 mg / acre / day
9.	Hydraulic Loading Filter No. 2	26.1 mg / acre / day
10.	Effluent BOD	60 mg/l
11.	Removal Efficiency	65.1%

The effect of chemical additions to the existing treatment should be investigated. This may cause improved removal of solids as well as organics. Chlorination is presently inadequate. A chlorine contact basin should be constructed to provide 20 minutes of detention time and maintenance of a one mg/1 chlorine residual in accordance with TSDH criteria. In addition, more operating personnel should be hired to provide better coverage.

APPENDIX B

ECONOMIC ANALYSIS OF ALTERNATIVES
CITY OF BIG SPRING, TEXAS

Each of the wastewater treatment facility alternatives for Big Spring was subjected to an economic analysis. The results of these analyses, by alternative, are presented as computer printouts following the cost summary. The first four column entries are input data and include a description of the item under consideration, the date by which an item is to be constructed or operational, the capital cost of each item, and the annual operation and maintenance cost of each item. The next three column entries are calculated values of Capital Cost Present Worth, O&M Present Worth, and Total Present Worth, all of which were calculated at 5.5 percent interest. These values were also calculated for 7.0 percent and 10.0 percent interest, with results appearing under line entries INT RT = 0.07 and INT RT = 0.10 respectively. All values shown are in January 1972 dollars.

BIG SPRING, TEXAS

COST SUMMARY

Alternative	Total Present Worth*		
	Interest		
	5.5%	7.0%	10.0%
1	$ 5,084,740	$ 4,167,146	$2,986,786
2	5,369,104	4,492,466	3,363,775
3	11,404,636	9,614,837	7,302,268
4	6,357,904	5,044,219	3,421,676
5	12,509,030	10,858,364	8,663,323
6	10,346,081	8,600,178	6,368,384
7	6,193,466	5,282,643	4,091,048
8	6,065,621	5,191,322	4,043,552
9	7,154,154	6,023,363	4,561,904
10	7,329,257	6,311,291	4,967,509
11	7,201,412	6,219,970	4,920,014
12	8,318,129	7,074,223	5,453,186

*Total Present Worth is equal to the Capital Cost Present Worth plus the O&M Present Worth.

Big Spring Alternatives

Cost Comparison

ALTERNATIVE 1

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
MODE EXP EXIST	1975	1118000.	115000.	952104.	1620611.	2572715.
SPRAY IRRIG	1983	1555000.	120000.	862886.	1043720.	1906606.
CULLECTION SYS	1980	470000.	9400.	306251.	98283.	404534.
CULLECTION SYS	1990	354000.	7100.	135039.	39363.	174402.
CULLECTION SYS	2020	346000.	6900.	26482.	0.	26482.
INT RT=.055000		3843000.	10204000.	2282763.	2801977.	5084740.
INT RT=.070000		3843000.	10204000.	2043118.	2124027.	4167146.
INT RT=.100000		3843000.	10204000.	1671483.	1315303.	2986786.

ALTERNATIVE 2

ITEM	DATE	CAPITAL COST	O-M COST	CAP CUST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
UPGRADE EXIST	1975	150000.	115000.	127742.	1620611.	1748353.
SPRAY IRRIG	1975	1555000.	120000.	1324259.	1691072.	3015332.
CULLECTION SYS	1980	470000.	9400.	306251.	98283.	404534.
CULLECTION SYS	1990	354000.	7100.	135039.	39363.	174402.
CULLECTION SYS	2020	346000.	6900.	26482.	0.	26482.
INT RT=.055000		2875000.	11164000.	1919774.	3449330.	5369104.
INT RT=.070000		2875000.	11164000.	1783516.	2708950.	4492466.
INT RT=.100000		2875000.	11164000.	1567487.	1796288.	3363775.

ALTERNATIVE 3

ITEM	DATE	CAPITAL COST	O-M COST	CAP CUST PRES WORTH	O-M PRES WORTH	TUTAL PRES WORTH
AS TERTIARY	1975	4225000.	511000.	3598068.	7201150.	10799217.
CULLECTION SYS	1980	470000.	9400.	306251.	98283.	404534.
CULLECTION SYS	1990	354000.	7100.	135039.	39363.	174402.
CULLECTION SYS	2020	346000.	6900.	26482.	0.	26482.
INT RT=.055000		5395000.	23584000.	4065841.	7338796.	11404636.
INT RT=.070000		5395000.	23584000.	3840587.	5774250.	9614837.
INT RT=.100000		5395000.	23584000.	3460800.	3841469.	7302268.

Big Spring Alternatives

Cost Comparison

(Cont'd)

ALTERNATIVE 4

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
MODS EXP EXIST	1975	1118000.	115000.	952104.	1620611.	2572715.
PARTIAL TERT	1983	740000.	200000.	410634.	1739533.	2150167.
TERTIARY	1985	680000.	90000.	339021.	690581.	1029602.
COLLECTION SYS	1980	470000.	9400.	306251.	98283.	404534.
COLLECTION SYS	1990	354000.	7100.	135039.	39363.	174402.
COLLECTION SYS	2020	346000.	6900.	26482.	0.	26482.
INT RT=.055000		3708000.	16314000.	2169532.	4188372.	6357904.
INT RT=.070000		3708000.	16314000.	1938094.	3106125.	5044219.
INT RT=.100000		3708000.	16314000.	1582802.	1838874.	3421676.

ALTERNATIVE 5

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
TF TERTIARY	1975	6796000.	434000.	5787566.	6116045.	11903611.
COLLECTION SYS	1980	470000.	9400.	306251.	98283.	404534.
COLLECTION SYS	1990	354000.	7100.	135039.	39363.	174402.
COLLECTION SYS	2020	346000.	6900.	26482.	0.	26482.
INT RT=.055000		7966000.	20119000.	6255339.	6253691.	12509030.
INT RT=.070000		7966000.	20119000.	5939288.	4919076.	10858364.
INT RT=.100000		7966000.	20119000.	5392430.	3270893.	8663323.

ALTERNATIVE 6

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
PC TERTIARY	1975	2982000.	511000.	2539512.	7201150.	9740662.
COLLECTION SYS	1980	470000.	9400.	306251.	98283.	404534.
COLLECTION SYS	1990	354000.	7100.	135039.	39363.	174402.
COLLECTION SYS	2020	346000.	6900.	26482.	0.	26482.
INT RT=.055000		4152000.	23584000.	3007285.	7338796.	10346081.
INT RT=.070000		4152000.	23584000.	2825928.	5774250.	8600178.
INT RT=.100000		4152000.	23584000.	2526916.	3841469.	6368384.

Big Spring Alternatives

Cost Comparison

(Cont'd)

ALTERNATIVE 7

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
AS-SP IRRIG	1975	2673000.	235000.	2276363.	3311683.	5588047.
COLLECTION SYS	1980	470000.	9400.	306251.	98283.	404534.
COLLECTION SYS	1990	354000.	7100.	135039.	39363.	174402.
COLLECTION SYS	2020	346000.	6900.	26482.	0.	26482.
INT RT=.055000		3843000.	11164000.	2744136.	3449330.	6193466.
INT RT=.070000		3843000.	11164000.	2573692.	2708950.	5282643.
INT RT=.100000		3843000.	11164000.	2294759.	1796288.	4091048.

ALTERNATIVE 8

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
TF-SP IRRIG	1975	2738000.	222000.	2331718.	3128484.	5460202.
COLLECTION SYS	1980	470000.	9400.	306251.	98283.	404534.
COLLECTION SYS	1990	354000.	7100.	135039.	39363.	174402.
COLLECTION SYS	2020	346000.	6900.	26482.	0.	26482.
INT RT=.055000		3908000.	10579000.	2799491.	3266130.	6065621.
INT RT=.070000		3908000.	10579000.	2626752.	2564570.	5191322.
INT RT=.100000		3908000.	10579000.	2343595.	1699957.	4043552.

ALTERNATIVE 9

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
PC-SP IRRIG	1975	2560000.	310000.	2180131.	4368603.	6548734.
COLLECTION SYS	1980	470000.	9400.	306251.	98283.	404534.
COLLECTION SYS	1990	354000.	7100.	135039.	39363.	174402.
COLLECTION SYS	2020	346000.	6900.	26482.	0.	26482.
INT RT=.055000		3730000.	14539000.	2647904.	4506250.	7154154.
INT RT=.070000		3730000.	14539000.	2481451.	3541912.	6023363.
INT RT=.100000		3730000.	14539000.	2209861.	2352044.	4561904.

Big Spring Alternatives

Cost Comparison

(Cont'd)

ALTERNATIVE 10

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
AS-OR IRRIG	1975	3593000.	260000.	3059840.	3663990.	6723830.
COLLECTION SYS	1980	470000.	9400.	306251.	98283.	404534.
COLLECTION SYS	1990	354000.	7100.	135039.	39363.	174402.
COLLECTION SYS	2020	346000.	6900.	26482.	0.	26482.
INT RT=.055000		4763000.	12289000.	3527621.	3801636.	7329257.
INT RT=.070000		4763000.	12289000.	3324686.	2986604.	6311291.
INT RT=.100000		4763000.	12289000.	2985969.	1981540.	4967509.

ALTERNATIVE 11

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
TF-OR IRRIG	1975	3658000.	247000.	3115203.	3480791.	6595993.
COLLECTION SYS	1980	470000.	9400.	306251.	98283.	404534.
COLLECTION SYS	1990	354000.	7100.	135039.	39363.	174402.
COLLECTION SYS	2020	346000.	6900.	26482.	0.	26482.
INT RT=.055000		4828000.	11704000.	3582976.	3618437.	7201412.
INT RT=.070000		4828000.	11704000.	3377746.	2842224.	6219970.
INT RT=.100000		4828000.	11704000.	3034804.	1885209.	4920014.

ALTERNATIVE 12

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
PC-OR IRRIG	1975	3480000.	337000.	2963616.	4749095.	7712710.
COLLECTION SYS	1980	470000.	9400.	306251.	98283.	404534.
COLLECTION SYS	1990	354000.	7100.	135039.	39363.	174402.
COLLECTION SYS	2020	346000.	6900.	26482.	0.	26482.
INT RT=.055000		4650000.	15754000.	3431388.	4886741.	8318129.
INT RT=.070000		4650000.	15754000.	3232445.	3841778.	7074223.
INT RT=.100000		4650000.	15754000.	2901070.	2552116.	5453186.

APPENDIX C

EVALUATION ANALYSIS OF ALTERNATIVES
CITY OF BIG SPRING, TEXAS

Appendix C presents an evaluation of the four most viable alternatives with respect to environmental, social, economic, technologial, and resource conservation considerations. In order to maintain the time schedule allotted for the study, the investigations of the foregoing features were conducted in a general manner with emphasis on their relation to the overall system evaluation. While detailed studies were not made on the specific features, these items were investigated to a degree that would uphold the integrity of the validity of the alternative evaluation process. The current status of the existing wastewater treatment facility was used as the base condition from which the evaluations were made.

BIG SPRING, TEXAS

Evaluation Analysis

	ALTERNATIVE 1: Modify and expand existing trickling filter to 3.5 mgd activated sludge secondary system by 1975. By 1983, utilize effluent for spray irrigation.	ALTERNATIVE 2: Upgrade existing trickling filter system by 1975. Also by 1975 effluent to be utilized for spray irrigation.	ALTERNATIVE 3: Modify and expand existing trickling filter system to an activated sludge tertiary system by 1975.	ALTERNATIVE 4: Modify and expand existing trickling filter to 3.5 mgd activated sludge secondary system by 1975. Add partial tertiary treatment by 1983 and full tertiary treatment by 1985.
A. Environmental Quality				
1. Water Resource				
a. Effluent Quality	Removal of BOD and SS by spray irrigation system would approach 100%. Spray irrigation system also removes more phosphorus than Alternatives 3 and 4. Effluent would be available for reuse if underdrains added to irrigation site.	Removal of BOD and SS by spray irrigation system would approach 100%. Spray irrigation system also removes more phosphorus than Alternatives 3 and 4. Effluent would be available for reuse if underdrains added to irrigation site.	Removal of BOD and SS would approach 98%. Effluent would be available directly for reuse.	Removal of BOD and SS would approach 98%. Effluent would be available directly for reuse.
b. Groundwater	Positive potential for recharge. High quality water would probably have no detrimental effect on groundwater.	Positive potential for recharge. High quality water would probably have no detrimental effect on groundwater.	Positive potential for recharge; however, probably would be used for industrial reuse instead of groundwater recharge.	Positive potential for recharge; however, probably would be used for industrial reuse instead of groundwater recharge.
c. Streamflow	Probably no change from existing. No flow to streams other than limited flow from percolation.	Probably no change from existing. No flow to streams other than limited flow from percolation.	Increase in streamflow or no change. Depends on quantity of effluent utilized for municipal or industrial reuse.	Increase in streamflow or no change. Depends on quantity of effluent utilized for municipal or industrial reuse.
2. Air Resource				
a. Odors	No odor problem anticipated. Probable decrease from existing odors as a result of utilizing activated sludge system.	For secondary system—no change. For land disposal system—no odors anticipated.	No odor problem anticipated. Probable decrease from existing odors as a result of utilizing activated sludge system.	No odor problem anticipated Probable decrease from existing odors as a result of utilizing activated sludge system.
b. Other Sources	Aerosol potential slight.	Aerosol potential slight.	Regeneration of chemicals could cause odor problems.	Regeneration of chemicals could cause odor problems.
3. Land Resource				
a. Land Quality	Increase in agricultural productivity.	Increase in agricultural productivity.	Land released for other uses.	Land released for other uses.

BIG SPRING, TEXAS

Evaluation Analysis (Cont'd.)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4
3. Land Resource (Cont'd.)				
b. Land Utilization	Large land area required. Land committed for long period of time (about 420 acres).	Large land area required. Land committed for long period of time (about 420 acres).	Small land requirement (about 5-10 acres).	Small land requirement (about 5-10 acres).
4. Biological				
a. Zoological	Would change wildlife habitat characteristics. Would probably increase species diversity and total number.	Would change wildlife habitat characteristics. Would probably increase species diversity and total number.	Probably little effect due to small land area requirement.	Probably little effect due to small land area requirement.
b. Botanical	Large land area requirement would probably cause destruction of vegetation. Existing vegetation replaced with crops.	Large land area requirement would probably cause destruction of vegetation. Existing vegetation replaced with crops.	Probably little effect due to small land area requirement.	Probably little effect due to small land area requirement.
5. Geological	If land disposal site within the outcrop of an aquifer, irrigation could affect rate of recharge.	If land disposal site within the outcrop of an aquifer, irrigation could affect rate of recharge.	Probably little effect due to small land area requirement.	Probably little effect dur to small land area requirement.
B. Social				
1. Manpower	Additional personnel required. Non-technical personnel for land disposal operation probably available locally.	Additional personnel required. Non-technical personnel for land disposal operation probably available locally.	Additional personnel required. Technical personnel required for operation of tertiary system may not be available locally.	Additional personnel required. Technical personnel required for operation of tertiary system may not be available locally.
2. Aesthetics	Land disposal site could be used as positive factor for influencing direction of growth —i.e., green belt.	Land disposal site could be used as positive factor for influencing direction of growth —i.e., green belt.	Little or no problem anticipated due to remoteness of plant from populated areas. Screening (i.e., vegetation) could be used if located near population concentration.	Little or no problem anticipated due to remoteness of plant from populated areas. Screening (i.e., vegetation) could be used if located near population concentration.
3. Political Acceptability	Generally acceptable to local interests. Possible objections to increase in city owned land if city owns and operates land disposal system.	Generally acceptable to local interests. Possible objections to increase in city owned land if city owns and operates land disposal system.	May not be acceptable because of change in water use patterns.	May not be acceptable because of change in water use patterns.

BIG SPRING, TEXAS

Evaluation Analysis (Cont'd.)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4
C. Economic	Potential for increased agricultural revenue. Additional employment required.	Potential for increased agricultural revenue. Additional employment required.	Greater revenue potential because higher economic use of water possible. Increase in skilled employment.	Greater revenue potential because higher economic use of water possible. Increase in skilled employment.
D. Technology				
1. Reliability/ Flexibility	More reliable. Effluent from land disposal system of very high quality.	More reliable. Effluent from land disposal system of very high quality.	More flexible. Effluent available directly for many uses.	More flexible. Effluent available directly for many uses.
2. Construction Effects	Construction of land disposal system would disrupt rural community by increasing noise and dust, etc. Extensive destruction of existing vegetation possible.	Construction of land disposal system would disrupt rural community by increasing noise and dust, etc. Extensive destruction of existing vegetation possible.	Less detrimental because of smaller land area requirement.	Less detrimental because of smaller land area requirement.
E. Institutional Arrangements	No change if city owns and operates land disposal system. Difficulties could be encountered if city contracts with farmer for operation of land disposal system.	No change if city owns and operates land disposal system. Difficulties could be encountered if city contracts with farmer for operation of land disposal system.	Change could be required to restructure functions and responsibilities of public works department.	Change could be required to restructure functions and responsibilities of public works department.
F. Resource Conservation	Large land area committed for long period of time. Energy requirements would be higher than for Alternatives 3 and 4.	Large land area committed for long period of time. Energy requirements would be higher than for Alternatives 3 and 4.	Chemical requirements would commit large quantities of non-renewable resources.	Chemical requirements would commit large quantities of non-renewable resources.

METROPOLITAN PLAN
FOR
MIDLAND, TEXAS

Physical Description.

The City of Midland, incorporated in 1906, is located in northwest Midland County at the junction of I. H. 20 and State Highways 158 and 349 in West Texas. Midland is primarily a distribution center for one of the State's principal petroleum and livestock regions. Major inlets and outlets for this metropolis include one interstate highway, two State highways, numerous farm-to-market roads, plus railway and air service. The high quality of these transportation means allows the City to function as the administrative headquarters of the Permian Basin oil and petrochemical industry.

Soil types underlying the City are numerous but not extensive in area. For pragmatic purposes, three of the most predominant soils will be discussed: the Amarillo, Arvana, and Midessa soils. Amarillo soils are typically friable, with a fine sandy loam to sandy clay loam surface from 6 to 15 inches thick. The surface layer overlies a friable, coarse, prismatic and granular, porous sandy clay loam or sandy clay with a thickness range up to 5 feet. Amarillo soils have a moderate permeability rate, ranging from 0.50 to 2.0 inches per hour, imposing slight to moderate restrictions on septic tank filter fields and moderate restrictions on sewage lagoons due to seepage.

Arvana soils are generally friable, loamy, fine sand to fine sandy loam from 7 to 12 inches thick, overlying 8 to 20 inches of moderately permeable, well-drained, sandy, clay loam that rests on hard, rock-like caliche from 16 to 36 inches below the surface. Arvana soil permeabilities range from 2.0 to 6.3 inches per hour in the surface layer and 0.6 to 2.0 inches in the lower strata. Although moderately permeable, the presence of indurated caliche at such shallow depths places severe restrictions on both septic tanks and sewage lagoons. This soil is also subject to water erosion and suffers high seepage losses as well.

Midessa soils are generally moderately deep with a friable, subangular and blocky calcareous sandy loam to loam and sandy clay loam surface. This top layer is from 8 to 12 inches thick, overlying a calcareous, friable and blocky sandy loam to sandy clay loam with weakly cemented qualities. This characteristic of moderate permeability imposes moderate restrictions on both septic tank filter fields and on sewage lagoons.

The City is afforded only slight to moderate topographical relief, with elevation variations ranging up to a maximum of about 20 feet per mile, sloping and draining eastward into Midland Draw. Although seemingly flat, Midland's topography could be classified as gently undulating.

Social and Economic Description.

Population.

Founded in the early 1880's as a railroad construction camp, it was originally called Midway in reference to its location halfway between Fort Worth and El Paso. At the turn of the century, Midway numbered approximately 1,000 people as it rose to prominence as a regional cattle-shipping center. It was incorporated in 1906 and renamed Midland. Thus, cattle was initially the major source of economy in Midland. In the mid 1920's, the discovery of oil around Odessa, twenty miles to the west, precipitated a major economic change for Midland as well as for its western neighbor. Midland's reaction to the oil boom was parallel to Odessa's, but the character of this response was of a different nature. Already established as a financial and social center for the cattle industry area, the transition to an oil information and financing center was accomplished quite naturally.

This transition and subsequent growth of the City's role in the region is reflected in the historical population figures of 1920 and 1930. Midland's 1920 population was 1,975, contrasted with 5,484 in 1930. As the oil industry expanded in scope throughout the region, so did the City's economy and the magnetism that attracts employment and opportunity. As a result, Midland's 1940 population rose 71 percent from the 1930 figure to 9,352. The wartime demand for oil, coupled with the advent of the oil exploration and drilling boom in the 50's, caused the City's population to soar. The 1950 Census figure was 21,756 while the 1960 count was 62,625. The period between 1962 and 1965 was one of growth cessation and stabilization as the oil boom subsided, with the corresponding decrease in drilling operations. The 1970 population of Midland was 59,463, which was 91 percent of the county population for the same year. An additional 2,540 people live outside the corporate limits within what will be defined as the Midland Urban Area for the purposes of this study. This Urban Area corresponds to the land use shown on Plate M-1.

Residential pockets are found in three sectors: north of the City adjacent to Midland Airpark, east of Midland fronting U.S. Highway 80 at the County Fairgrounds area, and south of the city limits line. Population density within Midland's 17,173 acres averages 3.35 people per acre, generally distributed in the central core of the incorporated area. An internal population shift to the northwest section of the City has led to residential development in that area of Midland, along with accompanying light commercial development. This relocation trend has caused a fragmentation of the downtown district, an occurrence not uncommon to metropolitan areas. Another repercussion arising from the exodus to the suburbs is evident in the inner-city sector. Substantial concentrations of abandoned and neglected housing units have remained in the south, southwest, and east portions of Midland. Aside from their unaesthetical nature, such pockets of blight have little present or future market potential. This situation is not unique to Midland, for it has been experienced in other metropolitan areas as well.

Population projections for Midland were developed by the TWDB. The projection methodology used in this study has taken into consideration the innumerable factors that affect people and their behavior patterns. The projections for the City of Midland show a gradual increase in the pattern of growth as illustrated below:

Population Projections

	Year 1970	1980	1990	2020
Midland	59,463	62,340	65,310	70,130
Urban Areas	62,000	65,000	68,100	73,100

Approximately one-fifth of the 1970 Midland population is comprised of Negroes and Mexican-Americans, equally divided in the percentage. These two ethnic minority groups are generally concentrated in the under-developed areas of the City previously discussed. Educational and income achievement in these groups average about half of what the remainder of the population enjoy. Median family income in 1970 for Midland was $10,575, with the two minorities having a median family income of approximately 50 percent of the City's figure. This minority income median, it should be noted, parallels the educational attainment for these groups when compared to the total City education achievement level. As an administrative center for the oil industry, along with many other businesses, it should be recalled that such a function will invariably demand the more highly educated and skilled personnel found in the administrative hierarchies of businesses and industry. Thus, one must keep this situation in consideration when comparing family incomes in Midland, to avoid misconstruing the socio-economic aspect of the City.

Land Use.

Land use for Midland is illustrated on Plate PB-M-1. According to the Midland Comprehensive Long-range Plan by Caudill Rowlett Scott, Architects, Planners and Engineers, existing land use within the City of Midland is represented by the following table:

Existing Land Use - Midland

Usage	Percentage
Residential	24.4
Commercial	4.1
Industrial	.1
Public	37.6
Undeveloped	33.8

The residential land use is generally at the central section of the City with a definite western development trend. The City's commercial area, as is the case with most metropolitan areas, is located downtown at the east central vicinity of the incorporated area and along U. S. Highway 80. New commercial development is occurring to the northwest and west as previously mentioned. The industrial area has three main areas of concentration, the predominant one found in the southwest sector of the City adjacent to U.S. 80. These projections were made on the basis of the TWDB Population Projections, conferences with City of Midland officials, reports previously published for the City, and observed existing trends and patterns. It is not the intent of this wastewater management study that the anticipated land-use projections be accepted as a final document, or that growth patterns be construed to mean exact locations indicated on the exhibit. Rather, the projected land-use pattern illustrated is merely a generalized interim plan to meet the requirements of the study.

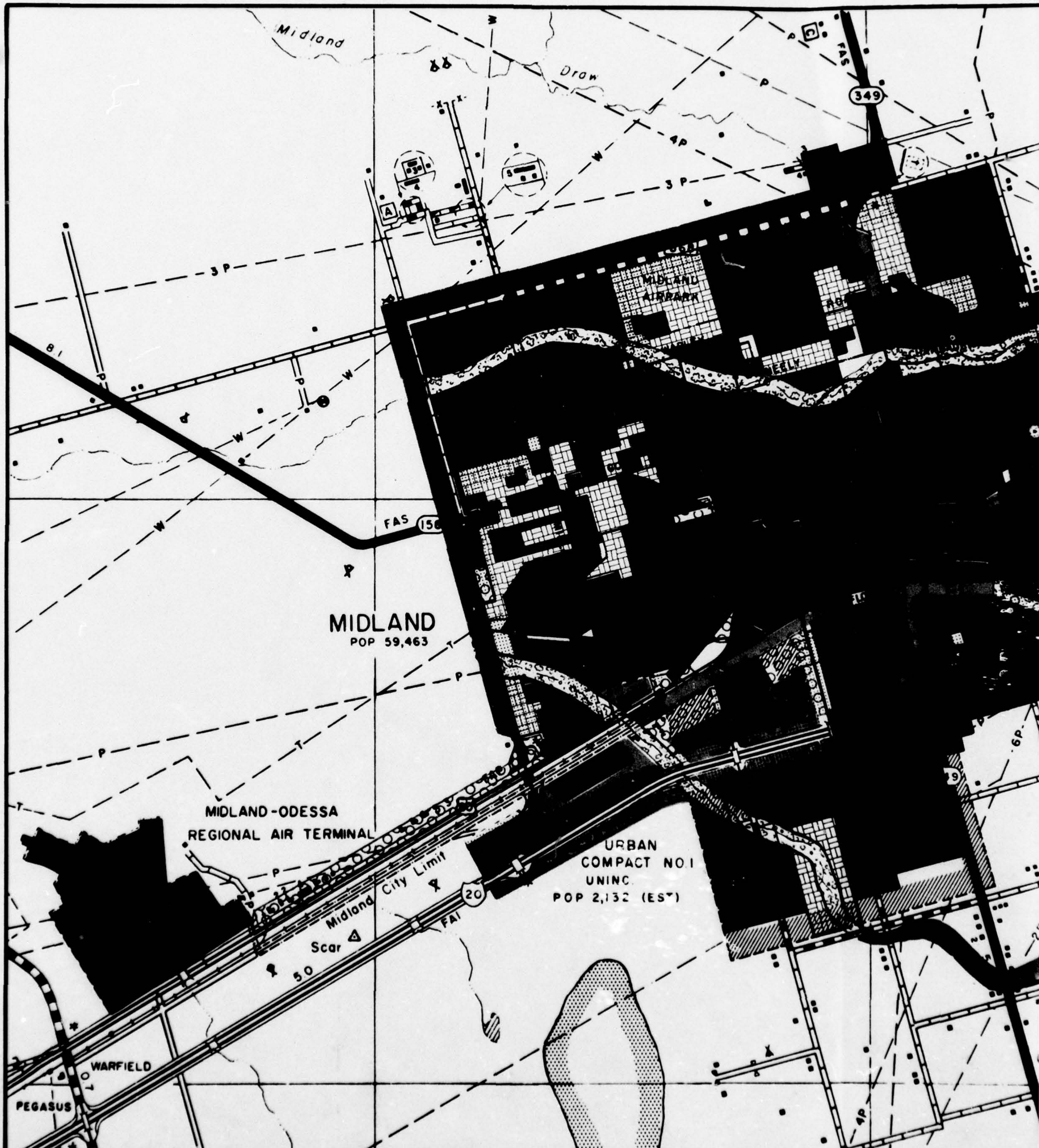
Economic Base.

Midland's major economic base is in oil administration. Little significant support on a city-wide basis can be attributed to other usual sources of revenue, such as manufacturing, services, and retailing enterprises. The result of this lack of economic diversification, as well as its isolated geographic location that places restrictions on its business market, handicaps the growth of the City. Industry, comprising approximately 0.1 percent of the total land use (16.7 acres), cannot be regarded as a major source of revenue for the City due to its small size geographically and economically.

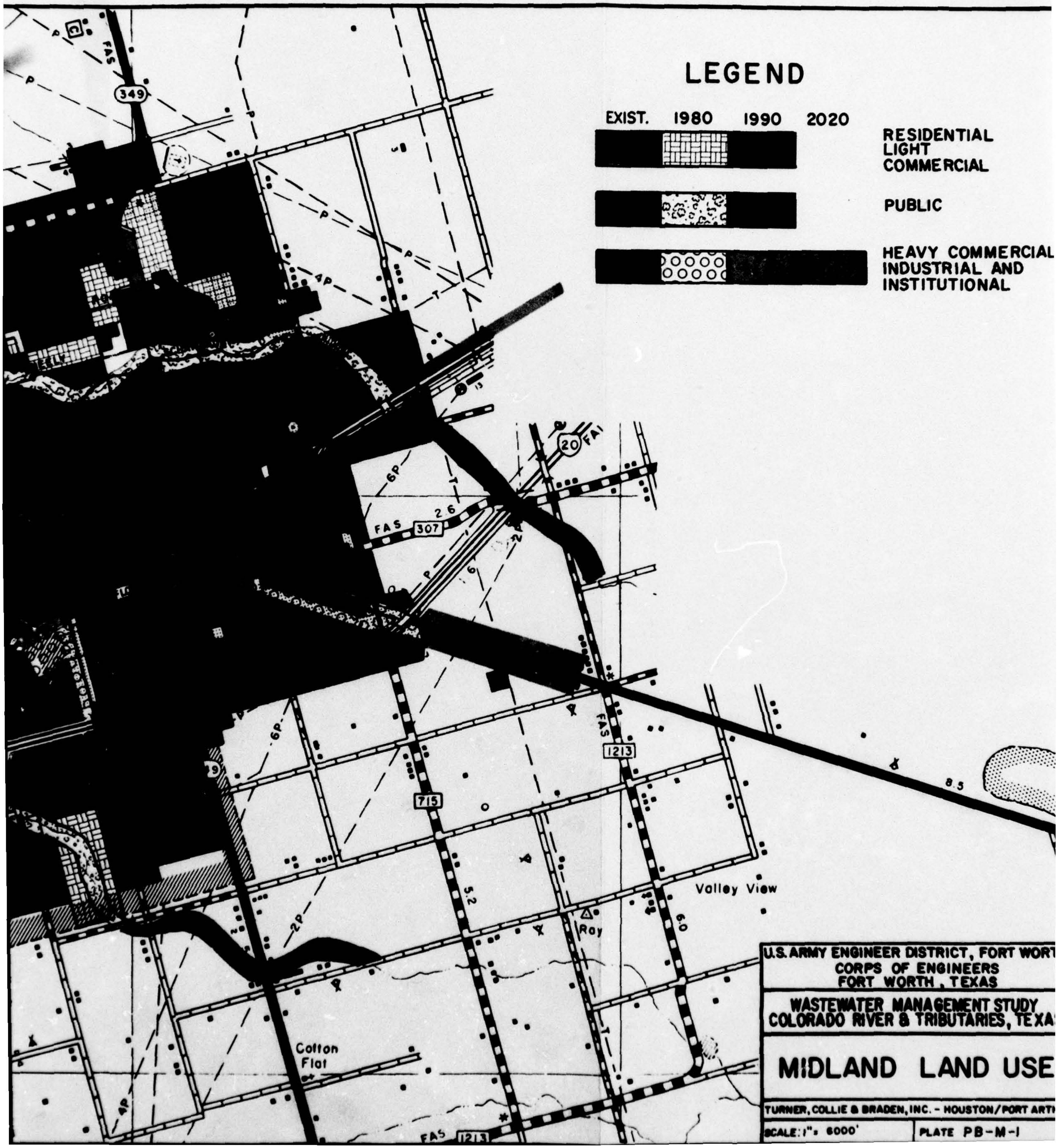
The City is in the midst of a growth arrest, with population figures projected to increase only slightly. The potential for development in this area is found primarily in the Odessa area rather than in Midland. As in most metropolises, the lack of parking facilities, congestion, and remoteness from the residential areas gives the downtown sector an unfavorable image. Any industrial development that may occur would probably be in the southwest.

Water Resources.

The City of Midland's ground water resources are easily accessible and quite extensive. These ground water supplies are drawn from the outcrop of the Ogallala Aquifer by a network of approximately 70 wells, the majority of which are found in the Paul Davis and McMillen Well Fields. The wells in both well fields are shallow, with average depths in the Paul Davis Field at 196 feet and 142 feet in the McMillen Field. Total yield from the two fields' resources is estimated at 29 mgd. Total storage for the City water supply is 25.08 mg, retained in ten storage reservoirs located throughout the City, and listed on the following page.



Midland
Draw
349
FAS
MIDLAND AIRPARK
FAS 158
MIDLAND
POP 59,463
MIDLAND-ODESSA
REGIONAL AIR TERMINAL
Midland City Limit
URBAN
COMPACT NO.1
UNINC.
POP 2,132 (EST)
20
FAI
Scar
WARFIELD
PEGASUS


LEGEND
EXIST. 1980 1990 2020
RESIDENTIAL
LIGHT
COMMERCIAL
PUBLIC
HEAVY COMMERCIAL
INDUSTRIAL AND
INSTITUTIONAL
FAS
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20
FAI
FAS 307
2.6
715
1213
5.2
6.0
8.5
Valley View
Ray
Cotton
Flat
FAS 1213
U.S. ARMY ENGINEER DISTRICT, FORT WORT
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
MIDLAND LAND USE
TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ART
SCALE: 1" = 6000'
PLATE PB-M-1

Storage Reservoirs

Type	Capacity (mg)	Material	Location
Ground	2.5	Concrete	Paul Davis Pump Station
Ground	2.0	Concrete	McMillen Pump Station
Ground	2.0	Concrete	McMillen Pump Station
Elevated Ground	5.0	Concrete	Edgewood Pump Station
Elevated Ground	5.0	Concrete	Edgewood Pump Station
Elevated	1.0	Steel	Edgewood Pump Station
Elevated	1.0	Steel	Shell Avenue Station
Elevated Ground	2.25	Steel	Powell Street
Elevated	0.33	Steel	Weatherford St. & Illinois Ave.
Clearwell	4.0	Concrete	Water Treatment Plant

The City supplements its ground water supply in the municipal use by purchasing water from the Colorado River Municipal Water District (CRMWD). The CRMWD has a network of pipes from Lake J. B. Thomas and E. V. Spence Reservoir through which water is transmitted to Big Spring, Midland, and Odessa. Since 1970, the CRMWD has supplied untreated water to Midland in the following amounts:

Year	mg
1970	2,771
1971	2,983
1972	3,451

The raw water is pumped to a treatment plant located at the point of intersection of the CRMWD boundary line and the City's Paul Davis Field supply line where it is blended with the ground water supply. This is done to avoid the possibility that chemical reactions will occur, causing cloudy water and precipitates. Thus, the blending of the ground and surface waters before treatment reduces the overall hardness and provides a water more responsive to softening.

The water treatment plant is of conventional design, with a rated capacity of 12 mgd. It can, on demand, treat up to 18 mgd or more. Facilities are included for coagulation, mixing, clarification, filtering, and softening, removal of suspended matter, reduction of taste and odors, disinfection, and pH adjustment for corrosion control. This plant is adjudged to be adequate to handle the water requirements of Midland for the scope of this study (2020). The projected water use, a reflection of the population trend, has been projected for the City by the TWDB to be as follows:

Water Use Projections
(in mgd)

	Year 1970	1980	1990	2020
Municipal Use	10.51	11.81	12.73	14.87
Industrial Use	0.07	0.14	0.17	0.29

Waste Load Analysis.

Municipal Waste Load.

Municipal wastewater return flows, projected for Midland by the TWQB, are as follows:

Waste Load Projections

	Year 1970	1980	1990	2020
Flows in mgd	5.05	5.29	5.55	5.96
BOD in lb/day	10,109	11,221	11,756	13,325
TSS in lb/day	11,893	13,091	14,368	16,130

For planning purposes, a per capita flow contribution of 100 gallons per day was used by the TWQB. Actual flows in the years 1971 and 1972 were about 4.3 mgd. Existing and anticipated service areas for the planning phases of this report are shown on Plate PB-M-2.

Urban and Agricultural Runoff.

Midland lies entirely within the drainage area of Midland Draw. Stormwater flows in the draw include any urban runoff from the City in addition to any agricultural runoff from surrounding farmland. The principal sources of pollutants in runoff include:

1. Street and parking lot litter, oil, and grease.

2. Animal and bird wastes deposited on impervious surfaces.

3. Fertilizers from lawns and parks.

4. Pesticides.

5. Suspended solids from excavation and construction activities and from unpaved and unplanted areas.

6. Leaves and grass.

7. Air pollutants which settle or are washed out by rain.

8. Unauthorized waste discharges into gutters, streets, storm sewers, etc.

9. Overflowing manholes in overloaded sanitary sewer systems.

Sources of agricultural runoff pollution include:

1. Inorganic fertilizers.

2. Animal and poultry wastes.

3. Insecticides and herbicides.

4. Silt and other suspended solids.

Concentrations of pollutants in runoff depend on the amounts available to be washed away by rain, time interval between rains, and the intensity and duration of rainfall. Existing studies seem to indicate that urban runoff is generally much higher in concentration of pollutants than agricultural runoff.

In the semi-arid regions around Midland, stormwater pollution is not a significant problem due to low annual rainfall rates and a general absence of flowing streams. Rainfall is often in the form of sudden annual storms which create more problems with flooding than with pollution from runoff, due to the poorly-defined drainage in the area.

Updated information is not available on Midland's storm sewer system; however, all drainage from the City is into Midland Draw or one of several small playa lakes. The branch of Midland Draw along Scharbauer Drive in the northeast part of town has been maintained as a drainage channel. The playa lakes, where they lie within the city limits, have mostly been left as parks in order that their holding capacities be left unhindered. Any overflow from these lakes will ultimately find its way into Midland Draw or, in some possible cases, into Monahans Draw about five miles south of town. Along Midland Draw downstream from the City itself, lies part of the City's sewage treatment facilities -- including several holding ponds constructed in the draw. These ponds effectively dam the draw to form a storage area through which stormwater runoff must pass.

One potential problem in the City is the concentration of pollutants in the numerous playa lakes which catch the initial runoff from much of the area. These lakes act as stormwater holding basins and, as stated previously, most have been developed as parks. After a rain, water in these lakes gradually evaporates or seeps away and can leave concentrations of the pollutants to destroy the appearance and recreational qualities of the park. One solution to this problem would be to provide facilities to drain the lakes following a storm, as has been done in some cases.

Industrial Wastes.

Industries in the Midland area which could produce significant wastes are listed below:

American Basic Chemicals, Inc.	Chemicals
American Chemical Co., Inc.	Chemicals
AMF Tuboscope, Inc.	Plastic Coatings
Atlantic Richfield Co.	Hydrocarbons
Bernards Tortilla Factory	Food Processing
Borden Dairy & Services	Dairy Products
CJM Packing Co.	Meat Processing
Craddick Enterprises	Chemicals
Gooch Blue Ribbon Meats	Meat Processing
Hutch's Meat Processing	Meat Processing
Phillips Petroleum Co.	Gasoline Plant
Russco Chemical Co.	Chemicals
Specialty Research & Sales, Inc.	Chemicals
Warren Petroleum Corp.	Hydrocarbons

Many of these industries, notably the refineries, do not discharge into Midland's sewer system, but all are potential producers of wastes with poor treatabilities which could require complete treatment prior to disposal. Existing pretreatment facilities for these industries are not known, but none have known permitted discharges of wastes other than into the Midland sewer system. Even in those cases in which no waste is discharged into the municipal system, sewer service could be extended later as the City grows, to include the industrial sites.

Stormwater runoff from industrial sites can pose significant problems, especially in the case of refineries and chemical plants. Containment and treatment of runoff would vary in each case and are probably nonexistent in many. A detailed study of each particular industrial site would be necessary to truly understand the nature and magnitude of this problem, and such is beyond the scope of this report. Industrial runoff could also cause problems due to location, since many of the industrial sites are located such that stormwater runoff from them must pass through major portions of the City to reach the draw. Industrial solid wastes for these industries are generally either handled onsite or taken to the municipal landfill for disposal.

Solid Waste.

Solid waste disposal in Midland consists of a sanitary landfill. Portions of the sludges from the water and wastewater plants which can be applied to the land for agricultural purposes are not disposed of at the landfill site. The landfill site is clay lined and protected from runoff so that it poses no water pollution problems at present.

Midland's new water treatment plant is served by an extension of the sanitary sewer system, but according to available information, water treatment wastes are not discharged into the system. Sludges are dewatered in open drying pits, and filter backwash water is recycled through the plant.

Waste Load Allocation.

The concept of waste load allocation is based on dividing the assimilative capacity of a particular stream among the waste producers in such a manner that the total waste load on the stream will not exceed its ability to renew and maintain itself at the desired quality level. Since there are no perennial streams in the Midland area, any wastewater effluent discharged to a waterway becomes the stream flow under low flow conditions; therefore, under an allocation methodology, stream quality standards would become effluent standards. For this reason, wastewater restrictions for Midland are and will remain effluent quality criteria. At present, the limiting effluent criteria for Midland is the TWQB requirements that effluent contain not more than 20 ppm BOD_5 and 20 ppm Total Suspended Solids, with at least 1.0 mg/1 chlorine residual after 20-minute detention time.

Under PL 92-500, secondary treatment of wastewater will be adequate until 1983, at which time application of the best practicable waste treatment technology will be required toward the ultimate goal of no discharge of pollutants by 1985.

Municipal Wastewater Collection System.

Existing Collection System.

The existing wastewater collection system for Midland is outlined on Plate PB-M-2. The service area boundaries, collection mains, and outfalls are shown to represent the system. In February 1968, Freese, Nichols and Endress - Esmond, Reed, and Associates, Consulting Engineers,Odessa, published "Midland, Texas - A Final Report on Sanitary

Sewerage System." That report analyzed in detail the collection system in use at that time. This included development of design criteria based on actual flow measurement, performance analysis of the existing lines, recommendation of remedial steps to correct problems, and delineation of proposed lines to meet future needs. City officials have provided information to update the report to the present so that the analysis of existing system could be used for this study. The City has made corrections in the major problem areas and is carefully monitoring areas which may require immediate modification as the City grows. At present, there seem to be no significant problems in the Midland sanitary sewer collection system.

The existing service area was divided into four sectors: northern, north-central, central, and southern as shown on the Plate. There are, at present, three major residential areas within the Midland urban area in which septic tanks are still the primary means of sewage treatment. These areas are not within the present city limits, and are not served by the municipal sewer system. One area is northeast of the Midland Airpark on the northern edge of town, another is east of town just north of Highway 80, and the other is directly south of the City, just north of the Cotton Flat area. General soil types in these areas indicate slight to severe restrictions on septic tank operation in any one area, depending on which particular soil type is found at the site. At present, these satellite communities are characterized by low-density population; but should they show growth parallel to Midland proper as projected, sewer service will be required.

Proposed Collection System.

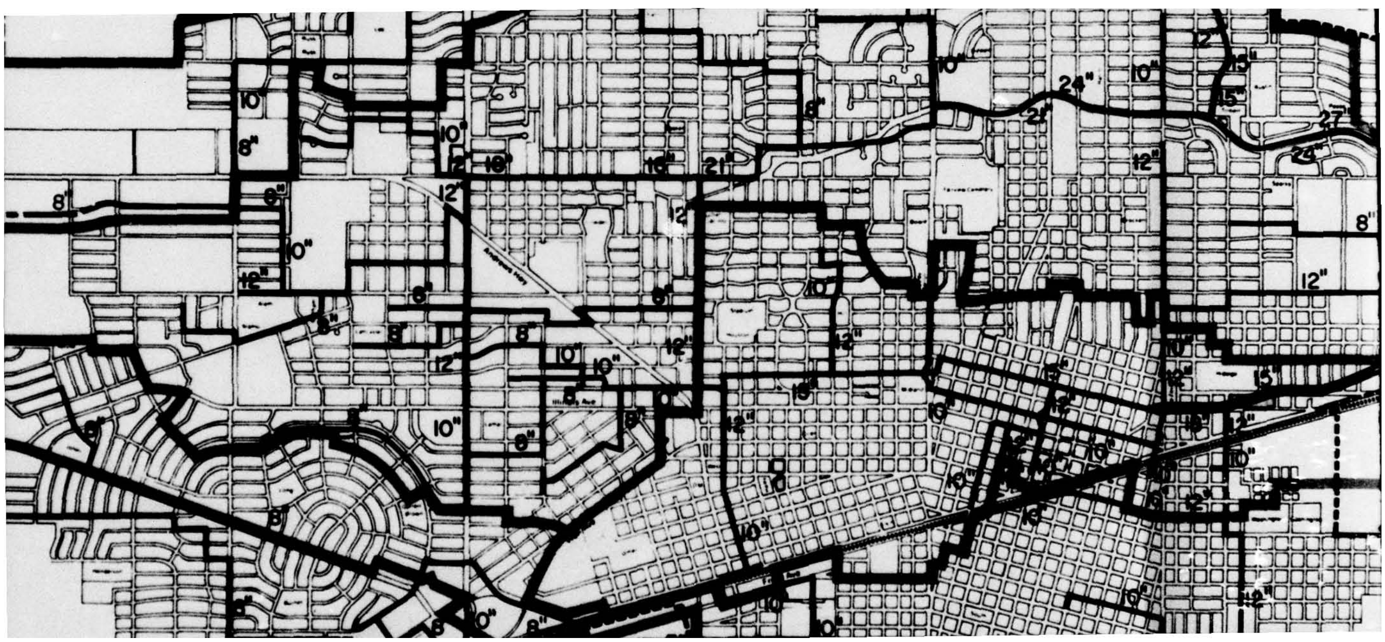
Proposed collection system improvements for the City of Midland are shown on Plate PB-M-2. Internal reliefs and expansions are based on the sewer report mentioned previously. External expansions and proposed systems are based on land use and population projections developed for this study and covered previously.

For the purposes of this study, an average population density of 3.5 people/acre was assumed for projected areas of new development. Design criteria for sewer lines were adopted from the above report, as follows:

Average daily contribution - 80 gallons per capita per day

Ratio of peak flow to average flow:

Population of area served	Ratio (%)
0 - 3,000	225
3,000 - 5,000	211
5,000 - 30,000	190
Over 30,000	174



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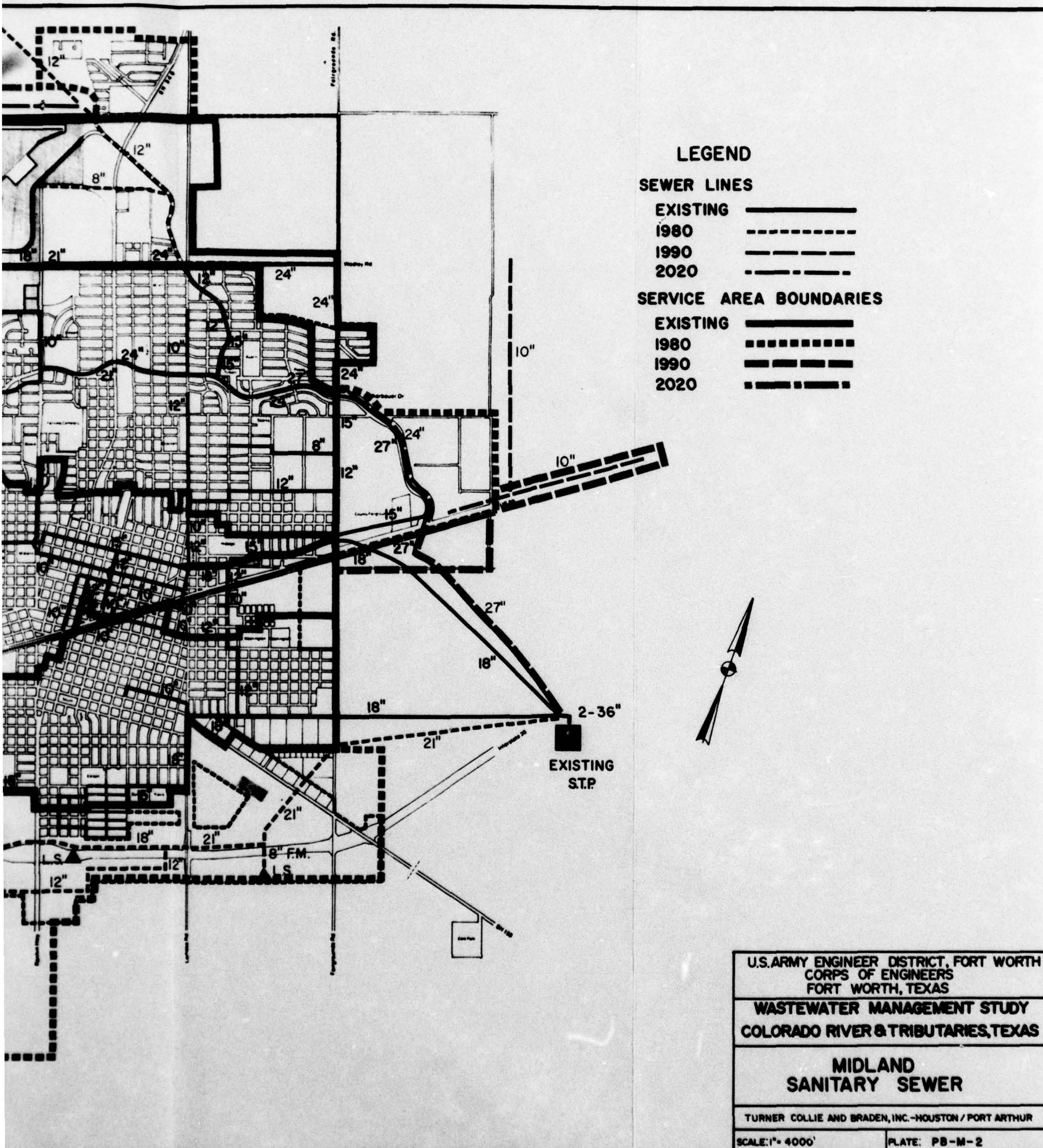
LEGEND
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1990
2020
SERVICE AREA BOUNDARIES
EXISTING
1980
1990
2020
2-36"
EXISTING S.T.P.
L.S.
8" F.M.
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
MIDLAND
SANITARY SEWER
TURNER COLLIE AND BRADEN, INC.-HOUSTON / PORT ARTHUR
SCALE: 1" = 4000'
PLATE: PB-M-2

2

These values are based on actual flow measurements and were adopted for use in the previous plan.

Since Midland is projected to grow only about 18 percent over the 50-year planning period and is experiencing somewhat of a migration to the suburbs, little internal expansion and relief is expected to be necessary. The adequacy of the internal system is also due to the City's part in carrying out the recommendations of the comprehensive sewer study.

Except for the northern, northwestern, and extreme southern areas, only minor extensions to the existing collection system are needed to meet projected future requirements. Most of the projected growth and much of the local migration is projected to be toward the north and northwest. For this reason, significant expansion into presently-undeveloped areas will be needed as shown. As these areas develop, relief in the existing outfall lines will be needed. At present, all flow from the northern system is bypassed into the north-central system through the 12 and 15-inch lines in Parkway Drive. These lines, and the 24-inch line in Sharbauer Drive into which they flow, will become overloaded as the northwestern area of the City develops. It will be necessary to construct the remainder of the 24-inch line in Wadley Road and Fairgrounds Road by 1980 and the 24-27-inch outfall shown parallel to the existing 27-inch outfall by 1990 to handle the flow from the new development.

The area south of I. H. 20 is presently unserved by any part of the municipal sewer system. There are presently over 2,000 people living in scattered residential clusters in the area, with some growth projected to occur there. Existing population densities are too low to justify municipal sewer service at the present time, but as future growth increases the density, such service will become a necessity. Since this is a relatively low-lying area, extension of municipal sewer collection lines from the existing Midland system will involve a major expenditure for pump stations and force mains, in addition to the cost for normal gravity collection lines. For this reason, it is proposed that the City of Midland monitor development in the area until the growth in this southern sector warrants the extension of sanitary sewer service. As an alternative, construction of a small sewage treatment plant to serve this southern sector was considered. A modified activated sludge plant with a capacity of 0.8 mgd would cost approximately $523,000 plus $40,000 per year for operation and maintenance. The corresponding pump station and force main to carry the sewage to the Midland system would cost only about $217,000 plus $8,000 per year for operation and maintenance.

Extension of sewer service to the areas of projected development is based on the assumption that the City of Midland will either annex the areas, which will probably be the case in the northwestern area, or the City will contract with the residents of an area to extend the service to them, as could happen in the southern sector.

Costs for proposed collection system improvements are shown in Table PB-M-1 on the following page.

TABLE M-1

COST OF PROPOSED COLLECTION SYSTEM IMPROVEMENTS

CITY OF MIDLAND, TEXAS

A. Gravity Mains:

Pipe Size (inches)	Cost ($/ft.)	Total Feet in Thousands			Total Capital Cost		
		1980	1990	2020	1980	1990	2020
8	9.50	8.5	6	40	$ 80,750	$ 57,000	$380,000
10	12.00	5.0	3	–	60,000	36,000	–
12	15.00	30.5	–	–	457,500	–	–
15	19.30	2.0	–	–	38,600	–	–
18	23.50	14.0	–	–	329,000	–	–
21	28.00	16.0	–	–	448,000	–	–
24*	32.70	7.5	15	–	241,500	490,500	
				Total with E&C	$1,936,760	$681,400	$452,200

***Additional flows or grade considerations may require that a portion of this line be laid with a 27-inch sewer.**

B. Force Mains and Pump Stations:

1980	Capital	Annual O&M
2 Pump Stations:		
0.68 MGD at 22 ft. head	$ 40,000	$ 2,900
1.66 MGD at 61 ft. head	110,000	8,000
1,000 ft. of 8-inch line @ $5.50/ft.	5,500	–
7,500 ft. of 12-inch line @ $9.30/ft.	69,750	–
Total with E&C	$270,300	$10,900

Municipal Wastewater Treatment System.

Existing Wastewater Treatment Facilities.

Midland's main treatment plant, including improvements now nearing completion, is of the activated-sludge type with a design capacity of 6.0 mgd. A complete description of Midland's existing municipal wastewater treatment facilities is given in Appendix A following this section. The average flow to the main plant over a 12-month period was 4.3 mgd, with periodic maximum daily flows approaching 6.0 mgd. Currently, all effluent is used to irrigate the golf course, one park, and farmland adjacent to the plant. Dried sludge is used as fill at an unspecified location.

According to the analysis of present and projected waste loads given previously, the 6.0-mgd capacity of Midland's main treatment plant should be adequate through the planning period; however, if expansion becomes necessary, adjacent City-owned land is available.

The activated sludge process is theoretically capable of up to 95 percent removal of BOD and suspended solids when properly operated and maintained. It is presently the most cost-effective process for secondary treatment of domestic sewage and is the most common type of treatment found in modern metropolitan areas.

Proposed Wastewater Treatment Facility Alternatives.

Introduction.

Prior to presentation of the proposed wastewater treatment facility alternatives, it should be noted that proposed collection system costs are common to each alternative, and these costs are repeated for all alternatives.

For Midland, a total of twelve alternative wastewater treatment schemes were investigated during the conduct of this study. These twelve alternatives were evaluated, and four alternatives were selected as the most viable alternatives. All of the twelve alternatives will meet the treatment requirements of PL 92-500. A discussion of the four most viable alternatives is presented, followed by a discussion of the eight remaining alternatives.

Alternative 1.

Alternative 1 includes utilization of the existing activated-sludge secondary treatment plant, followed by the present practice of total irrigation. Presently, all effluent is used to irrigate a golf course, one park, and farmland adjacent to the plant. Since no additional facilities are proposed, the only costs associated with this alternative are the operation and maintenance costs of the existing system, or about [illegible] annually.

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$2,207,100	$49,600
1990	681,400	13,600
2020	452,200	9,100

Further economic analysis of Alternative 1 is presented in Appendix B of this section. Alternative 1 was also subjected to an evaluation analysis. Results of that analysis are shown in Appendix C of this section.

Alternative 2.

Alternative 2 includes utilization of the existing 6.0 mgd activated-sludge secondary treatment system, followed by the rapid infiltration method of land disposal of all effluent by 1975. Rapid infiltration involves infiltration and evaporation from a series of crop-lined ponds with a typical application rate of one foot per day for ten days followed by five days of rest. To provide adequate treatment for the Midland area, a site would be needed with a known profile of permeable soil to a depth of 140 feet; however, it is doubtful that such a site can be found in the area.

The estimated 1975 capital costs for this irrigation alternative are presented below:

1975 Capital Cost

Description	Estimated Cost
Irrigation Facilities (6.0 mgd)	
Ponds	$155,000
Pumps	30,000
Land - 30 acres @ $200/ac	6,000
TOTAL*	$228,500

*Including engineering and contingencies.

1975 Annual O&M

Description		Estimated Cost
Existing Secondary Facilities (6.0 mgd)		$175,200
Irrigation Facilities (6.0 mgd)		
Ponds	$3,200	
Pumps	1,800	
		5,000
TOTAL		$180,200

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$2,207,100	$49,600
1990	681,400	13,600
2020	452,200	9,100

Further economic analysis of Alternative 2 is presented in Appendix B of this section. Alternative 2 was also subjected to an evaluation analysis. Results of that analysis are shown in Appendix C of this section.

Alternative 3.

Alternative 3 includes upgrading the existing 6.0 mgd activated-sludge secondary treatment plant by 1975 to a 6.0-mgd biological tertiary treatment plant. The tertiary treatment processes would include nitrification, denitrification, filtration, activated carbon treatment, chlorination, and aeration of the effluent. The capital cost for the tertiary treatment facilities is estimated to be $4,543,000, with an associated operation and maintenance cost of $744,600 annually.

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$2,207,100	$49,600
1990	681,400	13,600
2020	452,200	9,100

Further economic analysis of Alternative 3 is presented in Appendix B of this section. Alternative 3 was also subjected to an evaluation analysis. Results of that analysis are shown in Appendix C of this section.

Alternative 4.

Alternative 4 includes pumping Midland's domestic raw sewage to Odessa by 1975 for secondary treatment and subsequent sale to industries. The economic feasibility of pumping Midland's sewage to Odessa is based entirely on the assumption that industry in Odessa will buy up to 20 mgd of secondary effluent through year 2020. This assumption is questionable at best, and contractual agreements between both cities and several industries would be necessary before implementation could begin. Regionalization would include expansion to the Odessa secondary treatment plant above those proposed for Odessa alone, and pump stations and a pipeline to carry sewage from the site of Midland's existing plant to Odessa. For this alternative, Midland's existing treatment would be abandoned.

The estimated costs of this alternative are presented below.

1975 Capital Cost

Description	Estimated Cost
6.0-mgd expansion of Odessa's secondary facilities	$1,627,500
Four pump stations and 23 miles of 30-inch pipeline	6,770,000
TOTAL*	$8,397,500

*Including engineering and contingencies.

1975 Annual O&M Cost

Description	Estimated Cost
Pump Station	$ 32,000
Pipeline	102,000
TOTAL	$ 134,000

Note: Operation and maintenance costs of the expanded secondary facility in Odessa would be borne by Odessa, who currently sells wastewater to local industry.

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$ 2,207,100	$49,600
1990	681,400	13,600
2020	452,200	9,100

Further economic analysis of Alternative 4 is presented in Appendix B of this section. Alternative 4 was also subjected to an evaluation analysis. Results of that analysis are shown in Appendix C of this section.

The aforementioned four alternatives were selected as the most viable, cost-effective alternatives. The additional eight alternatives investigated, but not selected for further refinement, are presented below. All of these alternatives will meet the requirements of PL 92-500 and were considered for immediate (1975) implementation.

Alternative 5.

Alternative 5 includes utilization of the existing 6.0 mgd activated-sludge secondary treatment plant. By 1983, partial tertiary treatment consisting of partial filtration, alum addition, and nitrification would be added to the conventional secondary treatment plant. The partial tertiary treatment processes are designed to produce an effluent containing not more than 12 mg/l BOD_5, 9 mg/l TSS, and 1 mg/l phosphorus. This alternative, however, would not produce an effluent capable of meeting the 1985 goals of the law without additional construction.

The estimated costs of this alternative are presented below.

1975 Annual O&M

Description	Estimated Cost
Existing secondary facility (6.0 mgd)	$ 175,200

1983 Capital Cost

Description	Estimated Cost
Partial tertiary treatment facilities (6.0 mgd)	
Filtration	$ 240,000
Alum and polymer addition	50,000
Nitrification	700,000
Subtotal	990,000
Engineering and Contingencies	174,200
TOTAL	$1,164,200

1983 Annual O&M Cost

Description	Estimated Cost
Existing secondary facilities (6.0 mgd)	$175,200
Partial tertiary treatment facilities (6.0 mgd)	
Filtration	64,000
Alum and polymer addition	219,000
Nitrification	40,000
TOTAL	$498,200

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$2,207,100	$49,600
1990	681,400	13,600
2020	452,200	9,100

Further economic analysis of Alternative 5 is presented in Appendix B of this section.

Alternative 5 was not selected for further refinement because the City has expressed a desire to utilize the existing irrigation disposal operation, and this alternative was not one of the most cost-effective alternatives.

Alternative 6.

Alternative 6 includes treating Midland's wastewater at Midland's existing secondary plant and then pumping the treated effluent to Odessa by 1975, for sale to industries. The estimated costs of this alternative are presented below.

1975 Capital Cost

Description	Estimated Cost
Two pump stations @ $650,000 each	$1,300,000
Twenty-three miles of 24-inch pipe @ $25.50 per foot	3,096,700
TOTAL*	$5,100,000

*Including engineering and contingencies.

1975 Annual O&M Cost

Description	Estimated Cost
Existing secondary facilities (6.0 mgd)	$ 175,200
Pump stations	56,000
Pipeline	102,000
TOTAL	$ 333,200

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$2,207,100	$49,600
1990	681,400	13,600
2020	452,200	9,100

Further economic analysis of Alternative 6 is presented in Appendix B of this section.

Alternative 6 was not selected for further refinement because the City has expressed a desire to continue the present practice of effluent irrigation, and this alternative was not one of the most cost-effective alternatives.

Alternative 7.

Alternative 7 includes at least partial abandonment of the existing secondary facilities and construction of a new 6.0-mgd physical-chemical tertiary treatment facility by 1975. The tertiary treatment processes would include high lime treatment, recarbonation, filtration, ammonia stripping, denitrification, activated carbon treatment, chlorination, and aeration of the effluent. The capital cost for the tertiary treatment processes is estimated to be $4,194,000, with operation and maintenance costs estimated to be $744,600 annually.

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$2,207,100	$49,600
1990	681,400	13,600
2020	452,200	9,100

Further economic analysis of Alternative 7 is presented in Appendix B of this section.

Alternative 7 was not selected for further refinement because abandonment of the existing process would be required, the activated-sludge process is more flexible and more efficient, the City has expressed a desire to utilize the activated sludge process, this alternative was not one of the most cost-effective alternatives, O&M costs are greater than for biological treatment processes, larqe quantities of non-renewable resources (chemicals) would be required, and large volumes of chemical sludges would present handling and disposal problems.

Alternative 8.

Alternative 8 includes utilization of the existing 6.0-mgd activated-sludge secondary treatment system, followed by the spray irrigation method of land disposal of all effluent by 1975. Costs given for spray irrigation of effluent are based on land acquisition and City-owned facilities with the effluent applied at a rate of 4 inches per week by rotary-type, tower-suspended spray equipment. Irrigated crops are usually of the hay or grain type, with a dual crop system giving the best basis for year-round operation.

The estimated costs of this alternative are presented below.

1975 Capital Cost

Description	Estimated Cost
Irrigation facilities (6.0 mgd)	
Thirteen 40-acre spray towers @ $33,300 each	$432,900
Pumps @ $5,000/mgd	30,000
Distribution system	132,000
Land - 520 acres @ $200/acre	104,000
TOTAL*	$806,000

*Including engineering and contingencies.

1975 Annual O&M Cost

Description		Estimated Cost
Existing secondary facilities (6.0 mgd)		$175,200
Irrigation facilities		
Spray towers	$14,300	
Pumps	9,000	
		23,300
TOTAL		$198,500

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$2,207,100	$49,600
1990	681,400	13,600
2020	452,200	9,100

Further economic analysis of Alternative 8 is presented in Appendix B of this section.

Alternative 8 was not selected for further refinement because the City has expressed a desire to utilize the present method of spray irrigation disposal, and this alternative was not one of the most cost-effective alternatives.

Alternative 9.

Alternative 9 includes utilization of the existing 6.0-mgd activated-sludge secondary treatment system, followed by the overland runoff method of land disposal of all effluent by 1975. Overland runoff involves the application of effluent to a slope with crop cover and collection facilities at the toe of the slope. Existing design criteria require slopes in the range between two and six percent for this treatment method. Although a preliminary survey of the topography in the Midland area revealed no areas of sufficient acreage with the required two percent minimum slope, for this alternative it was assumed that a suitable site could be found.

The estimated costs of this alternative are presented below.

1975 Capital Cost

Description	Estimated Cost
Irrigation Facilities (6.0 mgd)	
Twenty 40-acre spray towers @ $33,300 each	$ 666,000
Pumps	30,000
Distribution system	264,000
Collection ditches	3,000
Land - 892 acres @ $200/acre	178,400
TOTAL*	$1,309,900

*Including engineering and contingencies.

1975 Annual O&M Cost

Description		Estimated Cost
Existing Secondary Facilities (6.0 mgd)		$175,200
Irrigation Facilities (6.0 mgd)		
Spray towers	$20,000	
Pumps	9,000	
		29,000
	TOTAL	$204,200

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$2,207,100	$49,600
1990	681,400	13,600
2020	452,200	9,100

Further economic analysis of Alternative 9 is presented in Appendix B of this section.

Alternative 9 was not selected for further refinement because the City has expressed a desire to utilize the present method of spray irrigation disposal, and this alternative was not one of the most cost-effective alternatives.

Alternative 10.

Alternative 10 includes at least partial abandonment of the existing secondary facilities and construction of a new 6.0-mgd physical-chemical secondary treatment facility by 1975, followed by the spray irrigation method of land disposal of all effluent. The physical-chemical secondary treatment plant would include primary treatment and high lime treatment. Costs given for spray irrigation of effluent are based on City-owned facilities, with the effluent applied at a rate of 4 inches per week by rotary type, tower-suspended spray equipment. Irrigated crops are usually of the hay or grain type, with a dual crop system giving the best basis for year-round operation.

The estimated costs of this alternative are presented on the following page.

1975 Capital Cost

Description		Estimated Cost
Physical-chemical secondary facilities (6.0 mgd)		$1,410,000
Irrigation facilities (6.0 mgd)		
Thirteen 40-acre spray towers at $33,300 each	$432,900	
Distribution system	132,000	
Pumps @ $5,000/mgd	30,000	
Land - 520 acres @ $200/ac	104,000	
		806,000*
TOTAL		$2,216,000

*Including engineering and contingencies.

1975 Annual O&M Cost

Description		Estimated Cost
Secondary facilities (6.0 mgd)		$ 295,650
Irrigation facilities (6.0 mgd)		
Spray towers	$ 14,300	
Pumps	9,000	
		23,300
TOTAL		$ 318,950

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$2,207,100	$49,600
1990	681,400	13,600
2020	452,200	9,100

Further economic analysis of Alternative 10 is presented in Appendix B of this section.

Alternative 10 was not selected for further refinement because extensive modification of the existing process would be required, the activated-sludge process is more flexible and more efficient, the City has expressed a desire to utilize the activated-sludge process, this alternative was not one of the most cost-effective alternatives; O&M costs are greater than for biological treatment processes, large quantities of non-renewable resources (chemicals) would be required, and large volumes of chemical sludges would present handling and disposal problems.

Alternative 11.

Alternative 11 includes at least partial abandonment of the existing secondary facilities and construction of a new 6.0-mgd physical-chemical secondary treatment facility by 1975, followed by the overland runoff method of land disposal of all effluent. The physical-chemical secondary treatment would include primary treatment and high lime treatment. Overland runoff involves the application of effluent to a slope, with crop cover and collection facilities at the toe of the slope. Although a preliminary survey of the topography in the Midland area revealed no areas of sufficient acreage with the required two percent minimum slope, for this alternative, it was assumed that a suitable site could be found.

The estimated costs of this alternative are presented below.

1975 Capital Cost

Description		Estimated Cost
Physical-chemical secondary facilities (6.0 mgd)		$1,410,000
Irrigation facilities (6.0 mgd)		
Twenty 40-acre spray towers @ $33,300 each	$666,000	
Distribution system	264,000	
Pumps	30,000	
Collection ditches	3,000	
Land - 892 acres @ $200/ac	178,400	
		1,309,900*
TOTAL		$2,719,900

*Including engineering and contingencies.

1975 Annual O&M Cost

Description		Estimated Cost
Secondary facilities (6.0 mgd)		$ 295,650
Irrigation facilities (6.0 mgd)		
Spray towers	$20,000	
Pumps	9,000	
		29,000
TOTAL		$ 324,650

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$ 2,207,100	$49,600
1990	681,400	13,600
2020	452,200	9,100

Further economic analysis of Alternative 11 is presented in Appendix B of this section.

Alternative 11 was not selected for further refinement because extensive modification of the existing process would be required, the activated-sludge process is more flexible and more efficient, the City has expressed a desire to utilize the activated-sludge process, this alternative was not one of the most cost-effective alternatives, O&M costs are greater than for biological treatment processes, large quantities of non-renewable resources (chemicals) would be required, and large volumes of chemical sludges would present handling and disposal problems.

Alternative 12.

Alternative 12 includes at least partial abandonment of the existing secondary facilities and construction of a new 6.0-mgd physical-chemical secondary treatment facility by 1975, followed by the rapid infiltration method of land disposal of all effluent. The physical-chemical secondary treatment would include primary treatment and high lime treatment. Rapid infiltration involves infiltration and evaporation from a series of crop-lined ponds with a typical application rate of one foot per day for ten days, followed by five days of rest. To provide adequate treatment for the Midland area, a site would be needed with a known profile of permeable soil to a depth of about 140 feet; however, it is doubtful that such a site can be found in the area.

The estimated costs of this alternative are presented on the following page.

1975 Capital Cost

Description		Estimated Cost
Physical-chemical secondary facilities (6.0 mgd)		$1,410,000
Irrigation facilities (6.0 mgd)		
Ponds	$155,000	
Pumps	30,000	
Land - 30 acres @ $200/ac	6,000	
		228,500*
TOTAL		$1,638,500

*Including engineering and contingencies.

1975 Annual O&M Cost

Description		Estimated Cost
Secondary facilities (6.0 mgd)		$ 295,650
Irrigation facilities (6.0 mgd)		
Ponds	$3,200	
Pumps	1,800	
		5,000
TOTAL		$ 300,650

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$2,207,100	$49,600
1990	681,400	13,600
2020	452,200	9,100

Further economic analysis of Alternative 12 is presented in Appendix B of this section.

Alternative 12 was not selected for further refinement because extensive modification of the existing process would be required, the activated-sludge process is more flexible and more efficient, the City has expressed a desire to utilize the activated-sludge process, this alternative was not one of the most cost-effective alternatives, O&M costs are greater than

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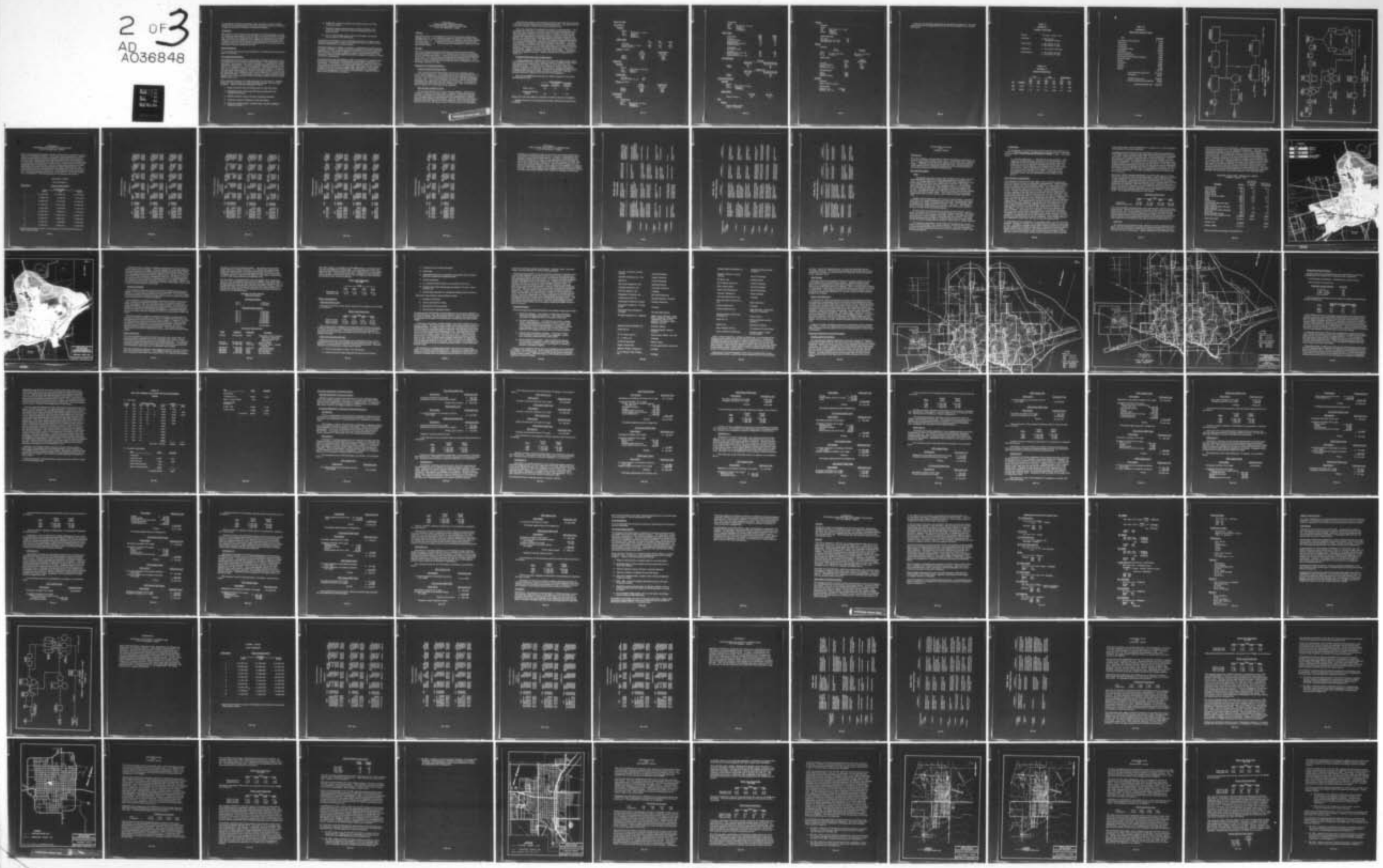

for biological treatment processes, large quantities of non-renewable resources (chemicals) would be required, and large volumes of chemical sludges would present handling and disposal problems.

Conclusion.

Alternative 1 was selected as the best plan for Midland because it meets the treatment requirements of PL 92-500; it is one of the most cost-effective alternatives; it retains effective system that has proven to be profitable to the City and acceptable to the regulatory agencies; during public workshop, this plan was selected by participating local interests; and it returns wastes to the soil, thereby complying with the national goal of no discharge of critical pollutants by 1985.

Recommendation.

It is recommended that all steps necessary to implement the Alternative 1 plan be undertaken.

Continuing Responsibility.

The planning and construction of wastewater treatment facilities is only one small part of the overall treatment scheme. The application of good operation, maintenance, and control techniques are essential for proper wastewater management. The most advanced equipment available is useless if it is improperly or poorly maintained. As an example of the optimum care required, a modern secondary treatment facility in the five to ten mgd range would employ as many as one superintendent, one chemist, six operators, one maintenance man, and two laborers, to provide round-the-clock attendance. Land disposal facilities for Midland would require another four to six employees, and conventional tertiary treatment could require even more.

Every operative function in a treatment plant which involves a variable treatment mode is based on a daily sampling, testing, and recording program. Typical tests and frequencies include:

1. Sludge measurements in settling tanks on each shift daily.

2. Settleable solids volume and pH measurements daily for influent and effluent.

3. Effluent stability tests on 24-hour composite samples.

4. Chlorine residual of effluent on each shift daily.

5. Total and volatile solids, volatile acids, and pH of digested sludge as needed.

6. BOD_5, TSS, and pH of influent and effluent daily on 24-hour composite sample.

7. Dissolved oxygen measurement on influent, effluent, and receiving stream above and below the discharge point five days per week.

8. For activated sludge plants, DO of mixed liquor and sludge volume index on each shift daily.

In addition to providing a record of treatment efficiency, regular sampling and testing programs aid in early detection and correction of operational malfunctions in a treatment plant.

When land disposal of effluent is utilized, an additional sampling program is usually required to monitor ground water quality in the area around the disposal site. This usually consists of a series of wells surrounding the site, from which periodic samples are drawn. Such monitoring is just one more means of maintaining the careful surveillance necessary to sound wastewater management.

In metropolitan areas like Midland, high concentrations of population and industry have increased both the quantity and strength of wastewater to be handled. Traditionally, wastewater handling has consisted of the minimum treatment necessary to prevent public health hazards, but new environmental priorities and increased public awareness of water quality problems have lent increased weight to the argument for responsible wastewater management, not just to meet government requirements but also to protect the local environment.

APPENDIX A
OPERATIONAL INVESTIGATION
WASTEWATER TREATMENT FACILITIES
CITY OF MIDLAND, TEXAS

Preface.

During the course of investigation for the Colorado River Wastewater Management Study, all municipal wastewater treatment facilities within the Basin were visited by the study staff. In addition, operational specialists were directed to investigate the treatment facilities located within the metropolitan areas. The following text represents a summary of that operational report.

General.

The City of Midland presently operates two sewage treatment plants. The airport plant is located on U.S. Highway 80, adjacent to the airport between Midland and Odessa. It serves the airport and surrounding business areas. The main sewage treatment plant is located off I.H. 20 and serves the City of Midland business district and outlying areas. A new plant now under construction at the main plant site is designed to increase the design capacity to 6 mgd.

Description of Existing Facilities.

Airport Sewage Treatment Plant.

The airport sewage treatment plant serves the municipal airport and the surrounding area. The facility which was constructed by the U.S. Army Corps of Engineers during World War II has a design capacity of 1.0 mgd. However, the average daily flow is 0.14 mgd with a negligible nighttime flow. The overall condition is adequate, and the plant is well maintained with eight-hour-per-day operator coverage. The effluent is discharged onto the land across U.S. Highway 80. The flow scheme is shown in Figure A-1 at the end of this Appendix.

Main Sewage Treatment Plant.

The present facilities are in poor overall condition. Sewage flow reaches the entrance structure where it passes a comminuter and grit chamber. Although the comminuter has had no mechanical problems, as a shredding device its operation has been unsatisfactory, allowing rags and other solids to pass through. The grit removal device does not function well under high or low-flow conditions. Due to periodic sand storms in the area, the amount of grit in the wastewater is substantial.

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The flow then passes to two primary clarifiers that each have a volume of 90,700 cubic feet and an area of 10,600 square feet. The clarifiers are in good mechanical condition and operate satisfactorily.

From the clarifiers, the sewage is pumped to a trickling filter. The trickling filter effluent is returned to the small clarifiers and the overflow from these clarifiers is pumped back to the filter distribution box. The mechanical condition of the two smaller clarifiers is poor and the existing flow distribution and sludge collection equipment should be replaced. An overflow weir in the distribution box diverts a portion of the flow to the oxidation ponds. The flow that reaches the pond thus consists of a mixture of settled raw sewage and settled filter effluent. The primary digester is equipped with external heating and mixing. The supernatant overflows to the two secondary digesters, which are unheated and unmixed. Supernatant from the secondary digesters overflows to the oxidation ponds. Sludge is drawn to the sludge drying beds. There is no provision for sludge recirculation from one unit to another. Mechanical condition of digesters is poor. Present facilities are summarized in Table A-1.

Proposed Plant (now under construction).

A design population of 80,000 was selected in the design report and it was estimated that this number would be reached in 1980; however, population projections developed for this study do not predict that much immediate growth. To provide for increases in the per capita use, a value of 75 gallons per capita per day was used, yielding an estimated average sewage flow of 6.0 mgd. A summary of design parameters used in planning the proposed facilities is shown in Table A-2. The flow scheme is shown in Figure A-2 at the end of this Appendix.

The current TWQB permit decrees an effluent quality not to exceed the following criteria:

	Not to Exceed		
	Average	24-hour Composite	Individual Sample
BOD (mg/1)	20	25	30
Suspended Solids (mg/l)	20	25	30

Plans are to sell the effluent to industry as well as use it for irrigation.

Design criteria for the proposed (now under construction) facility are as follows:

Design Date 1980

Primary Clarifiers:

Description

Number:	2
Size:	80 ft. diameter x 9 ft. deep
Area:	10,060 sq. ft.
Volume:	90,700 cu. ft. (680,000 gals.)

Applied Loading

	Avg.	Max.	Storm
Flow (mgd)	6.0	7.5	16.0
Overflow Rate (gal. / sq. ft. / day	600.0	750.0	1600.0
Detention time (hrs.)	2.9	2.2	1.0

Efficiency (estimated)

	BOD_5 (lbs. / day)	Suspended Solids (lbs. / day)
Applied	16,000	13,600
Removed	5,300	6,800
Effluent	11,700	6,800

Trickling Filter

Description

Number:	1
Size:	110 ft. diameter x 4.33 ft. deep
Area:	9500 sq. ft.
Volume:	41,000 cu. ft.

Applied Loading

Flow (mgd)	12.0
BOD_5 lbs. / 1000 cu. ft. / day	285.0

Efficiency (estimated)

	BOD_5 (lbs. / day)	Suspended Solids (lbs. / day)
Applied	11,700	6,800
Removed	6,800	2,400
Effluent	4,900	4,400

Activated Sludge

Description

Aeration Basins:

Number:	2
Size:	76 ft. diameter x 15 ft. deep
Volume:	136,000 cu. ft. (1,020,000 gals.)

Final Clarifiers:

Number:	2
Size:	80 ft. diameter x 15 ft. deep
Area:	10,060 sq. ft.
Volume:	151,000 cu. ft. (1,130,000 gals.)

Applied Loading

Aeration Basin:	**With Filter**	**Without Filter**
MLSS (mg/l)	1900	4300
Lbs. BOD / lbs. MLSS	0.3	0.3
Sludge Age (days)	7.5	7.5
Oxygen Requirement (mg/l / hr.)	26	62
Detention Time (hrs.)	4.1	4.1

Final Clarifiers:
(recirculation rate 100%

Flow (mgd)	12.0	12.0
Overflow Rate (gal. / sq. ft. / day)	600	600
Detention Time (hrs.)	4.5	4.5
Underflow Rate (lbs. / sq. ft. / day)	18.8	4.3

Estimated Efficiency

	With Filter	
	BOD_5 (mg/l)	**Suspended Solids (mg/l)**
Influent	98	88
Effluent	9	20

	Without Filter	
	BOD_5 (mg/l)	**Suspended Solids (mg/l)**
Influent	234	136
Effluent	11	20

Chlorine Contact Chamber

Description:

Number:	**1**
Size:	**24 ft. x 58 ft. x 12 ft. deep**
Volume:	**16,700 cu. ft.** **(125,000 gals.)**

Applied Loading:

	Avg. Flow	**Max. Flow**
Detention Time (hrs.)	**0.5**	**0.4**

Solids

Degritter:

Pumps 2 - 25 gpm var. speed
Cyclone 1 - 12" diameter

Thickener:

Description:

Number:	1
Size:	55 ft. diameter x 7 ft. deep
Area:	2380 sq. ft.
Volume:	21,400 cu. ft. (160,000 gals.)

Applied Loading (avg.):

Flow (mgd)	0.36
Overflow Rate (gal. / sq. ft. / day)	150
Solids Applied (lbs. / sq. ft. / day)	5.3

Digesters:

Description:

	Primary	Secondary
Number:	1	2
Size:	70 ft. diam. x 26 ft. deep	55 ft. diam. x 21 ft. deep
Volume:	111,300 cu. ft.	60,000 cu. ft.

Applied Loading:

	Primary	Primary and Secondary
Flow (mgd)	0.03	0.03
Detention Time (days)	28	58
Solids (lbs. / day)	12,800	12,800
Solids (lbs. / cu. ft. / day)	0.11	0.055

Estimated Efficiency:

Applied	12,800
Destroyed	6,400
Wasted to Drying Beds	6,400

Drying Beds

Description:

28 beds – 3400 sq. ft. total area

Applied Loading:

Applied lbs. / year	2,340,000
Applied lbs. / year / sq. ft.	690

Costs for the facilities described are tabulated in Table A-3. No other capital improvement expenditures are known to be planned for the immediate future.

TABLE A-1

APPENDIX A

PRESENT FACILITIES

Screening:	1 comminuter – capacity 11 mgd
Grit Removal:	1 scraper mechanism – Flow through – 324 sq. ft.
Primary Clarifiers:	2 – 80 ft. diameter x 9 ft. deep 2 – 55 ft. diameter x 9 ft. deep
Trickling Filters:	1 – 110 ft. diameter x 4.33 ft. deep
Anaerobic Digesters:	1 – 70 ft. diameter x 26 ft. deep 2 – 55 ft. diameter x 21 ft. deep

TABLE A-2

APPENDIX A

DESIGN PARAMETERS

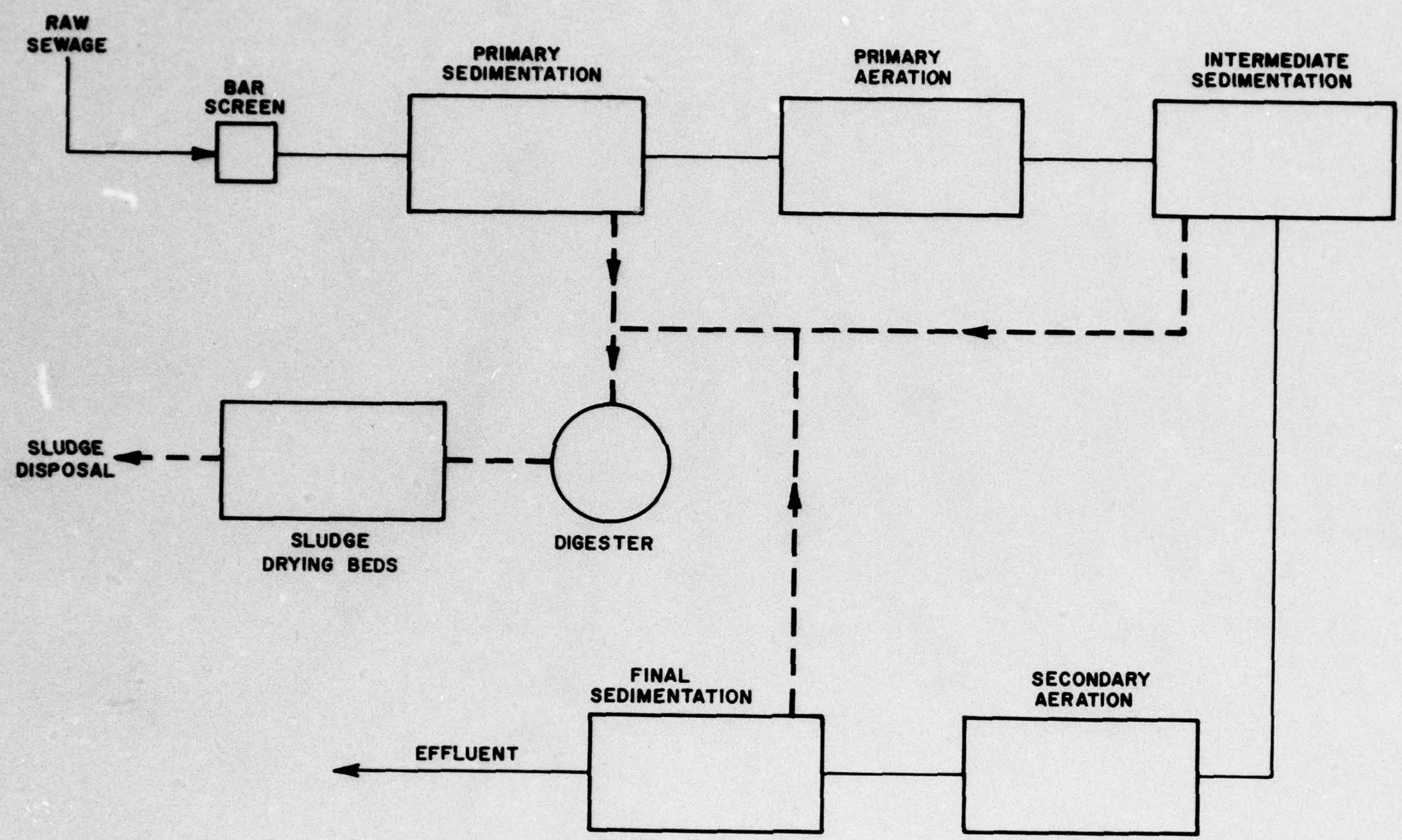
		Flow		BOD_5		Suspended Solids	
Year	Population	Per Capita gpd	Total mgd	Per Capita gpd	Total mgd	Per Capita gpd	Total mgd
1966	61,700	70	4.3	0.19	11,700	0.16	9,900
1980	80,000	75	6.0	0.20	16,000	0.17	13,600

TABLE A-3

APPENDIX A

ESTIMATED PROJECT COSTS

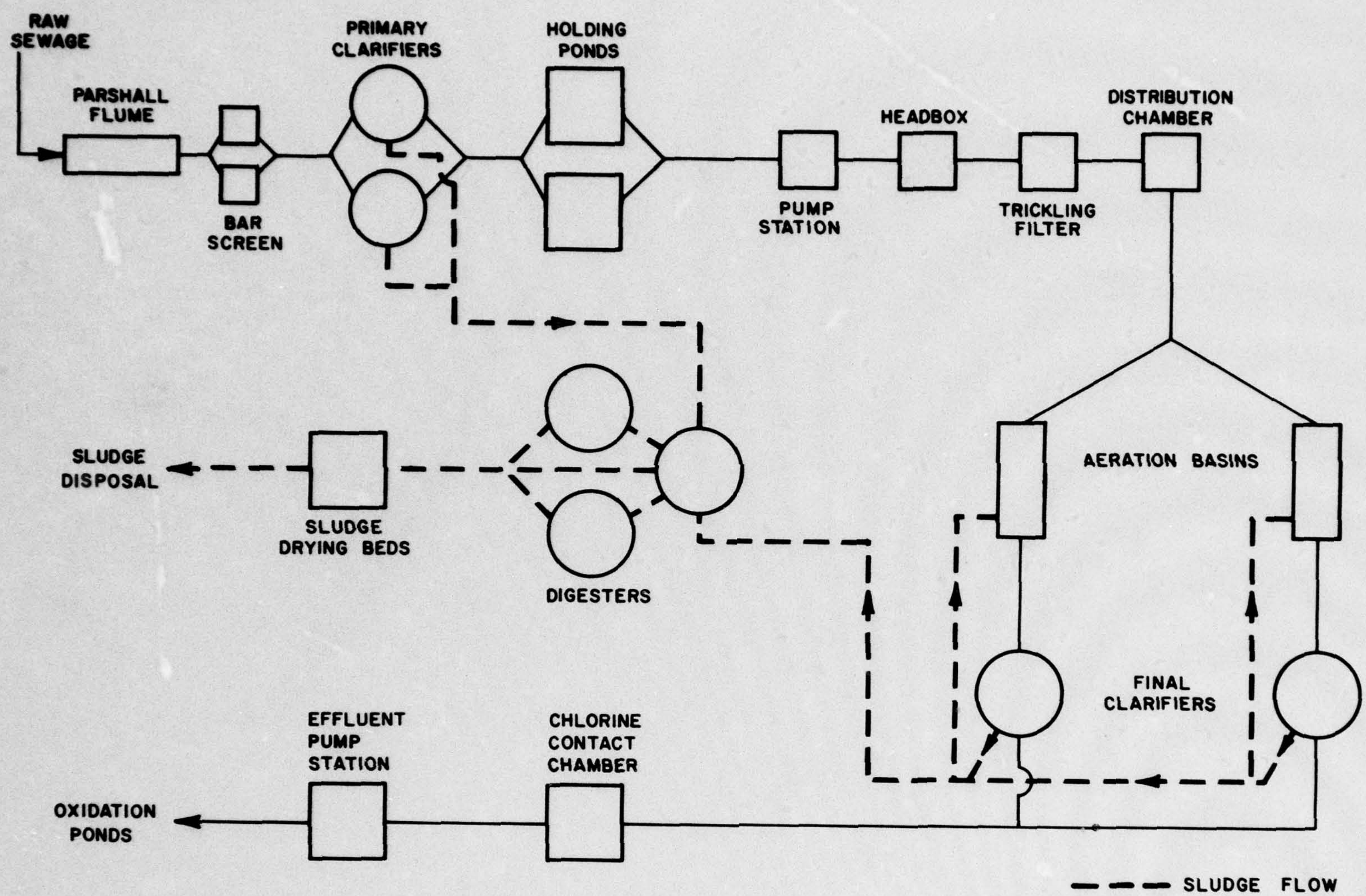
Item	Total Project
Screening and Grit Removal Building	$ 76,500
Holding Basin	77,000
Pumping Station	130,000
Aeration Basins	272,800
Final Sedimentation Basins	235,400
Main Building	191,500
Chlorine Contact Basin	58,300
Maintenance Division Office	8,500
Blower House and Return Sludge Pumping Station	135,000
Revisions to Digesters	15,000
Thickener	43,000
Effluent Canal	98,500
Yard Work	206,000
Mechanical	30,000
Electrical	240,000
Current Estimated Construction Cost:	$1,817,500
Contingencies:	145,000
Estimated Construction Cost:	$1,962,500
Engineering, Administrative, and Legal Costs:	196,250
ESTIMATED PROJECT COST	$2,158,750



FLOW DIAGRAM

AIRPORT SEWAGE TREATMENT PLANT

FIGURE A-1



FLOW DIAGRAM
MIDLAND MAIN SEWAGE TREATMENT PLANT
FIGURE A-2

APPENDIX B
ECONOMIC ANALYSIS OF ALTERNATIVES
CITY OF MIDLAND, TEXAS

Each of the wastewater treatment facility alternatives for Midland was subjected to an economic analysis. The results of these analyses, by alternative, are presented as computer printouts following the cost summary. The first four column entries are input data and include a description of the item under consideration, the date by whch an item is to be constructed or operational, the capital cost of each item, and the annual operation and maintenance cost of each item. The next three column entries are calculated values of Capital Cost Present Worth, O&M Present Worth, and Total Present Worth, all of which were calculated at 5.5 percent interest. These values were also calculated for 7.0 percent and 10.0 percent interest, with results appearing under line entries INT RT = 0.07 and INT RT = 0.10, respectively. All values shown are in January 1972 dollars.

MIDLAND, TEXAS

COST SUMMARY

Alternative	Total Present Worth* Interest Rate 5.5%	7.0%	10.0%
1	$ 4,795,651	$ 3,884,314	$ 2,704,424
2	5,060,706	4,126,369	2,913,150
3	16,688,670	13,916,602	10,336,943
4	11,366,475	10,281,602	8,708,295
5	8,251,024	6,450,289	4,211,272
6	11,365,459	9,802,207	7,706,921
7	16,391,457	13,631,714	10,074,734
8	5,810,401	4,801,024	3,482,639
9	6,319,855	5,275,662	3,903,464
10	8,708,591	7,289,741	5,434,536

*Total Present Worth is equal to the Capital Cost Present Worth plus the O&M Present Worth.

Midland Alternatives

Cost Comparison

ALTERNATIVE 1

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
EXISTING SYS	1975	0.	175200.	0.	2468966.	2468966.
COLLECTION SYS	1980	2207100.	49600.	1438144.	518600.	1956743.
COLLECTION SYS	1990	681400.	13600.	259931.	75400.	335331.
COLLECTION SYS	2020	452200.	9100.	34611.	0.	34611.
INT RT=.055000		3340700.	10276000.	1732686.	3062965.	4795651.
INT RT=.070000		3340700.	10276000.	1503730.	2380585.	3884314.
INT RT=.100000		3340700.	10276000.	1156845.	1547579.	2704424.

ALTERNATIVE 2

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
AS-RI IRRIG	1975	228500.	180200.	194594.	2539427.	2734021.
COLLECTION SYS	1980	2207100.	49600.	1438144.	518600.	1956743.
COLLECTION SYS	1990	681400.	13600.	259931.	75400.	335331.
COLLECTION SYS	2020	452200.	9100.	34611.	0.	34611.
INT RT=.055000		3569200.	10501000.	1927279.	3133427.	5060706.
INT RT=.070000		3569200.	10501000.	1690254.	2436116.	4126369.
INT RT=.100000		3569200.	10501000.	1328521.	1584629.	2913150.

ALTERNATIVE 3

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
AS TERTIARY	1975	4543000.	744600.	3868881.	10493104.	14361985.
COLLECTION SYS	1980	2207100.	49600.	1438144.	518600.	1956743.
COLLECTION SYS	1990	681400.	13600.	259931.	75400.	335331.
COLLECTION SYS	2020	452200.	9100.	34611.	0.	34611.
INT RT=.055000		7883700.	35899000.	5601566.	11087103.	16688670.
INT RT=.070000		7883700.	35899000.	5212171.	8704432.	13916602.
INT RT=.100000		7883700.	35899000.	4570068.	5766875.	10336943.

Midland Alternatives

Cost Comparison

(Cont'd)

ALTERNATIVE 4

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
EXP SECONDARY	1975	1627500.	0.	1386001.	0.	1386001.
PUMPS-PIPELINE	1975	6770000.	0.	5765425.	0.	5765425.
O-M PUMPS	1975	0.	32000.	0.	450953.	450953.
O-M PIPELINE	1975	0.	102000.	0.	1437411.	1437411.
COLLECTION SYS	1980	2207100.	49600.	1438144.	518600.	1956743.
COLLECTION SYS	1990	681400.	13600.	259931.	75400.	335331.
COLLECTION SYS	2020	452200.	9100.	34611.	0.	34611.
INT RT=.055000		11738200.	8422000.	8884111.	2482364.	11366475.
INT RT=.070000		11738200.	8422000.	8358591.	1923011.	10281602.
INT RT=.100000		11738200.	8422000.	7466011.	1242284.	8708295.

ALTERNATIVE 5

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
EXISTING SYS	1975	0.	175200.	0.	2468966.	2468966.
PARTIAL TERT	1983	1164200.	323000.	646027.	2809346.	3455373.
COLLECTION SYS	1980	2207100.	49600.	1438144.	518600.	1956743.
COLLECTION SYS	1990	681400.	13600.	259931.	75400.	335331.
COLLECTION SYS	2020	452200.	9100.	34611.	0.	34611.
INT RT=.055000		4504900.	22227000.	2378712.	5872312.	8251024.
INT RT=.070000		4504900.	22227000.	2056833.	4393456.	6450289.
INT RT=.100000		4504900.	22227000.	1564890.	2646381.	4211272.

ALTERNATIVE 6

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
EXISTING SYS	1975	0.	175200.	0.	2468966.	2468966.
PUMPS-PIPELINE	1975	5100000.	158000.	4343230.	2226579.	6569808.
COLLECTION SYS	1980	2207100.	49600.	1438144.	518600.	1956743.
COLLECTION SYS	1990	681400.	13600.	259931.	75400.	335331.
COLLECTION SYS	2020	452200.	9100.	34611.	0.	34611.
INT RT=.055000		8440700.	17386000.	6075915.	5289544.	11365459.

Midland Alternatives

Cost Comparison

(Cont'd)

ALTERNATIVE 6

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
INT RT=.070000		8440700.	17386000.	5666849.	4135358.	9802207.
INT RT=.100000		8440700.	17386000.	4988551.	2718371.	7706921.

ALTERNATIVE 7

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
PC TERTIARY	1975	4194000.	744600.	3571668.	10493104.	14064771.
COLLECTION SYS	1980	2207100.	49600.	1438144.	518600.	1956743.
COLLECTION SYS	1990	681400.	13600.	259931.	75400.	335331.
COLLECTION SYS	2020	452200.	9100.	34611.	0.	34611.
INT RT=.055000		7534700.	35899000.	5304353.	11087103.	16391457.
INT RT=.070000		7534700.	35899000.	4927283.	8704432.	13631714.
INT RT=.100000		7534700.	35899000.	4307860.	5766875.	10074734.

ALTERNATIVE 8

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
AS-SP IRRIG	1975	806000.	198500.	686401.	2797315.	3483716.
COLLECTION SYS	1980	2207100.	49600.	1438144.	518600.	1956743.
COLLECTION SYS	1990	681400.	13600.	259931.	75400.	335331.
COLLECTION SYS	2020	452200.	9100.	34611.	0.	34611.
INT RT=.055000		4146700.	11324500.	2419086.	3391315.	5810401.
INT RT=.070000		4146700.	11324500.	2161666.	2639358.	4801024.
INT RT=.100000		4146700.	11324500.	1762405.	1720234.	3482639.

ALTERNATIVE 9

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
AS-CR IRRIG	1975	1309900.	204200.	1115529.	2877641.	3993170.
COLLECTION SYS	1980	2207100.	49600.	1438144.	518600.	1956743.
COLLECTION SYS	1990	681400.	13600.	259931.	75400.	335331.

Midland Alternatives

Cost Comparison

(Cont'd)

ALTERNATIVE 9

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
COLLECTION SYS	2020	452200.	9100.	34611.	0.	34611.
INT RT=.055000		4650600.	11581000.	2848214.	3471641.	6319855.
INT RT=.070000		4650600.	11581000.	2572998.	2702664.	5275662.
INT RT=.100000		4650600.	11581000.	2140993.	1762471.	3903464.

ALTERNATIVE 10

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
PC-SP IRRIG	1975	2216000.	318950.	1887176.	4494729.	6381905.
COLLECTION SYS	1980	2207100.	49600.	1438144.	518600.	1956743.
COLLECTION SYS	1990	681400.	13600.	259931.	75400.	335331.
COLLECTION SYS	2020	452200.	9100.	34611.	0.	34611.
INT RT=.055000		5556700.	16744750.	3619861.	5088729.	8708591.
INT RT=.070000		5556700.	16744750.	3312646.	3977095.	7289741.
INT RT=.100000		5556700.	16744750.	2821759.	2612777.	5434536.

APPENDIX C
EVALUATION ANALYSIS OF ALTERNATIVES
CITY OF MIDLAND, TEXAS

Appendix C presents an evaluation of the four most viable alternatives with respect to environmental, social, economic, technological, and resource conservation considerations. In order to maintain the time schedule allotted for the study, the investigations of the foregoing features were conducted in a general manner with emphases on their relation to the overall system evaluation. While detailed studies were not made on the specific features, these items were investigated to a degree that would uphold the integrity of the validity of the alternative evaluation process. The current status of the existing wastewater treatment facility was used as the base condition from which the evaluations were made.

MIDLAND, TEXAS

Evaluation Analysis

	ALTERNATIVE 1: Existing activated sludge system plus existing irrigation practices.	ALTERNATIVE 2: Existing activated sludge system plus rapid infiltration.	ALTERNATIVE 3: Activated sludge tertiory system by 1975.	ALTERNATIVE 4: Pumping raw sewage to Odessa for treatment and subsequent sale of treated effluent to industry.
A. Environmental Quality				
1. Water Resource				
a. Effluent Quality	Removal of BOD and TSS would approach 100% and would be higher than attainable by overland runoff. High removal of nutrients. Best removal of phosphorus.	Removal of BOD and TSS would approach 100% and would be higher than attainable by overland runoff. High removal of nutrients.	Removal of BOD/TSS would approach 98%.	Effluent quality to industry would have BOD and TSS removals of approximately 90%. No eventual discharge would be anticipated.
b. Groundwater	Positive potential for recharge. No detrimental effect due to high quality water.	Positive potential for recharge. No detrimental effect due to high quality water.	No potential for recharge unless ultimate use was for irrigation purposes.	No potential for recharge.
c. Streamflow	No change from existing. No flow to streams other than small flow from percolation.	No change from existing. No flow to streams other than small flow from percolation.	Increase in streamflow or no change. Depends upon amount of reuse for municipality or industry.	No change from existing.
2. Air Resource				
a. Odors	No additional odor problems anticipated.	No additional odor problems anticipated.	Carbon regeneration could cause odor problems.	No additional odor problems anticipated.
b. Other Sources	Aerosol potential slight.	Aerosol potential slight.	Increased odor problems associated with sludge handling.	Aerosol potential slight.
3. Land Resource				
a. Land Quality	Increased productivity.	Some increased productivity, but only as secondary benefit.	Land released for other uses.	No effect.
b. Land Utilization	Large area requirement. Committed for long period of time.	Less land requirement than spray irrigation. Additional land released for other uses.	Small land requirements.	Large land areas released for other uses.

MIDLAND, TEXAS

Evaluation Analysis (Cont'd.)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4
A. Environmental Quality (Cont'd.)				
4. Biological				
a. Zoological	Would change wildlife habitat characteristics. Probably increase species diversity and total number.	Would change wildlife habitat characteristics, but impact would be less than spray irrigation due to reduced land requirement.	Change depends upon use of land no longer needed for disposal.	Change depends upon use of land no longer needed for disposal.
b. Botanical	Land requirements could cause destruction of trees, etc. Change species of grasses. Destruction of vegetation during land clearing.	Land requirements could cause destruction of trees, etc. Change species of grasses. Destruction of vegetation during land clearing.	Change depends upon use of land no longer needed for disposal.	Change depends upon use of land no longer needed for disposal.
5. Geological	If land disposal site was within the outcrop of an aquifer, irrigation could affect the rate of recharge.	If land disposal site was within the outcrop of an aquifer, irrigation could affect the rate of recharge.	Change depends upon use of land no longer needed for disposal.	Change depends upon use of land no longer needed for disposal.
B. Social				
1. Manpower	Additional personnel required. Non-technical for land disposal system locally available.	Additional personnel required. Non-technical for land disposal system locally available.	Additional personnel required. Highly skilled technical personnel may not be available locally.	Possible reduction in overall personnel requirement.
2. Aesthetics	Land disposal site could be used to influence direction of growth—utilized as green belt.	Land disposal site could be used to influence direction of growth—utilized as green belt.	No problems due to remoteness of plant from populated areas.	No problems due to remoteness of plant from populated areas.
3. Political Acceptability	System presently utilized and accepted. Possible objections to increase of city owned land if leasing is not available.	System presently utilized and accepted. Possible objections to increase of city owned land if leasing is not available.	May not be acceptable because of change in water use patterns.	May not be acceptable because of change in water use patterns.
C. Economic	Possible agricultural revenue. Additional employment required.	Possible agricultural revenue. Additional employment required.	Larger revenue potential because of higher economic use of water. Increase in skilled employment.	No net gain in operational revenue.

MIDLAND, TEXAS

Evaluation Analysis (Cont'd.)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4
D. Technology 1. Reliability/ Flexibility	More reliable. Effluent quality not as susceptible to load variations or influent quality.	More reliable. Effluent quality not as susceptible to load variations or influent quality.	More flexible. Effluent available directly for many uses.	More flexible. Effluent available directly for many uses.
2. Construction Effects	Construction of land disposal system would disrupt rural community by increasing noise, dust. Extensive destruction of existing vegetation possible.	Construction of land disposal system would disrupt rural community by increasing noise, dust. Extensive destruction of existing vegetation possible.	Less detrimental because of smaller land requirements.	Less detrimental because of smaller land requirements.
E. Institutional Arrangements	No change anticipated for existing acceptable system.	Change could be required if the City were to operate the system.	Change could be required to restructure functions and responsibilities of public works departments.	Serious difficulties anticipated in any contractual inter-city arrangement.
F. Resource Conservation	Large land areas would be committed for many years.	Less land area requirement; however, method of disposal does not optimize resource utilization.	Chemical requirements would commit large quantities of non-renewable resources.	Substantial pumping requirements could not be offset by benefits.

METROPOLITAN PLAN FOR ODESSA, TEXAS

Introduction.

The City of Odessa, incorporated in 1927 on the heels of an oil boom, is located in east Ector County in West Texas. This county seat is bisected by U. S. Highways 80 and 385 and is skirted by I.H. 20 on its southern fringe. Primarily an oil and gas production center, Odessa houses the multi-related service industries resulting from oil and petrochemical operations existing in the Permian Basin area.

Physical Description.

Soils.

Consisting of an area of more than 12,000 acres in size, the City is predominantly underlain by Kimbrough-Stegall and Portales-Arch soils. Kimbrough soils have a shallow surface layer ranging from 2 to 4 inches deep over a thick, hard, platy layer of caliche. The surface layer of Kimbrough soil is a loam, gravelly loam or, in some places, fine sandy loam or light clay. Permeability in this soil ranges from 0.5 to 1.0 inch per hour due to the stoniness prevalent throughout the profile. The shallow depth to the indurated caliche restricts the installation and operation of septic tanks. The transmissibility and seepage tendencies of the soil place severe restrictions on sewage lagoons as well.

Stegall soils are generally 4 to 12 inches of well-drained, noncalcareous loam over slowly permeable heavy clay loam developed over indurated caliche at a depth of approximately 40 inches. Permeability rates for Stegall soils range from 0.6 to 1.0 inch per hour. The shallow depth to caliche and the slow permeability of the soil severely restrict the use of septic tanks and sewage lagoons.

Portales soils are typically 8 to 16 inches of well-drained, calcareous, fine sandy loam over 6 to 18 inches of sandy clay loam. The underlying material is very strongly calcareous caliche. Permeability in this soil occurs at a rate of about 1.0 inch per hour at all strata. The slow transmissiveness places slight to moderate restrictions on septic tanks, and the moderate seepage places moderate restrictions on sewage lagoons.

Arch soils are generally 4 to 10 inches of well-drained calcareous loam or fine sandy loam over chalky material. These are deep soils with a very slow permeability rate of 0.2 to 0.8 inch per hour throughout the soil, thereby imposing moderate to severe limitations on septic tanks and sewage lagoons.

Topography.

The topography of the Odessa area is best described and summarized in the 1972 Summary Report, Population and Land Use by Marvin Springer and Associates, Urban Planning Consultants of Dallas, Texas. The report states:

> "...two low ridge lines ... subdivide the surface drainge. One ridge line running generally northwest from the Downtown Area delineates the area draining directly into Monahan's Draw and separates it from an undefined drainage system generally centered on the Andrews Highway and extending east to near Grandview Avenue. East of Grandview the slope is south and east. All of the surface drainage from Odessa, except that which accumulates in the several playa lakes, is directed towards Monahan's Draw, the only pronounced terrain feature in the Area."

Socio-Economic Description.

The founding of Odessa in the late 1880's from a railroad construction camp was similar in nature to Midland's establishment. Unlike Midland, however, Odessa was not incorporated until 1927, on the heels of an oil boom occurring in the prolific McElroy Field. The 1930 population of the City was 2,407. Due to the oil boom, the 1940 population rose to 9,573. Firmly established as an oil center, growth in Odessa experienced an upsurge in the 40's due to the massive wartime demand for oil, thereby reflected in the 1950 Census figure for the City of 29,495. The years between 1950 and 1960 saw a phenomenal increase in population due to the tremendous expansion in oil exploration and drilling. Odessa's 1960 count was 80,338, an increase of 50,843 from the previous decade's Census figure. The stabilization of Odessa's growth followed as the oil industry's expansion subsided, causing the tide of immigration into the City to ebb as employment opportunities became less numerous. The 1970 population for the City was 78,380, down almost 2,000 from the 1960 figure. One factor involved in this decrease is not unique to the City of Odessa. The decline is a reflection of a drastically receding birth rate and a moderately-rising death rate, as has been experienced throughout not only the rest of the State but the Nation as well. Another reason for the population drop was the decline in jobs available due to readjustments and automation of the oil industries. Such changes spurred the emigration of many from the City to more promising areas.

In evaluating the City population as it presently exists, one fact warrants attention: Odessa is a young city, having achieved its size in a short span of time. The influx of people in such great numbers expanded and altered the City population to include persons from a diversity of socio-economic status, belief, and occupation. The 1970 tabulation from the Census Bureau for all families lists 20,451 families with an average of 3.3 persons per family and having a median yearly household income of $9,251.

In the City's entire over-25 population, a median of 12.1 years of educational attainment has been achieved.

An insight into the ethnic minority community in Odessa is provided by 1970 Census data as related to the Negro and Mexican-American citizens of the City. Negro families number 999, with an average of 4.2 persons per family and a median household income of $6,022 annually. Of the total number of families, approximately 9.5 percent receive some form of public assistance. The median level of educational achievement in the Negro population over 25 years of age was 10.4 years. In the other major minority group represented in Odessa, the Mexican-American population numbers a total of 2,346 families, each averaging 4.7 persons. Of these, the median income is $6,839, while 3.5 percent of the total number receive public assistance. The mean educational level is 7.0 years in the over-25 group.

During the 1960's, Odessa's population received a high volume of prime labor force persons in the 25 to 45-age group. This immigration has had a major impact on the City in raising the childbearing potential of the overall population. Although birth rates have declined, the immigration of this age group required the development of more housing units to accommodate the new demand. With such developments, growth in the northeast area occurred. However, no major internal shifts of population were noted, contrary to Midland's situation. The City is projected to grow as illustrated by the population data developed by the TWDB for use in this study. The population projections are as follows:

Population Projections

	Year			
	1970	1980	1990	2020
Population	78,383	91,520	105,240	149,350
Odessa Urban Area	89,300	104,200	119,800	170,200

Previous population estimates from other sources also indicate such population trends. Odessa will experience another inflow of new residents and students from the new University of Texas of the Permian Basin on the City's east sector. Growth for Odessa is inevitable, with over 10,000 people already settled in the outer periphery of the city limits within what will be defined as the Odessa Urban area for the purposes of this study. This Urban Area corresponds to the land use shown on Plate PB-O-1.

Land Use.

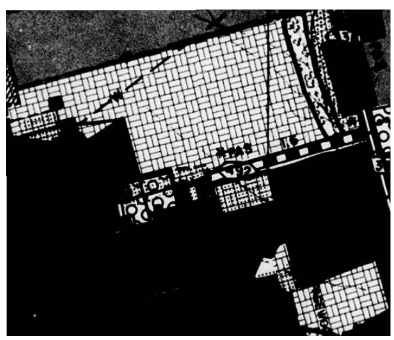
As is shown on the land-use map, Odessa is a fairly compacted metropolis, with the residential area gathered mostly throughout the City core. Some of the major factors in land-use projections are physical features. and their effect on development. Odessa possesses some obstacles, both natural and artificial, to development. Monahans Draw imposes restrictions on development due to the flooding susceptibility. The other growth constraints around the City are artificial. To the east of Odessa, a high-density network of pipelines from a nearby oil field limits growth in that direction. The University of Texas of the Permian Basin to the east also forms a barrier due to the land demands such institutions require. Extensive development around the campus area is expected, but the campus itself will cover about 600 acres which will be closed to other forms of development. Industrial land use in the southern sector of the City exists as an adverse influence to residential growth in that area. The City's growth is left with outlets to the north, and particularly the northeast where the development pattern is most explicit now. The existing land use at the time of the publication of the previously-cited Marvin Springer and Associates report was as shown on the following table.

EXISTING LAND USE* - INSIDE CITY LIMITS
ODESSA, TEXAS - 1971

Category	Acres	Percent of Developed Area	Percent of Total Area
Single-Family	4,096.2	38.5	33.0
Two-Family	72.7	.7	.6
Multi-Family	105.5	1.0	.9
Mobile Home	17.2	.2	.1
Trailer Park	31.5	.3	.3
Public and Semi-Public	1,890.6	17.8	15.3
Park	207.0	1.9	1.7
Retail	399.6	3.8	3.2
Commercial	327.5	3.1	2.6
Commercial (Open Storage)	2.5		
Light Industry	124.9		1.0
Light Industry (Open Storage)	121.7	2.3	1.0
Heavy Industry	65.3	.8	.5
Heavy Industry (Open Storage)	17.2		.1
Drill Site	278.5	2.6	2.3
Railroad Right-of-way	36.9	.3	.3
Street and Alley Right-of-way	2,839.5	26.7	22.9
Total Developed	10,634.3	100.0	85.8
Vacant Land	1,763.0		14.2
TOTAL AREA	12,397.3		100.0

*Survey by Marvin Springer and Associates.

LEGEND
EXIST. 1980 1990 2020
RESIDENTIAL LIGHT COMMERCIAL
PUBLIC
HEAVY COMMERCIAL INDUSTRIAL AND INSTITUTIONAL
RATLIFF OIL FIELD
NORTH HEADLEE OIL FIELD
FAS
1936
302
7.7
URBAN COMPACT NO.1
UNINC.
POP 2,132 (EST)
2.2
JOHNSON-FOSTER
SOUTH
2020
7.0
HARPER OIL FIELD
UNINC.
20
2227
385
34
ODESSA
POP. 78,380



Another fact that is unique to Odessa's existing land use is the lack of vacant land in the City proper. This low quantity of vacant land indicates that the metropolis will expand in the directions previously noted. What load this future land use will impose upon the City's service facilities will be a consequence of growth that City officials face. Moreover, it is not the intent of this wastewater management study that the anticipated land-use projections be accepted as a final document or that growth patterns be construed to mean exact locations indicated on the exhibit. Rather, the projected land-use pattern illustrated is merely a generalized interim plan to meet the requirements of the study.

Economic Analysis.

As previously mentioned, Odessa is primarily sustained by the oil industry. The University of Texas of the Permian Basin will undoubtedly expand the commercial and retail functions in the City. The City economy is further boosted by livestock revenue and the many petrochemical industries arising from the Permian Oil Basin.

The constantly increasing demand for petroleum products has placed a heavy burden on the Permian Oil Basin, one of the nation's major oil-producing regions. The City has taken steps to insure its continuity as a major metropolis by the diversification of its economy to relieve its dependency on the oil and petrochemical industries. Previous projections for the oil fields in the area predict oil supplies to continually dwindle in spite of improved recovery methods and to be near exhaustion in 20 or 30 years.

The City's ability to adapt to changing conditions is facilitated by the excellent accesses provided by I.H. 20, U. S. Highways 80 and 385, and numerous farm-to-market roads serving the region. In addition, the City is large enough to enjoy major airline and rail service. Thus, through the stability of its economy, the excellent transportation facilities, and the University of Texas of the Permian Basin's impact, the City of Odessa possesses immense growth potential. This outlook is further bolstered by the decline of Midland's role as a vital hub of the West Texas region.

Water Resources.

The City of Odessa has approximately 75 ground water wells which are used to provide a small portion of the municipal water supply. These wells draw water from the outcrop of the Ogallala Aquifer. This resource is especially tapped during peak demand periods that occur. A sprawling network of pipes carries the water to the City's treatment plant from the well fields which also supply part of Midland's water supply.

The bulk of Odessa's municipal water supply is obtained from the Colorado River Municipal Water District. The CRMWD owns and maintains a network of pipelines that draws water from Lake J. B. Thomas and transmits the water to the City's treatment plant. The quality of the surface water source is variable, as Lake J. B. Thomas will exhibit water quality variations typical of the warm monomictic reservoirs of the Southwest. This source is located approximately 90 miles northeast of Odessa and has a capacity of 204,000 acre-feet with a surface area of over 7,800 acres at the service spillway level.

The raw water is transported by a 26-mile supply line to Big Spring and a 63-mile continuation of the line on to Odessa. The water is propelled by gravity and by booster stations at key points along the line. A 35-mgd-capacity treatment plant receives the inflow, treats it, and distributes the water into storage and into the City's water system by a total service pump system. The distribution and storage systems are itemized in the following table.

ODESSA WATER SYSTEM
SERVICE PUMPS

11th Street Station

No. 1	4,500 gpm
No. 2	4,500 gpm

42nd and Golder Station

No. 2	3,000 gpm
No. 3	3,000 gpm
No. 4	3,000 gpm
No. 5	4,900 gpm
No. 6	4,900 gpm
No. 7	10,000 gpm
No. 8	12,500 gpm
	50,300 gpm

STORAGE RESERVOIRS

Type	Capacity	Material	Location
Ground	80,000,000	Earth	Diagonally across intersection from Treatment Plant at Golder and 42nd Street
Ground	80,000,000	Earth	Same as above
Clearwell	11,000,000	Concrete	Treatment Plant - Golder and 42nd
Clearwell	2,000,000	Concrete	11th Street Station
Elevated	500,000	Steel	10th and Bernice
Elevated	500,000	Steel	7th and Dixie
Elevated	2,000,000	Steel	53rd and Dawn

The water system, according to a 1972 TSDH survey, serves the entire City and an additional 50 connections. Average daily use in 1971 was approximately 26 mg through 21,048 water connections to a total population of 77,810. The projected water use, a reflection of the population trend, has been projected for the City by the TWDB for both municipal and industrial use, and is as follows:

Water Use Projections
(in mgd)

	Year			
	1970	1980	1990	2020
Municipal Use	11.70	14.71	17.44	27.11
Industrial Use	2.11	3.69	4.69	9.60

Waste Load Analysis.

Municipal Waste Load.

Municipal wastewater return flows, projected for Odessa by the TWQB, are as follows:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flows in mgd	6.66	7.78	8.94	12.69
BOD in lb/day	13,325	16,472	18,943	28,376
TSS in lb/day	15,677	19,217	23,153	34,350

These projections correspond to the population projections presented earlier in this report. Existing and projected sewer service boundaries are shown on Plate PB-O-2. The future boundaries are based on the projected land use discussed previously and are intended only for broad planning purposes.

Urban and Agricultural Runoff.

Odessa lies entirely in the drainage area of Monahan's Draw so that stormwater flows in the draw include any urban runoff from the City, in addition to any agricultural runoff from surrounding farmland. The principal sources of pollutants in urban runoff include:

1. Street and parking lot litter, oil, and grease.
2. Animal and bird wastes deposited on impervious surfaces.

3. Fertilizers from lawns and parks.

4. Pesticides.

5. Suspended solids from excavation and construction activities and from unpaved and unplanted areas.

6. Leaves and grass.

7. Air pollutants which settle or are washed out by rain.

8. Unauthorized waste discharges into gutters, streets, storm sewers, etc.

9. Overflowing manholes in overloaded sanitary sewer systems.

Sources of agricultural runoff pollution include:

1. Inorganic fertilizers.

2. Animal and poultry wastes.

3. Insecticides and herbicides.

4. Silt and other suspended solids.

Concentrations of pollutants in runoff depend on the amounts available to be washed away by rain, time interval between rains, and the intensity and duration of rainfall. Existing studies seem to indicate that urban runoff is generally much higher in concentration of pollutants than agricultural runoff.

In the semi-arid regions around Odessa, stormwater pollution is not a severe problem, due to low annual rainfall rates and a general absence of flowing streams. R°infall is often in the form of sudden annual storms, which create more problems with flooding than with pollution from runoff due to the poorly-defined drainage in the area. One potential problem in the City is the concentration of pollutants in the numerous playa lakes which catch the initial runoff from much of the area. These lakes act as stormwater holding basins, and most have been developed as parks. After a rain, water in these lakes gradually evaporates or seeps away and can leave concentrations of the pollutants to destroy the appearance and recreational qualities of the park. One solution to this problem is to provide facilities to drain the lakes following a storm, as has been done in some cases.

All stormwater in Odessa drains either into one of the local playa lakes or ultimately into Monahans Draw. Stormwater drainage improvements are too numerous and complex to be delineated in this report, but extensive drainage study and planning has been done for the City by the local firm of Freese, Nichols and Endress - Esmond, Reed, and Associates, formerly Kenneth E. Esmond and Associates.

Drainage improvements in the City consist primarily of inverted crown streets, open channels, some older storm sewers in the downtown and west-central sections, and storm sewers to drain the stormwater detention basins and some of the playa lakes. All of these facilities ultimately outfall to Monahans Draw or its tributaries. Odessa has little annual rainfall, but most of it is in the form of sudden intense storms. In the past, the City has chosen to utilize the full capacity of the playa lakes and of some artificial detention basins to reduce peak stormwater flows rather than try to construct storm sewers to handle the maximum flow rates. The procedure is well suited to the infrequent rainstorm pattern in the region, but development in Odessa is occurring at such a rapid rate that the City is hard-pressed to keep up with needed improvements. One much needed step now being undertaken is the purchase of drainage easements along the major drainageways and playa lakes. This is hindered, however, by the fact that much new development is occurring outside the present city limits. The City Planning Department is well aware of this problem and is presently using all available means to reach a solution.

Industrial Wastes.

Permitted industrial waste discharges in the Odessa urban area include:

1. Shell Oil Company - 0.22 mgd of cooling tower and boiler blowdown and waste process water. This waste is treated and used to irrigate 45 acres of company-owned land.

2. El Paso Products Co. - 1.62 mgd process water, cooling water, boiler blowdown, and water treatment wastes to be treated and disposed of by evaporation, incineration, deep well injection, and oil field flooding for secondary recovery. Approximately 14 to 15 tons per day of solid wastes are disposed of at registered dump sites on company property.

3. General Tire and Rubber Company - 0.50 mgd of waste from synthetic rubber process to be coagulated, settled, and completely evaporated from lined ponds.

4. Roxene Polymers Company - Approximately 50 tons per day of polymer wastes in a solid or semi-solid state with very low water solubilities are to be dumped in a sanitary landfill on company property.

These are the industrial wastes which are registered and permitted by the TWQB in the Odessa area. Other industrial wastes in the area are unspecified, but no discharges are permitted except into the municipal sanitary sewer system. The following is a list of potential producers of significant wastes in Odessa.

A.G.M. Tortilla & Tamale Factory	Food Processing
AM-SUL Chemical Co., Inc.	Liquid Fertilizer
Beyer Co.	Food Processing
Big Three Industries, Inc.	Industrial Gases
Cardinal Products, Inc.	Corrosion Inhibitors
Century Plastics, Inc.	Coatings
Champion Chemicals, Inc.	Oil Field Chemicals
Cities Service Oil Co.	Natural Gasoline, Propane
Continental Products of Texas	Oilfield Chemicals
Corrosion Coating Co. of West Texas	Coatings
Corrosion Proof Fitting Co. of Texas	Oil Field Specialities
El Paso Products Co. (7 plants)	Adipic acid, Ammonia, Butadiene, Isobutane, Hexamethylenediamine, Nitric acid, Ethylene, Propylene, Ethylbenzene, Styrene
General Tire and Rubber Co.	Synthetic Rubber
Getty Oil Co.	Natural Gasoline, Butane, Propane
W. R. Grace and Co.	Insecticides, Sulfur, and Talc
A. J. Hunt, Inc.	Coatings
K-Flex Corporation	Plastic liners
Magna Corporation	Oil and agricultural chemicals
Meister Plastic Coating Co.	Coatings
T. E. Mercer Pipe Coating Co.	Coatings

Odessa Natural Gasoline Co.	Natural Gasoline and By-products
Odessa Tortilla & Tamale Factory	Food Processing
Oil Base, Inc.	Drilling fluids
Orr's Ready Foods Co.	Food Processing
Otto's Dairy Store	Food Processing
Pepsi-Cola Bottling Co.	Food Processing
Permian Casting Co.	Metal Castings
Permian Enterprises, Inc.	Coatings
Permian Sand & Gravel Co., Inc.	Sand and Gravel
Plastic Applicators	Coatings
Rexene Polymers Co.	Poly-ethylene, -propylene, Ethylene, Propylene
Sid Richardson Carbon and Gasoline Co.	Carbon Black
Shell Oil Co.	Natural Gasoline and By-products
Shield, Inc.	Industrial Cleaners
Stice Wiping Cloth Co.	Processing of Cotton Waste
Union Carbide Corporation	Industrial gases, fluids, and lubricants

Many of these industries, notably the refineries, do not discharge into Odessa's sewer system, but all are potential producers of wastes with treatabilities which could require complete treatment prior to disposal. Existing pretreatment facilities for these industries are not known, but none have known permitted discharges of wastes other than into the Odessa sewer system. Even in those cases in which no waste is discharged into the municipal system, sewer service could be extended later as the City grows, to include the industrial sites.

Since most of the heavy industry in the City is located south of town along Monahans Draw, runoff from these industries will not pass through the City. Below the industrial park, the draw has been dammed for irrigation purposes. The resultant impoundment effectively serves as a stormwater clarifier for initial runoff, but adversely affects the quality of the irrigation water.

Solid Wastes.

Municipal solid waste disposal facilities in Odessa consist of a sanitary landfill near the Ector County Airport. Industrial solid wastes which are not registered for onsite plant disposal are assumed to be taken to the municipal landfill for disposal. Water treatment plant wastes are dewatered in open pits, and the dried sludge can be applied to the land or used as fill. The municipal landfill and the industrial dumps are protected from runoff and exfiltration so that they create no water pollution problems at present.

Waste Load Allocation.

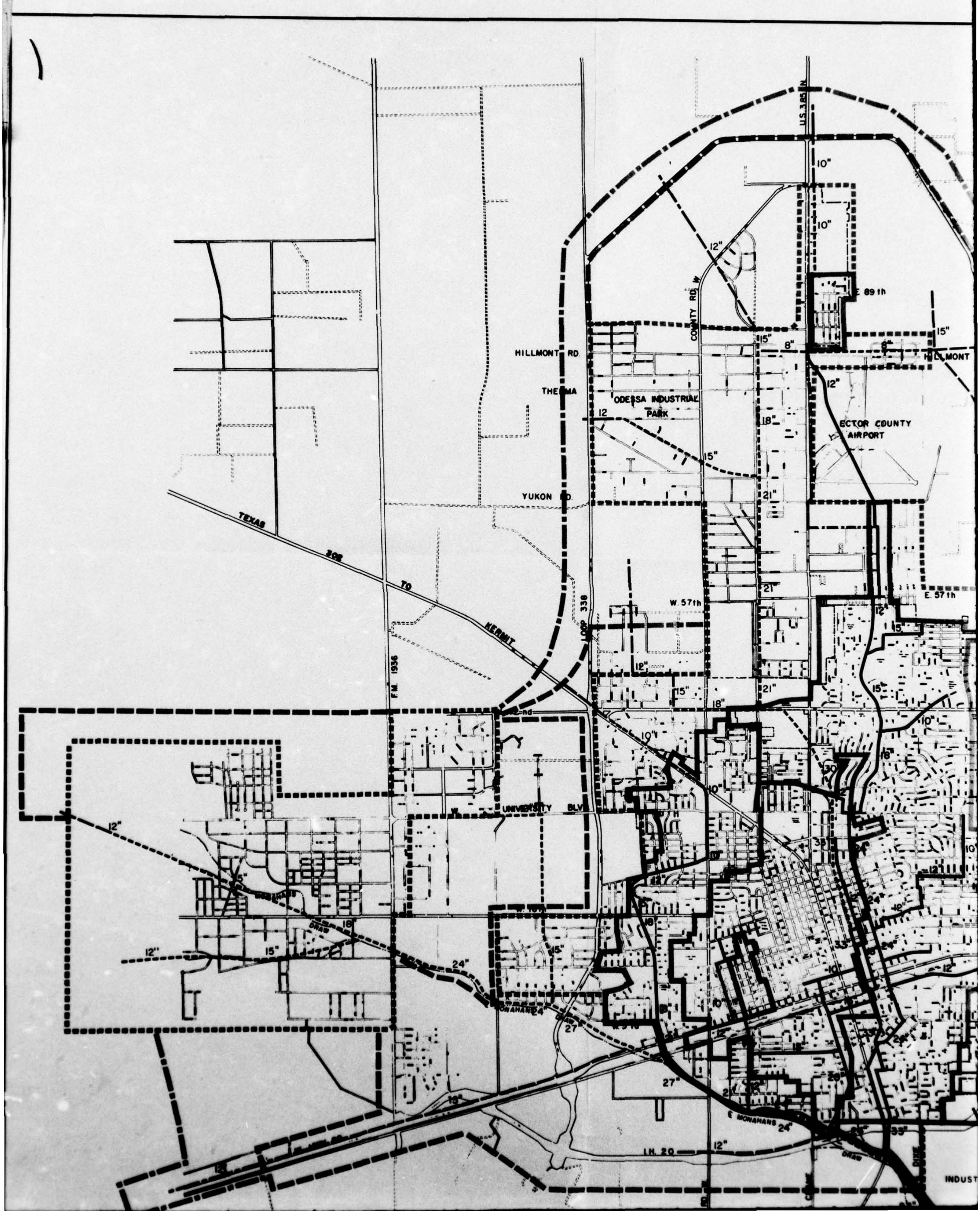
The concept of waste load allocation is based on dividing the assimilative capacity of a particular stream among the waste producers in such a manner that the total waste load on the stream will not exceed its ability to renew and maintain itself at the desired quality level. Since there are no perennnial streams in the Odessa area, any wastewater effluent discharged to a waterway becomes the stream flow under low flow conditions; therefore, under an allocation methodology, stream quality standards would become effluent standards. For this reason, wastewater restrictions for Odessa are and will remain effluent quality criteria. At present, the limiting effluent criteria for Odessa is the TWQB requirement that effluent contain not more than 20 ppm BOD and 20 ppm Total Suspended Solids, with at least 1.0 mg/1 chlorine residual after 20-minute detention time.

Under PL 92-500, secondary treatment of wastewater will be adequate until 1983, at which time application of the best practicable waste treatment technology will be required toward the ultimate goal of no discharge of pollutants.

Municipal Wastewater Collection System.

Existing Collection System.

The existing and proposed wastewater collection systems for Odessa are shown on Plate PB-O-2. Only the service area boundaries, collection mains and outfalls are shown, in order to best represent the system without confusion. The layout of proposed lines is intended for planning purposes only and is not meant to specify exact locations or line sizes. The basis for the analysis of the existing collection system was the 1958 "Master Plan for the City of Odessa" by Kenneth E. Esmond and Associates of Odessa. Updated information for developments since the time of that report was provided by the Department of Public Works of the City of Odessa.



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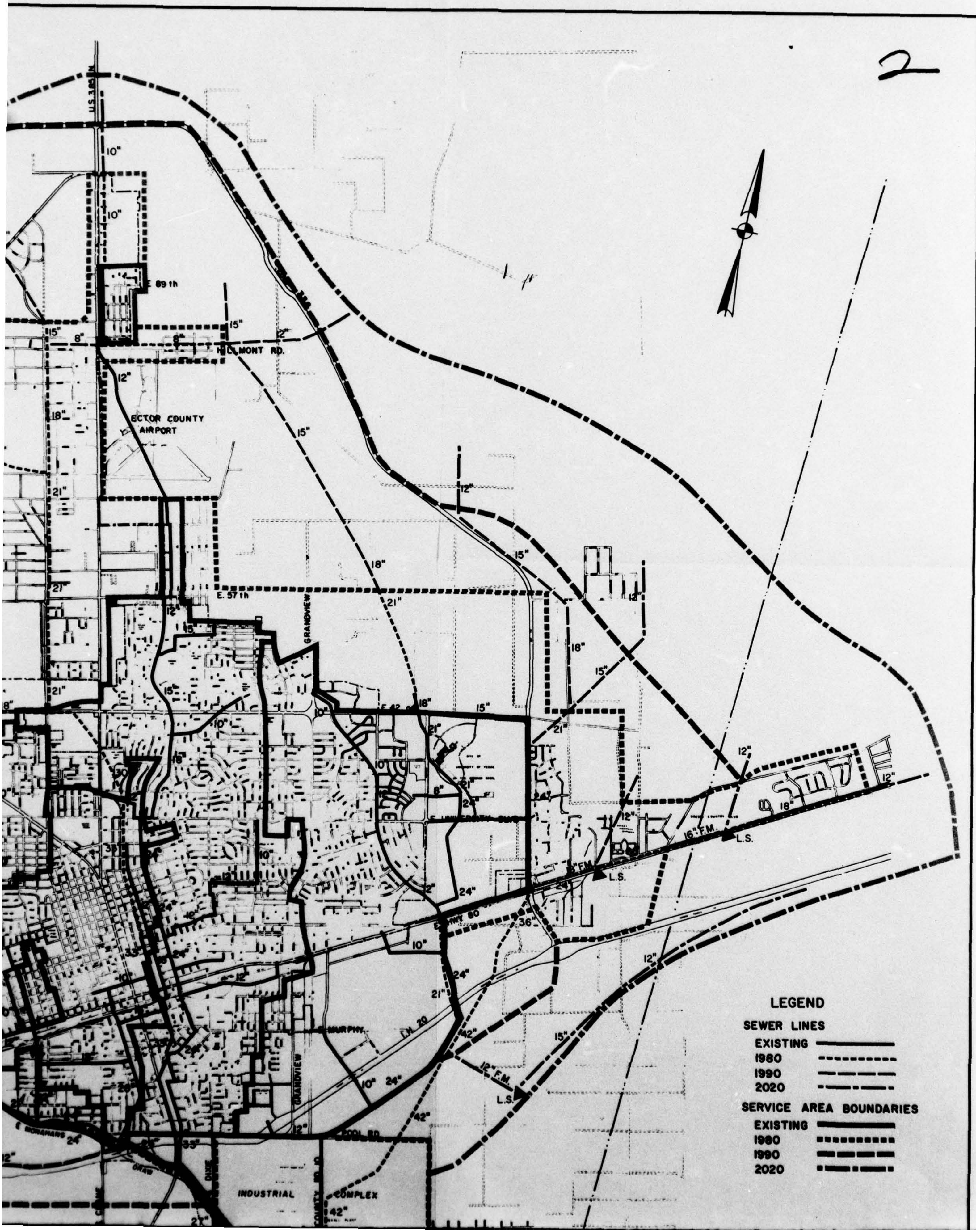

2
U.S. 385 N
E 89th
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AIRPORT
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1980
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SERVICE AREA BOUNDARIES
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1980
1990
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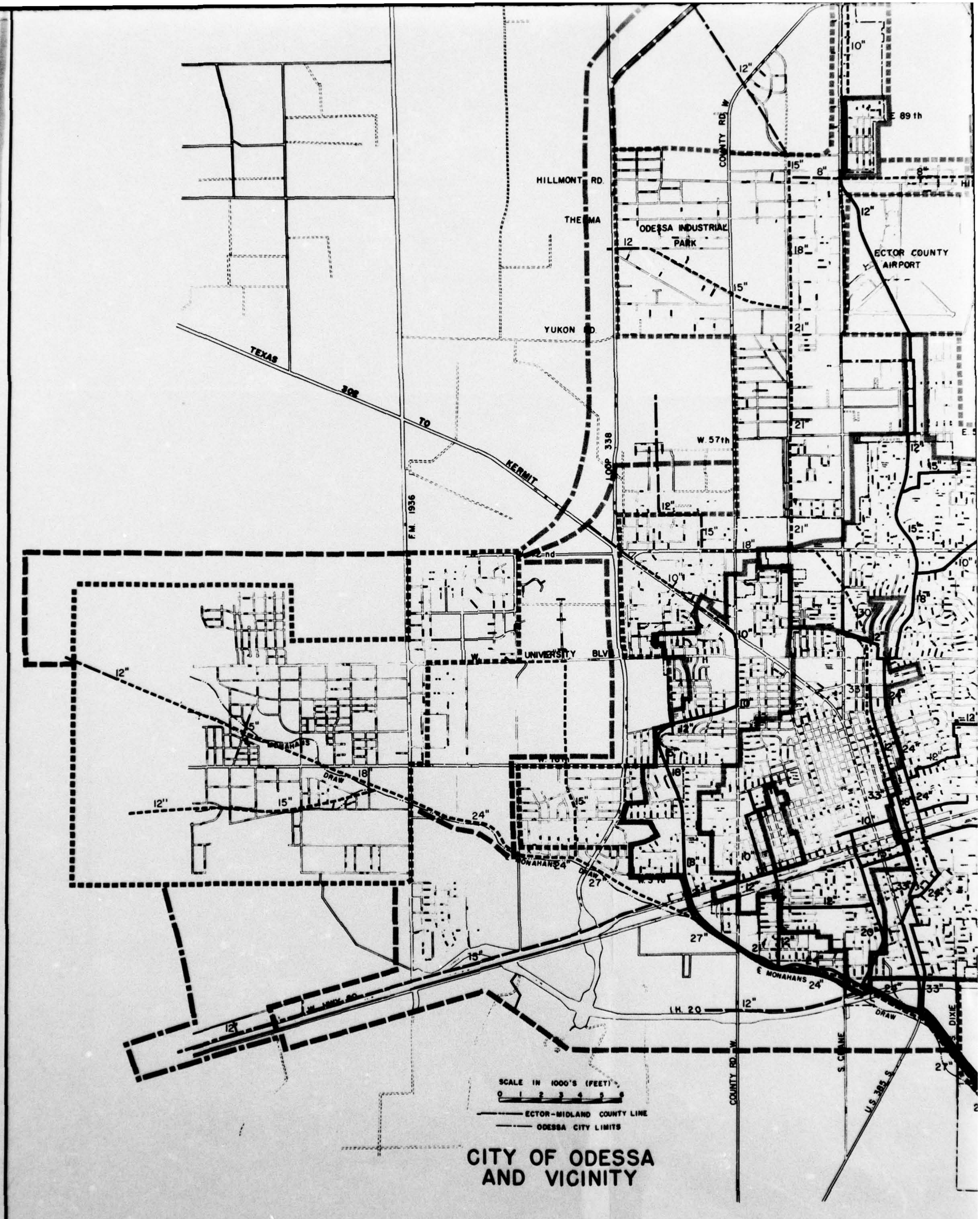
CITY OF ODESSA
AND VICINITY
SCALE IN 1000'S (FEET)
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ECTOR-MIDLAND COUNTY LINE
ODESSA CITY LIMITS
HILLMONT RD.
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ODESSA INDUSTRIAL PARK
YUKON RD.
TEXAS 302 TO KERMIT
LOOP 338
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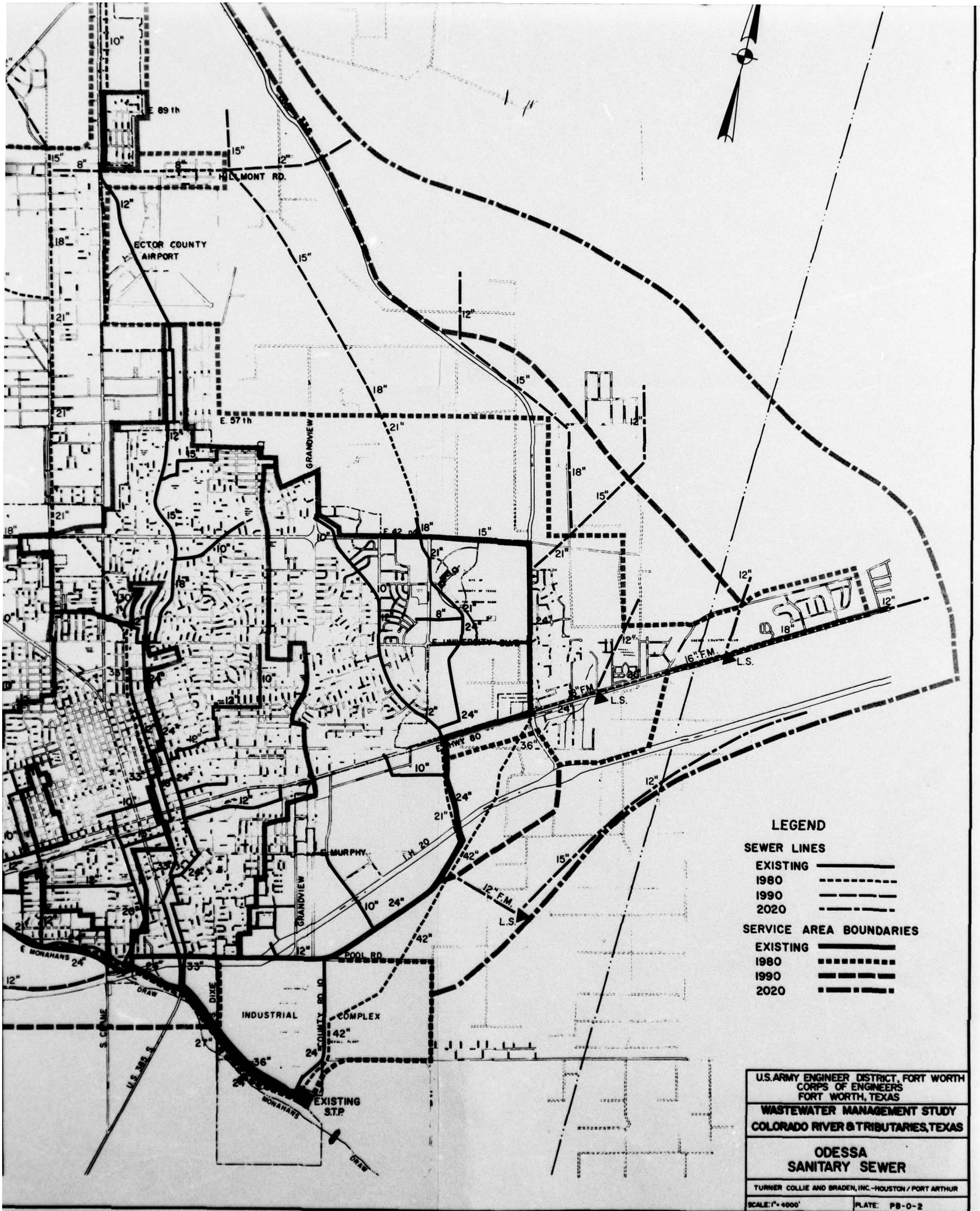
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E MONAHANS
DRAW
S. CRANE
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COUNTY RD 10
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MONAHANS
DRAW
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12" F.M.
LEGEND
SEWER LINES
EXISTING
1980
1990
2020
SERVICE AREA BOUNDARIES
EXISTING
1980
1990
2020
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
ODESSA
SANITARY SEWER
TURNER COLLIE AND BRADEN, INC.-HOUSTON / PORT ARTHUR
SCALE: 1" = 4000'
PLATE: PB-O-2

Proposed Collection System.

Design criteria for proposed sewer lines and analysis criteria for existing lines were taken from the Master Plan, as follows:

Average daily contribution: 80 gallons per capita per day

Ratio of peak to average flow:

Population of Area Served	Ratio (%)
0 - 3,000	225
3,000 - 5,000	211
5,000 - 30,000	188
Over 30,000	170

Land projections developed for this study were based on the following general assumptions:

Area	Average Density (people/acre) 1980	1990	2020
East	3.0	5.0	7.0
West	2.0	2.5	5.0
North	3.0	5.0	7.0

Since Odessa seems to be growing outward rather than filling existing internal vacancies, collection system expansions will be primarily outside the existing system, except in the case of the northwestern areas where outfalls must pass through the central part of the City to reach the sewage treatment plant. The City has provided for this future development by constructing the initial portion of the 33-inch interceptor through the center of town, as shown on Plate PB-O-2. As the northwestern area develops, the rest of this line will need to be constructed past the existing service area boundary to provide service to the new areas.

At present, there are several areas of significant residential development outside the existing service area boundaries in Odessa where septic tanks are the primary means of sewage disposal. For the purpose of this discussion, these will be considered as the area west of town and the area north and east of town. These two broad categories will be assumed to include about 90 percent of the existing and proposed development outside the present city limits.

Projections made in conjunction with the City Planning Department predict that approximately 25 percent of Odessa's external growth will occur in the area west of town. This area is broken by numerous small draws which converge to the east to form Monahans Draw. Present development in the area is characterized by individual mobile homes and modest permanent structures on 0.5 to 5-acre homesites, as opposed to traditional subdivision-type development found in other parts of the urban area. General soil types in the area are moderately deep sandy loams which allow fairly good septic tank operation as long as population densities are low. Natural grade and existing right-of-way along the draw will make sewer service for this area relatively inexpensive to provide as soon as new development warrants such service. The proposed improvements for this area shown on the map for 1980 would cost approximately $2,183,000, including engineering and contingencies. This cost includes only the major collectors and outfall shown in the exhibit.

The area east and northeast of town is projcted to experience about 65 percent of Odessa's growth. The new University of Texas of the Permian Basin campus, Midland, and the Midland Airport are all factors which encourage Odessa to grow eastward. General soil types on this side of the City impose only moderate restrictions to proper septic tank operation, but the typical subdivision-type development projected for the area will create population densities much too great for individual sewage treatment units. This area, especially the section east of the University, is broken by several small draws and generally drains toward the part of Mohans Draw which lies downstream from the Odessa sewage treatment plant. As shown on the Plate, extension of sewer service to this far eastern sector will require pump stations and force mains to overcome the natural grades, but if the area develops as projected, the expenditure will be necessary. The existing 24-inch outfall which crosses Highway 80 east of Parkway Drive will soon become overloaded as the area around the University develops. To utilize the full capacity of the existing lines, a 21-inch relief line is proposed as shown on Plate PB-O-22, to parallel the overloaded 24-inch line up to the point where it intercepts the proposed 42-inch extreme eastern outfall. A 15-inch relief is proposed for 1990 to follow 42nd Street along the northern edge of the University campus. This will allow maximum usage of the existing lines without allowing overloading as new development occurs.

Basically, all proposed sewer lines flow into the 33-inch central interceptor, the proposed 27-inch western outfall, or the proposed 42-inch eastern outfall, as shown on the exhibit. Extension of sewer service to areas of new development is based on the assumption that the City will either annex the areas or will contract with the residents to extend service to them.

Costs for proposed collection system improvements are shown in Table 0-1 on the following page.

TABLE O-1

COST FOR PROPOSED COLLECTION SYSTEM IMPROVEMENTS

ODESSA

A. Gravity Mains:

Pipe Size (inches)	Cost $ / ft.	Total Feet in Thousands 1980	1990	2020	Total Cost 1980	1990	2020
8	9.50	6.0	2.5	–	$ 570,000	$ 23,750	$ –
10	12.00	10.0	5.0	2	120,000	50,000	24,000
12	15.00	11.0	23.0	48	165,000	345,000	720,000
15	19.30	32.5	49.5	–	627,250	955,350	–
18	23.50	22.5	10.0	–	528,750	235,000	–
21	28.00	27.0	3.0	–	756,000	84,000	–
24	32.20	18.5	–	–	595,700	–	–
27	37.20	26.0	–	–	967,200	–	–
30	41.70	5.5	–	–	229,350	–	–
33	42.20	7.0	–	–	295,400	–	–
36	42.70	8.0	–	–	341,600	–	–
42	51.80	16.0	–	–	828,800	–	–
				Total with E&C	$7,001,000	$1,992,600	$876,400

B. Force Mains and Pump Stations:

1980	Capital	Annual O&M
2 Pump Stations:		
0.8 MGD at 28 ft. head	$ 45,000	$3,500
3.2 MGD at 15 ft. head	70,000	4,800
2500 ft. of 16-inch line @ $15/ft.	37,500	–
2000 ft. of 18-inch line @ $17.30/ft.	127,090	–
Total with E&C	$223,900	$8,300

2020	Capital	Annual O&M
New Pump Station:		
1.84 MGD at 46 ft. head	$100,000	$ 6,500
4,000 ft. of 12-inch line @ $9.25/ft.	37,000	–
Expand the two 1980 Pump Stations:		
0.8 MGD – 4 MGD	$110,000	$ 7.200
3.2 MGD – 6.4 MGD	104,000	6,800
Total with E&C	$430,300	$11,500

Municipal Wastewater Treatment System.

Existing Wastewater Treatment System.

Odessa's existing sewage treatment plant is of the activated-sludge type with a design capacity of 6.0 mgd. A complete description of the plant is given in Appendix A following the Odessa section. Average sewage flow to the plant is about 6.2 mgd, but effluent quality is presently quite good in spite of the slight hydraulic overload.

Proposed Wastewater Treatment Facility Alternatives.

Introduction.

Prior to presentation of the proposed wastewater treatment facility alternatives it should be noted that proposed collection system costs are common to each alternative, and these costs are repeated for all alternatives.

For Odessa, a total of ten alternative wastewater treatment schemes were investigated during the conduct of this study. These ten alternatives were evaluated, and four alternatives were selected as the most viable alternatives. All of the ten alternatives will meet the requirements of PL 92-500. A discussion of the four most viable alternatives is presented, followed by a discussion of the six remaining alternatives.

Alternative 1.

Alternative 1 includes expansion of the existing 6.0-mgd activated-sludge secondary treatment plant by 1975 to a capacity of 10.0 mgd, followed by industrial reuse of the treated effluent. Odessa presently sells about 6.0 mgd of secondary effluent to El Paso Products Co. for $0.15 per 1,000 gallons, with any excess effluent used by local farmers for irrigation. For this alternative, it will be assumed that all influent is sold to industries for $0.15 per 1,000 gallons. By 1990, a 4.0-mgd expansion of the secondary facilities would be required.

The estimated costs of this alternative, by phases, are presented below.

1975 Capital Cost

Description	Estimated Cost
4.0-mgd expansion by secondary facilities (10.0 mgd)	$1,116,000

1975 Annual O&M Cost

Description	Estimated Cost
Secondary facilities (10.0 mgd)	$ 262,800
Income from sale of effluent (10.0 mgd)*	-547,500
TOTAL (net income)	$ -284,700

1990 Capital Cost

Description	Estimated Cost
4.0-mgd expansion of secondary facilities (14.0 mgd)	$ 1,116,000

1990 Annual O&M Cost

Description	Estimated Cost
Secondary facilities (14.0 mgd)	$ 347,500
Income from sale of effluent (14.0 mgd)*	-766,500
TOTAL (net income)	$ -419,000

*Negative numbers denote income.

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$ 7,224,900	$ 148,300
1990	1,992,600	39,900
2020	1,306,700	29,000

Further economic analysis of Alternative 1 is presented in Appendix B of this section. Alternative 1 was also subjected to an evaluation analysis. Results of that analysis are shown in Appendix C of this section.

Alternative 2.

Alternative 2 includes construction of a new 10.0-mgd physical-chemical plant by 1975, capable of providing complete tertiary treatment. This tertiary system would include high lime treatment, recarbonation, filtration, ammonia stripping, dentrification, activated carbon treatment, chlorination, and aeration of the effluent. Effluent from this system has a great potential for reuse by industry or for domestic purposes. The costs do not include income from possible sale of effluent. By 1990, a 4.0-mgd expansion to the system would be required.

The estimated costs of this alternative, by phases, are presented below

1975 Capital Cost

Description	Estimated Cost
Tertiary treatment facilities (10.0 mgd)	$6,164,000

1975 Annual O&M Cost

Description	Estimated Cost
Tertiary treatment facilities (10.0 mgd)	$1,058,500

1990 Capital Cost

Description	Estimated Cost
Expand facilities by 4.0 mgd (14.0 mgd)	$1,758,000

1990 Annual O&M Cost

Description	Estimated Cost
Tertiary treatment facilities (14.0 mgd)	$1,379,700

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$7,224,900	$148,300
1990	1,992,600	39,900
2020	1,306,700	29,000

Further economic analysis of Alternative 2 is presented in Appendix B of this section. Alternative 2 was also subjected to an evaluation analysis. Results of that analysis are shown in Appendix C of this section.

Alternative 3.

Alternative 3 includes expansion of the existing secondary treatment activated sludge plant by 1975 to a capacity of 10.0 mgd, followed by total reuse of all effluent through spray irrigation of City-owned land. The effluent would be applied at a rate of 4 inches per week by rotary-type tower-suspended spray equipment. Irrigated crops are hay or grains, with a dual crop system giving the best basis for year-round operation. A 4.0-mgd expansion of the facilities would be required by 1990.

The estimated costs of this alternative, by phases, follows.

1975 Capital Costs

Description		Estimated Cost
Expansion of secondary facilities (10.0 mgd)		$1,116,000
Irrigation facilities (10.0 mgd)		
Twenty-one 40-acre spray towers @ $33,300 each	$ 669,300	
Distribution system	220,000	
Pumps	50,000	
Holding ponds (43 acres)	200,000	
Pump station and force main	1,270,500	
Land at $200/acre	180,000	
		3,028,500*
TOTAL		$4,144,500

*Including engineering and contingencies.

1975 Annual O&M Costs

Description		Estimated Cost
Secondary facilities (10.0 mgd)		$ 262,800
Irrigation facilities (10.0 mgd)		
Spray towers	$23,100	
Pumps	36,000	
Holding ponds (43 acres)	3,900	
Pump station and force main	28,000	
		91,000
TOTAL		$ 353,800

1990 Capital Costs

Description	Estimated Cost
4.0 mgd expansion of secondary facilities (14.0 mgd)	$1,116,000
Expand irrigation facilities (14.0 mgd)	850,300
TOTAL*	$1,966,300

*Including engineering and contingencies.

1990 Annual O&M Costs

Description	Estimated Cost
Secondary facilities (14.0 mgd)	$ 347,100
Irrigation facilities (14.0 mgd)	123,800
TOTAL	$ 470,900

Cost estimates for the proposed collection systems are as follows:

Date	Capital Cost	Annual O&M
1980	$ 7,224,900	$ 148,300
1990	1,992,600	39,900
2020	1,306,700	29,000

Further economic analysis of Alternative 3 is presented in Appendix B of this section. Alternative 3 was also subjected to an evaluation analysis. Results of that analysis are shown in Appendix C of this section.

Alternative 4.

Alternative 4 includes expansion of the existing activated-sludge plant by 1975 to a capacity of 10.0 mgd, followed by total reuse of all effluent by the rapid infiltration method of irrigation. Rapid infiltration involves infiltration and evaporation from a series of crop-lined ponds with a typical application rate of one foot per day for ten days, followed by five days of rest. To provide adequate treatment in the Odessa area, a site would be needed with a known profile of permeable soil to a depth of 140 feet; however, it is doubtful that such a site can be found in the area. By 1990, a 4.0-mgd expansion of the facilities would be required.

The estimated costs of this alternative, by phases, are presented below.

1975 Capital Costs

Description		Estimated Cost
Expansion of secondary facilities (10.0 mgd)		$ 1,116,000
Irrigation facilities (10.0 mgd)		
Holding ponds	$ 200,000	
Infiltration ponds	200,000	

Description		Estimated Cost
Pumps	$ 50,000	
Pump station and force mains	1,270,500	
Land	18,000	
		2,029,200*
TOTAL		$ 3,145,200

*Including engineering and contingencies.

1975 Annual O&M Costs

Description		Estimated Cost
Secondary facilities (10.0 mgd)		$ 262,800
Irrigation facilities (10.0 mgd)		
Holding ponds	$ 4,000	
Infiltration ponds	4,000	
Pumps	3,000	
Pump station and force main	28,000	
		39,000
TOTAL		$ 301,800

1990 Capital Costs

Description	Estimated Cost
4.0-mgd expansion of secondary facilities (14.0 mgd)	$1,116,000
Expand irrigation facilities (14.0 mgd)	512,500
TOTAL*	$1,628,500

*Including engineering and contingencies.

1990 Annual O&M Costs

Description	Estimated Cost
Secondary facilities (14.0 mgd)	$ 347,200
Irrigation facilities (14.0 mgd)	57,400
TOTAL	$ 404,500

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$7,224,900	$148,300
1990	1,992,600	39,900
2020	1,306,700	29,000

Further economic analysis of Alternative 4 is presented in Appendix B of this section. Alternative 4 was also subjected to an evaluation analysis. Results of that analysis are shown in Appendix C.

The aforementioned four alternatives were selected as the most viable, cost-effective alternatives. The additional six alternatives investigated, but not selected for further refinement, are presented below. All of these alternatives will meet the requirements of PL 92-500 and were considered for immediate (1975) implementation.

Alternative 5.

Alternative 5 includes expansion of the existing secondary activated-sludge plant by 1975 to a capacity of 10.0 mgd, followed by biological tertiary treatment. The tertiary treatment would include nitrification, denitrification, filtration, activated carbon treatment, chlorination, and aeration of the effluent. Expansion of the facilities to 14.0 mgd would be required by 1990.

The estimated costs of this alternative, by phases, are presented below.

1975 Capital Costs

Description	Estimated Cost
Expansion of secondary facilities (10.0 mgd)	$1,116,000
Tertiary treatment facilities (10.0 mgd)	6,410,000
TOTAL	$7,526,000

1975 Annual O&M Costs

Description	Estimated Cost
Secondary facilities (10.0 mgd)	$ 262,800
Tertiary facilities (10.0 mgd)	1,058,500
TOTAL	$1,321,300

1990 Capital Cost

Description	Estimated Cost
4.0-mgd expansion of tertiary facilities (14.0 mgd)	$2,269,000

1990 Annual O&M Costs

Description	Estimated Cost
Secondary facilities (10.0 mgd)	$ 262,800
Tertiary facilities (14.0 mgd)	1,251,950
TOTAL	$1,514,750

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$7,224,900	$148,300
1990	1,992,600	39,900
2020	1,306,700	29,000

Further economic analysis of Alternative 5 is presented in Appendix B of this section.

Alternative 5 was not selected for further refinement because the City has expressed a desire to continue industrial reuse, and this alternative was not one of the most cost-effective alternatives.

Alternative 6.

Alternative 6 includes expansion of the existing secondary activated-sludge plant by 1975 to a capacity of 10.0 mgd, followed by irrigation of all effluent by the overland runoff method of land disposal. Overland runoff involves the application of effluent to a slope with crop cover and collection facilities at the toe of the slope. Existing design criteria require slopes in the range between two percent and six percent for this treatment method. Although a preliminary survey of the topography in the Odessa area revealed no areas of sufficient acreage with the required two percent minimum slope, for this alternative it was assumed that a suitable site could be found. Expansion of the facilities to 14.0 mgd would be required by 1990.

The estimated costs of this alternative, by phases, are presented on the following page.

1975 Capital Costs

Description		Estimated Cost
Expansion of secondary facilities (10.0 mgd)		$1,116,000
Irrigation facilities (10.0 mgd)		
Thirty-two 40-acre spray towers @ $33,300 each	$1,065,600	
Distribution system	352,000	
Pumps	50,000	
Holding ponds	200,000	
Pump station and force main	1,270,500	
Collection ditches	4,800	
Land @ $200/acre	294,000	
		3,737,200*
TOTAL		$4,853,200

*Including engineering and contingencies.

1975 Annual O&M Costs

Description		Estimated Cost
Secondary facilities (10.0 mgd)		$ 262,800
Irrigation facilities (10.0 mgd)		
Spray towers	$ 32,000	
Pumps	36,000	
Holding ponds	4,000	
Pump station and force main	28,000	
		100,000
TOTAL		$ 362,800

1990 Capital Costs

Description	Estimated Cost
4.0-mgd expansion of secondary facilities (14.0 mgd)	$1,116,000
4.0-mgd expansion of irrigation facilities	923,400
TOTAL	$2,039,400

1990 Annual O&M Costs

Description	Estimated Cost
Secondary facilities (14.0 mgd)	$ 347,100
Irrigation facilities (14.0 mgd)	128,300
TOTAL	$ 475,400

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$7,224,900	$148,300
1990	1,992,600	39,900
2020	1,306,700	29,000

Further economic analysis of Alternative 6 is presented in Appendix B of this section.

Alternative 6 was not selected for further refinement because the City has expressed a desire to continue industrial reuse, and this alternative was not one of the most cost-effective alternatives.

Alternative 7.

Alternative 7 includes at least partial abandonment of existing facilities and construction of a new 10.0-mgd physical-chemical secondary plant by 1975. This physical-chemical secondary treatment would include primary treatment and high lime treatment, and would be followed by the spray irrigation method of land disposal of all effluent. Expansion of the facilities to 14.0 mgd would be required by 1990.

The estimated costs of this alternative, by phases, are presented below.

1975 Capital Costs

Description		Estimated Cost
Secondary facilities (10.0 mgd)		$ 2,000,000
Irrigation facilities (10.0 mgd)		
Twenty-one 40-acre spray towers @ $33,300 each	$ 669,300	
Distribution system	220,000	
Pumps	50,000	
Holding ponds (43 acres)	200,000	

Description		Estimated Cost
Pump station and force main	$1,270,500	
Land @ $200/acre	180,000	
		3,028,500*
TOTAL		$5,028,500

*Including engineering and contingencies.

1975 Annual O&M Costs

Description		Estimated Cost
Secondary facilities (10.0 mgd)		$ 456,200
Irrigation facilities (10.0 mgd)		
Spray towers	$ 23,100	
Pumps	36,000	
Holding ponds	3,900	
Pump station and force main	28,000	
		91,000
TOTAL		$ 547,200

1990 Capital Costs

Description	Estimated Cost
4.0-mgd expansion of secondary facilities (14.0 mgd)	$ 475,600
4.0-mgd expansion of irrigation facilities (14.0 mgd)	850,300
TOTAL	$1,325,900

1990 Annual O&M Costs

Description	Estimated Cost
Secondary facilities (14.0 mgd)	$ 613,200
Irrigation facilities (14.0 mgd)	123,800
TOTAL	$ 737,000

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$7,224,900	$148,300
1990	1,992,600	39,900
2020	1,306,700	29,000

Further economic analysis of Alternative 7 is presented in Appendix B of this section.

Alternative 7 was not selected for further refinement because extensive modification of the existing process would be required, the activated-sludge process is more flexible and more efficient, the City has expressed a desire to continue industrial reuse, this alternative was not one of the most cost-effective alternatives, O&M costs are greater than for biological treatment processes, large quantities of non-renewable resources (chemicals) would be required, and large volumes of chemical sludges would present handling and disposal problems.

Alternative 8.

Alternative 8 includes at least partial abandonment of existing facilities and construction of a new 10.0-mgd physical-chemical secondary plant by 1975. This physical-chemical secondary treatment would include primary treatment and high lime treatment, and would be followed by the overland runoff method of land disposal of all effluent. Overland runoff involves the application of effluent to a slope with crop cover and collection facilities at the toe of the slope. Existing design criteria require slopes in the range between two percent and six percent for this treatment method. Although a preliminary survey of the topography in the Odessa area revealed no areas of sufficient acreage with the required two percent minimum slope, for this alternative it was assumed that a suitable site could be found. Expansion of the facilities to 14.0 mgd would be required by 1990.

The estimated costs of this alternative, by phases, are presented below.

1975 Capital Costs

Description		Estimated Cost
Secondary facilities (10.0 mgd)		$2,000,000
Irrigation facilities (10.0 mgd)		
Thirty-two 40-acre spray towers @ $33,300 each	$1,065,600	
Distribution system	352,000	

Description		Estimated Cost
Pumps	$ 50,000	
Holding ponds	200,000	
Pump station and force main	1,270,500	
Collection ditches	4,800	
Land @ $200/acre	294,000	
		3,737,200*
TOTAL		$ 5,737,200

*Including engineering and contingencies.

1975 Annual O&M Costs

Description		Estimated Cost
Secondary facilities (10.0 mgd)		$ 456,200
Irrigation facilities (10.0 mgd)		
Spray towers	$ 32,000	
Pumps	36,000	
Holding ponds	4,000	
Pump station and force main	28,000	
		100,000
TOTAL		$ 556,200

1990 Capital Costs

Description	Estimated Cost
4.0-mgd expansion of secondary facilities (14.0 mgd)	$ 475,600
4.0-mgd expansion of irrigation facilities (14.0 mgd)	923,400
TOTAL	$ 1,399,000

1990 Annual O&M Costs

Description	Estimated Cost
Secondary facilities (14.0 mgd)	$ 613,200
Irrigation facilities (14.0 mgd)	128,300
TOTAL	$ 741,500

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$7,224,900	$148,300
1990	1,992,600	39,900
2020	1,306,700	29,000

Further economic analysis of Alternative 8 is presented in Appendix B of this section.

Alternative 8 was not selected for further refinement because modification of the existing process would be required, the activated sludge process is more flexible and more efficient, the City has expressed a desire to continue industrial reuse, this alternative was not one of the most cost-effective alternatives, O&M costs are greater than for biological treatment processes, large quantities of non-renewable resources (chemicals) would be required, and large volumes of chemical sludges would present handling and disposal problems.

Alternative 9.

Alternative 9 includes at least partial abandonment of the existing facilities and construction of a new 10.0-mgd physical-chemical secondary plant by 1975. This physical-chemical secondary treatment includes primary treatment and high lime treatment, and will be followed by the rapid infiltration method of land disposal of all effluent. Rapid infiltration involves infiltration and evaporation from a series of crop-lined ponds with a typical application rate of one foot per day for ten days, followed by five days of rest. To provide adequate treatment in the Odessa area, a site would be needed with a known profile of permeable soil to a depth of 140 feet; however, it is doubtful that such a site can be found in the area. Expansion of the facilities to 14.0 mgd would be required by 1990.

The estimated costs of this alternative, by phases, are presented below.

1975 Capital Costs

Description		Estimated Cost
Expansion of secondary facilities (10.0 mgd)		$ 2,000,000
Irrigation facilities (10.0 mgd)		
Holding ponds	$ 200,000	
Infiltration ponds	200,000	
Pumps	50,000	

Description		Estimated Cost
Pump station and force main	$1,270,500	
Land	18,000	
		2,029,200*
TOTAL		$4,029,200

*Including engineering and contingencies.

1975 Annual O&M Costs

Description		Estimated Cost
Secondary facilities (10.0 mgd)		$ 456,200
Irrigation facilities (10.0 mgd)		
Holding ponds	$ 4,000	
Infiltration ponds	4,000	
Pumps	3,000	
Pump station and force main	28,000	
		39,000
TOTAL		$ 495,200

1990 Capital Costs

4.0-mgd expansion of secondary facilities (14.0 mgd)	$ 475,600
4.0-mgd expansion of irrigation facilities (14.0 mgd)	512,500
TOTAL	$ 988,100

1990 Annual O&M Costs

Secondary facilities (14.0 mgd)	$ 613,200
Irrigation facilities (14.0 mgd)	57,400
TOTAL	$ 670,600

Cost estimates for the proposed collection system improvements are presented on the following page.

Date	Capital Cost	Annual O&M
1980	$7,224,900	$148,300
1990	1,992,600	39,900
2020	1,306,700	29,000

Further economic analysis of Alternative 9 is presented in Appendix B of this section.

Alternative 9 was not selected for further refinement because extensive, and therefore costly, modification of the existing process would be required, the activated sludge process is more flexible and more efficient, the City has expressed a desire to continue industrial reuse, this alternative was not one of the most cost-effective alternatives, O&M costs are greater than for biological treatment processes, large quantities of non-renewable resources (chemicals) would be required, and large volumes of chemical sludges would present handling and disposal problems.

Alternative 10.

Alternative 10 includes expansion of the existing 6.0 mgd activated-sludge secondary treatment plant by 1975 to a capacity of 10.0 mgd, followed by industrial reuse of the treated effluent. By 1990, a new 4.0 mgd biological (activated sludge) tertiary treatment plant would be constructed. For this alternative, it would be assumed that the 10.0-mgd of secondary effluent would be sold for industrial reuse for $0.15 per 1,000 gallons and the tertiary effluent for $0.50 per 1,000 gallons.

The estimated costs for this alternative, by phases, are presented below.

1975 Capital Cost

Description	Estimated Cost
4.0-mgd expansion of secondary facilities (10.0 mgd)	$1,116,000

1975 Annual O&M Costs

Description	Estimated Cost
Secondary facilities (10.0 mgd)	$ 262,800
Income from sale of secondary effluent (10. mgd)*	-547,500
TOTAL (Net Income)	$ -284,700

*Negative number denotes income.

1990 Capital Cost

Description	Estimated Cost
4.0 tertiary facilities (4.0 mgd)	$ 4,889,000*

*Including engineering and contingencies.

1990 Annual O&M Costs

Description	Estimated Cost
Secondary facilities (10.0 mgd)	$ 262,800
Income from sale of secondary effluent (10.0 mgd)*	-547,500
Tertiary facilities (4.0 mgd)	54,000
Income from sale of tertiary effluent (4.0 mgd)*	-730,000
TOTAL (Net Income)	$ -960,700

*Negative numbers denote income.

Cost estimates for the proposed collection system improvements are as follows:

Date	Capital Cost	Annual O&M
1980	$ 7,224,900	$148,300
1990	1,992,600	39,900
2020	1,306,700	29,000

Further economic analysis of Alternative 10 is presented in Appendix B of this section.

Alternative 10 was not selected for further refinement because the City has expressed a desire to continue the present industrial reuse relationship and the alternative would require the City to maintain a facility staff capable of maintaining advanced waste treatment facilities.

Conclusion.

Alternative 1 was selected as the best plan for Odessa because it meets the treatment requirements of PL 92-500; it is one of the most cost-effective alternatives; it retains effective system that has proved to be profitable to the City and acceptable to the regulatory agencies; during public workshop, this plan was selected by participating local interests;

and it returns wastes to the soil, thereby complying with the national goal of no discharge of critical pollutants by 1985.

Recommendation.

It is recommended that all steps necessary to implement the Alternative 1 plan be undertaken.

Continuing Responsibility.

The planning and construction of wastewater treatment facilities is only one small part of the overall treatment scheme. The application of good operation, maintenance, and control techniques are essential for proper wastewater management. The most advanced equipment available is useless if it is improperly operated or poorly maintained. As an example of the optimum care required, a modern secondary treatment facility in the five to ten-mgd range would employ as many as one superintendent, one chemist, six operators, one maintenance man, and two laborers, to provide around-the-clock attendance. Land disposal facilities for Odessa would require another six to eight employees, and conventional tertiary treatment could require even more.

Every operative function in a treatment plant which involves a variable treatment mode, is based on a daily sampling testing, and recording program. Typical tests and frequencies include:

1. Sludge measurements in settling tanks on each shift daily.

2. Settleable solids volume and pH measurements daily for influent and effluent.

3. Effluent stability tests on 24-hour composite samples.

4. Chlorine residual of effluent on each shift daily.

5. Total and volatile solids, volatile acids, and pH of digested sludge as needed.

6. BOD, TSS, and pH of influent and effluent daily on 24-hour composite sample.

7. Dissolved oxygen measurement on influent, effluent, and receiving stream above and below the discharge point five days per week.

8. For activated-sludge plants, DO of mixed liquor and sludge volume index on each shift daily.

In addition to providing a record of treatment efficiency, regular sampling and testing programs aid in early detection and correction of operational malfunctions in a treatment plant.

When land disposal of effluent is utilized, an additional sampling program is usually required to monitor ground water quality in the area around the disposal site. This usually consists of a series of wells surrounding the site, from which periodic samples are drawn. Such monitoring is just one more means of maintaining the careful surveillance necessary to sound wastewater management.

In metropolitan areas like Odessa, high concentrations of population and industry have increased both the quantity and strength of wastewater to be handled. Traditionally, wastewater treatment has consisted of the minimum treatment necessary to prevent public health hazards, but new environmental priorities and increased public awareness of water quality problems have lent increased weight to the argument for responsible wastewater management, not just to meet government requirements but also to protect the local environment.

APPENDIX A
MUNICIPAL WASTEWATER TREATMENT FACILITIES
CITY OF ODESSA, TEXAS

Preface.

During the course of investigation for the Colorado River Wastewater Management Study, all municipal wastewater treatment facilities within the Basin were visited by the study staff. In addition, operational specialists were directed to investigate the treatment facilities located within the metropolitan areas. The following text represents a summary of that operational report.

General

The City of Odessa is served by one sewage treatment plant which is located south of the City, off I.H. 20 (see Figure A-1). The plant is situated in the vicinity of a large industrial park which contains seven major industries. The treatment facility, which was originally constructed and financed by El Paso Products Co. (EPP), was later given to the City of Odessa. Operation and maintenance, although executed by the City's Department of Public Utilities, is still largely financed by EPP Co, which is also the only industrial consumer of treated effluent. The portion of the effluent not used for industrial purposes is discharged outside the plant perimeter into a series of large lagoons. Several neighboring farmers have already been contracted by the City to use the water for irrigation of farmland and pumps have been installed and are now being used for irrigation. The lagoons have an ultimate high level overflow into Monahans Draw, which is a tributary of Midland Draw.

The Shell Gasoline Refinery, which is located north of the treatment plant, discharges an effluent at the same point, ahead of the lagoons. The water now used for irrigation thus includes this industrial discharge of unknown quality. Although none were observed, it is conceivable that other industrial discharges exist in the area.

Description of Present Facility.

Raw sewage reaches the plant via three trunk sewers, which come together in a distribution box which contains several gate valves. The flow is thus distributed, with part of the sewage being directed to the old grit removal unit while the major part goes to the new grit removal facility. Slide gates can block either passage. In both cases, the flow passes through mechanical bar screens, grit and grease-removal units prior to discharge into the primary clarifiers. The grit-removal units in both cases are the square flow-through type with revolving rakes. Grit is collected and removed manually.

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In the older part of the plant, the sewage passes through another bar screen before entering a rectangular grease-removal facility. This unit is aerated and has rotoline-type scum removal. The overflow enters a trough which leads to the primary clarifiers.

In the new part of the plant, the overflow of the grit removal unit enters a channel which contains a Parshall flume with an integral flow recorder. The channel conveys the sewage to the pump station where it is subsequently pumped to the large circular grease-removal facility. This unit is aerated in the center section and has radial, traveling scum removal. Overflow, together with that from the old unit, is channeled to the two primary clarifiers. Underflow is pumped to the primary digester, while the overflow is pumped to the primary and subsequently to the secondary holding basins. Both basins are rectangular concrete structures with aerators to prevent septic conditions. The secondary holding basin serves mainly to equalize the flow prior to biological treatment.

Biological treatment, in this case being of the conventional activated-sludge type, occurs in three parallel basins. The mixed liquor from the aeration basins flows to a distribution box which distributes the flow to the three final clarifiers. The underflow from these clarifiers is returned via a distribution box. Overflow continues to the chlorine contact tank, a rectangular, baffled concrete basin. Chlorination now occurs according to the requirements of EPP Co. and is below State requirements. The major part of the plant effluent is pumped to EPP Co. while the remainder flows to the lagoons for irrigation or ultimate discharge into Monahans Draw.

Since the plant is situated in the immediate vicinity of seven major industries, conditions for combined treatment seem good. EPP Co. at one time attempted such a plan, which was eventually abandoned for lack of interest on the part of the other industries.

Waste sludge is pumped to a series of three anaerobic digesters and eventually put out on drying beds. Digester supernatant is discharged to a lagoon adjacent to the plant.

Actual dimensions of the individual units are listed on the following pages, while a schematic flow diagram of the primary and secondary facilities is shown in Figure A-1.

DIMENSIONS AND CAPACITIES OF PRESENT UNITS

No. 1 Grit Removal Tank

$$\frac{14 \text{ ft.} \times 14 \text{ ft.} \times 2 \text{ ft.} \times 7.48 \text{ gals.}}{1 \text{ cu. ft.}} = 2932 \text{ gals.}$$

Dimensions:	width	14 ft.
	depth	2 ft.
	length	14 ft.

No. 2 Grit Unit

10 ft. x 18 ft. x 3 ft. = 7270 gals.

No. 1 Grease Removal Tank

14 ft. x 10 ft. x 9 ft. = 9424 gals. 1 pass
Total 2 passes = 18,848 gals.

No. 3 Primary Clarifier (grease unit)

$$\frac{30 \text{ ft.} \times 30 \text{ ft.} \times 12 \text{ ft.} \times 3.1416}{1. \text{ cu. ft.}} \times 7.48 = 253{,}791 \text{ gals.}$$

Wet Well

31 ft. x 12 ft. x 9 ft. = 25,043 gals.

Dimensions:	length	31 ft.
	width	9 ft.
	depth	12 ft.

No. 1 Primary Clarifier

35 ft. x 35 ft. x 7.75 x 3.416 x 7.48 gals. = 223,095 gals.

Diameter	70 ft.
Depth	7.75 ft.

No. 2 Primary Clarifier

35 ft. x 35 ft. x 7.75 x 3.1416 x 7.48 = 223,095 gals.

Diameter	70 ft.
Depth	7.75 ft.

No. 1 Holding Tank

$$\frac{70 \text{ ft.} \times 36 \text{ ft.} \times 10 \text{ ft.} \times 7.48 \text{ gals.}}{1 \text{ cu. ft.}} = 188.496 + \text{sump } 3436 \text{ gals.}$$

Total = 191,932 gals.

Dimensions:	length	70 ft.
	width	36 ft.
	depth	10 ft.

No. 2 Holding Tank

174 ft. x 35 ft. x 15 ft. = 683,298 gals.

Dimensions:	length	174 ft.
	width	35 ft.
	depth	15 ft.

No. 1 Digester

$$40 \text{ ft.} \times 40 \text{ ft.} \times 21 \text{ ft.} \times 3.1416 \times \frac{7.48 \text{ gals.}}{1 \text{ cu. ft.}} = 789{,}572 \text{ gals.}$$

$$40 \text{ ft.} \times 40 \text{ ft.} \times 12.3 \text{ ft.} \times \frac{7.48 \text{ gals.}}{1 \text{ cu. ft.}} \times 1/3 = 154{,}154 \text{ gals.}$$

Total 943,723 gals.

Diameter	80 ft.
Depth	21 ft.

No. 2 Digester

30 ft. x 30 ft. x 20 ft. = 422,985 gals.
30 ft. x 30 ft. x 7.75 ft. = 54,635 gals.

Total 477,620 gals.

Diameter	60 ft.
Depth	20 ft.

No. 3 Digester

30 ft. x 30 ft. x 20 ft. = 422,985 gals.
30 ft. x 30 ft. x 7.75 ft. = 54,635 gals.

Total 477,620 gals.

Diameter	60 ft.
Depth	20 ft.

3 Aeration Tanks (detention now 3-4 hrs., 11 mgd throughput)

93 ft. x 15 ft. x 30 ft. = 313,038 gals. per pass

$$\frac{913{,}038 \text{ gals.}}{\text{pass}} \times 6 \text{ passes} = 1{,}878{,}228 - 41{,}904 \text{ (vol. of walls)}$$

Total volume = 1,836,324 gals.

length	93 ft.
depth	15 ft.
width	30 ft.

No. 1 Final Clarifier

35 ft. x 35 ft. x 11 ft. = 316,651 gals.

Diameter	70 ft.
Depth	11 ft.

No. 2 Final Clarifier

35 ft. x 35 ft. x 11 ft. = 316,651 gals.

Diameter	70 ft.
Depth	11 ft.

No. 3 Final Clarifier

45 ft. x 45 ft. x 13 ft. = 618,615 gals.

Diameter	90 ft.
Depth	13 ft.

Chlorine Contact Basin

68 ft. x 32 ft. x 8 ft. = 130,211 gals.

length 68 ft.
width 32 ft.
depth 8 ft.

Chlorinators No. 1 and No. 2

Wallace & Tiernan – V notch
Model A-711 Ser. AA-6145 (No. 2 AA-6147)
1000 lb. 1 hr. 160 pressure

1965 Blower No. 1

Motor: Gen. Dyn.
Phase 3
Serial 60100205 A-1
HP 200
Volts 440
Cycle 60

Blower: Roots–Cormersville
Size 18 x 18
Inlet Volume 4030 cu. ft. / min.

Blower No. 2

General Electric
Serial OPJ204006
3 phase Model 5K6324 x D22A
HP 150/75
Blower: Sutorbilt
Ser. No. A-12248 Series 3000
Size 16 x 17
Displacement 6

Blower No. 3

Motor: General Electric Ser. OPJ204007
Model 5K6324 x D22A
HP 150/75
Blower: Sutorbilt
Ser. No. 126 Series 3200

Blower No. 4

Motor: Allis-Chalmers
HP 200
Ser. No. 1-5151-43303-1-1
Blower: Roots–Cormersville
Size 18 x 18
4030 cu. ft/mi. inlet vol.

Capital Improvements.

No major expenditures are planned for the near future, although industrial expansion--including an extension of the University of Texas--is expected. Room for expansion of the facility is unlimited toward the east and south.

Conclusions.

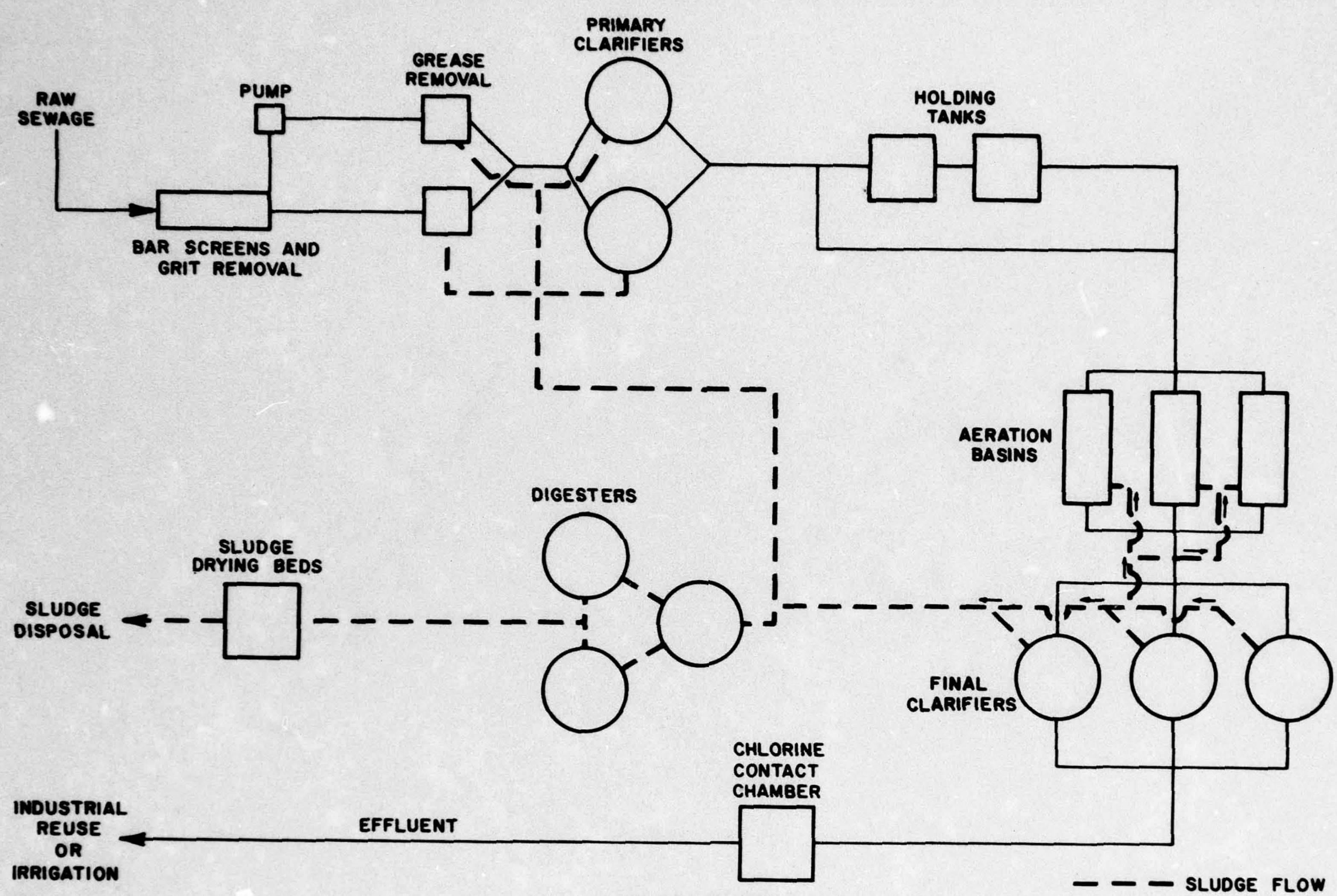
The plant in its current state is overloaded. Aeration basin detention time averages less than four hours, which is below State requirements for conventional activated sludge. However, the plant through the addition of polymers has been successful in maintaining effluent levels consistent with the permit requirements.

Operational practices are satisfactory, while maintenance and housekeeping are good. General condition of equipment is good. With 16 men total personnel and 24-hour operator coverage, adequate coverage is furnished. All monitoring and quality data are obtained by the plant's laboratory.

At the present time chlorination of effluent is not practiced, since the effluent stream is delivered directly to EPP Co. and the refinery does not desire a chlorine residual in the water prior to its further treatment and use as process and cooling water. Although the stated discharge permit requires the City to maintain a chlorine residual in the discharge, compliance with the requirement would result in a needless and wasteful expenditure. However, any effluent that is not delivered to EPP Co. and is discharged into an open ditch or pond should be in compliance with the discharge permit.

Consideration should be given to returning digester supernatant to the plant instead of being discharged in a lagoon adjacent to the lagoons being used for irrigation.

Areawide joint treatment of industrial and domestic waste must still be considered a viable proposition. It would seem advisable that more control be exercised over other discharges into the same watercourse. In general, the present facility operates well, and although to some extent loaded in excess of the 6-mgd design capacity, it produces an effluent consistently below the permit criteria set by the TWQB.



FLOW DIAGRAM
ODESSA SEWAGE TREATMENT PLANT
FIGURE A-1

APPENDIX B

ECONOMIC ANALYSIS OF ALTERNATIVES
CITY OF ODESSA, TEXAS

Each of the wastewater treatment facility alternatives for Odessa was subjected to an economic analysis. The results of these analyses, by alternative, are presented as computer printouts following the cost summary. The first four column entries are input data and include a description of the item under consideration, the date by which an item is to be constructed or operational, the capital cost of each item, and the annual operation and maintenance cost of each item. The next three column entries are calculated values of Capital Cost Present Worth, O&M Present Worth, and Total Present Worth, all of which were calculated at 5.5 percent interest. These values were also calculated for 7.0 percent and 10.0 percent interest, with results appearing under line entries INT RT = 0.07 and INT RT = 0.10 respectively. All values shown are in January 1972 dollars.

ODESSA, TEXAS

COST SUMMARY

Atlternative	Total Present Worth*		
	Interest		
	5.5%	7.0%	10.0%
1	$ 3,959,112	$ 3,728,639	$ 3,188,354
2	29,957,045	24,629,365	17,821,978
3	17,254,292	14,466,639	10,774,229
4	15,461,782	12,920,582	9,552,945
5	34,307,058	28,342,027	20,667,942
6	17,987,598	15,150,212	11,378,895
7	20,891,331	17,413,616	12,879,582
8	21,624,636	18,097,189	13,484,247
9	19,098,821	15,867,559	11,658,298
10	2,395,128	2,856,143	2,948,502

*Total Present Worth is equal to the Capital Cost Present Worth plus the O&M Present Worth.

Odessa Alternatives

Cost Comparison

ALTERNATIVE 1

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
EXP SECONDARY	1975	1116000.	262800.	950401.	3703448.	4653849.
INCOME-10 MGD	1975	0.	-547500.	0.	-7715517.	-7715517.
EXP SECONDARY	1990	1116000.	84700.	425716.	469588.	895304.
INCOME-14 MGD	1990	0.	-219000.	0.	-1214164.	-1214164.
COLLECTION SYS	1980	7224900.	148300.	4707737.	1550571.	6258308.
COLLECTION SYS	1990	1992600.	39900.	760109.	221211.	981320.
COLLECTION SYS	2020	1306700.	29000.	100013.	0.	100013.
INT RT=.055000		12756200.	-9711500.	6943976.	-2984864.	3959112.
INT RT=.070000		12756200.	-9711500.	6086456.	-2357816.	3728639.
INT RT=.100000		12756200.	-9711500.	4781514.	-1593160.	3188354.

ALTERNATIVE 2

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
PC TERTIARY	1975	6164000.	1058500.	5249347.	14916667.	20166014.
EXP TERTIARY	1990	1758000.	321200.	670617.	1780774.	2451391.
COLLECTION SYS	1980	7224900.	148300.	4707737.	1550571.	6258308.
COLLECTION SYS	1990	1992600.	39900.	760109.	221211.	981320.
COLLECTION SYS	2020	1306700.	29000.	100013.	0.	100013.
INT RT=.055000		18446200.	64397500.	11487823.	18469223.	29957045.
INT RT=.070000		18446200.	64397500.	10397072.	14232292.	24629365.
INT RT=.100000		18446200.	64397500.	8689621.	9132357.	17821978.

ALTERNATIVE 3

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
EXP SECONDARY	1975	1116000.	262800.	950401.	3703448.	4653849.
SPRAY IRRIG	1975	3028500.	91000.	2579112.	1282397.	3861508.
EXP FACILITIES	1990	1966300.	117100.	750076.	649217.	1399294.
COLLECTION SYS	1980	7224900.	148300.	4707737.	1550571.	6258308.
COLLECTION SYS	1990	1992600.	39900.	760109.	221211.	981320.
COLLECTION SYS	2020	1306700.	29000.	100013.	0.	100013.
INT RT=.0.5000		16635000.	26563000.	9847448.	7406844.	17254292.

Odessa Alternatives

Cost Comparison

(Cont'd)

ALTERNATIVE 3

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
INT RT=.070000		16635000.	26563000.	8810187.	5656452.	14466639.
INT RT=.100000		16635000.	26563000.	7209805.	3564424.	10774229.

ALTERNATIVE 4

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
EXP SECONDARY	1975	1116000.	262800.	950401.	3703448.	4653849.
RI IRRIG	1975	2029200.	39000.	1728094.	549599.	2277693.
EXP FACILITIES	1990	1628500.	102700.	621217.	569382.	1190599.
COLLECTION SYS	1980	7224900.	148300.	4707737.	1550571.	6258308.
COLLECTION SYS	1990	1992600.	39900.	760109.	221211.	981320.
COLLECTION SYS	2020	1306700.	29000.	100013.	0.	100013.
INT RT=.055000		15297900.	23791000.	8867571.	6594210.	15461782.
INT RT=.070000		15297900.	23791000.	7894518.	5026064.	12920582.
INT RT=.100000		15297900.	23791000.	6398260.	3154685.	9552945.

ALTERNATIVE 5

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
EXP SECONDARY	1975	1116000.	262800.	950401.	3703448.	4653849.
AS TERTIARY	1975	6410000.	1058500.	5458844.	14916667.	20375511.
EXP TERTIARY	1990	2269000.	193450.	865546.	1072512.	1938058.
COLLECTION SYS	1980	7224900.	148300.	4707737.	1550571.	6258308.
COLLECTION SYS	1990	1992600.	39900.	760109.	221211.	981320.
COLLECTION SYS	2020	1306700.	29000.	100013.	0.	100013.
INT RT=.055000		20319200.	72391000.	12842650.	21464409.	34307058.
INT RT=.070000		20319200.	72391000.	11660056.	16681971.	28342027.
INT RT=.100000		20319200.	72391000.	9804819.	10863123.	20667942.

Odessa Alternatives

Cost Comparison

(Cont'd)

ALTERNATIVE 6

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
EXP SECONDARY	1975	1116000.	262800.	950401.	3703448.	4653849.
OR IRRIG	1975	3737200.	100000.	3182651.	1409227.	4591878.
EXP FACILITIES	1990	2039400.	112600.	777962.	624269.	1402230.
COLLECTION SYS	1980	7224900.	148300.	4707737.	1550571.	6258308.
COLLECTION SYS	1990	1992600.	39900.	760109.	221211.	981320.
COLLECTION SYS	2020	1306700.	29000.	100013.	0.	100013.
INT RT=.055000		17416800.	26833000.	10478872.	7508726.	17987598.
INT RT=.070000		17416800.	26833000.	9410325.	5739887.	15150212.
INT RT=.100000		17416800.	26833000.	7755410.	3623485.	11378895.

ALTERNATIVE 7

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
PC SECONDARY	1975	2000000.	456200.	1703227.	6428893.	8132121.
SPRAY IRRIG	1975	3028500.	91000.	2579112.	1282397.	3861508.
EXP FACILITIES	1990	1325900.	189800.	505786.	1052276.	1558061.
COLLECTION SYS	1980	7224900.	148300.	4707737.	1550571.	6258308.
COLLECTION SYS	1990	1992600.	39900.	760109.	221211.	981320.
COLLECTION SYS	2020	1306700.	29000.	100013.	0.	100013.
INT RT=.055000		16878600.	37447000.	10355984.	10535347.	20891331.
INT RT=.070000		16878600.	37447000.	9342323.	8071293.	17413616.
INT RT=.100000		16878600.	37447000.	7758786.	5120796.	12679582.

ALTERNATIVE 8

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
PC SECONDARY	1975	2000000.	456200.	1703227.	6428893.	8132121.
OR IRRIG	1975	3737200.	100000.	3182651.	1409227.	4591878.
EXP SECONDARY	1990	475600.	157000.	181425.	870428.	1051853.
EXP IRRIG	1990	923400.	28300.	352246.	156899.	509144.
COLLECTION SYS	1980	7224900.	148300.	4707737.	1550571.	6258308.
COLLECTION SYS	1990	1992600.	39900.	760109.	221211.	981320.
COLLECTION SYS	2020	1306700.	29000.	100013.	0.	100013.

Odessa Alternatives

Cost Comparison

(Cont'd)

ALTERNATIVE 8

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
INT RT=.055000		17660400.	37717000.	10987408.	10637229.	21624636.
INT RT=.070000		17660400.	37717000.	9942461.	8154728.	18097189.
INT RT=.100000		17660400.	37717000.	8304390.	5179857.	13484247.

ALTERNATIVE 9

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
PC SECONDARY	1975	2000000.	456200.	1703227.	6428893.	8132121.
RI IRRIG	1975	2029200.	39000.	1728094.	549599.	2277693.
EXP SECONDARY	1990	475600.	157000.	181425.	870428.	1051853.
EXP IRRIG	1990	512500.	18400.	195501.	102012.	297513.
COLLECTION SYS	1980	7224900.	148300.	4707737.	1550571.	6258308.
COLLECTION SYS	1990	1992600.	39900.	760109.	221211.	981320.
COLLECTION SYS	2020	1306700.	29000.	100013.	0.	100013.
INT RT=.055000		15541500.	34675000.	9376107.	9722714.	19098821.
INT RT=.070000		15541500.	34675000.	8426654.	7440905.	15867559.
INT RT=.100000		15541500.	34675000.	6947241.	4711057.	11658298.

ALTERNATIVE 10

ITEM	DATE	CAPITAL COST	O-M COST	CAP COST PRES WORTH	O-M PRES WORTH	TOTAL PRES WORTH
EXP SECONDARY	1975	1116000.	262800.	950401.	3703448.	4653849.
INCOME-10MGD	1975	0.	-547500.	0.	-7715517.	-7715517.
AS TERTIARY	1990	4889000.	54000.	1864987.	299383.	2164370.
INCOME-4MGD	1990	0.	-730000.	0.	-4047214.	-4047214.
COLLECTION SYS	1980	7224900.	148300.	4707737.	1550571.	6258308.
COLLECTION SYS	1990	1992600.	39900.	760109.	221211.	981320.
COLLECTION SYS	2020	1306700.	29000.	100013.	0.	100013.
INT RT=.055000		16529200.	-25962500.	8383247.	-5988118.	2395128.
INT RT=.070000		16529200.	-25962500.	7202750.	-4346607.	2856143.
INT RT=.100000		16529200.	-25962500.	5460121.	-2511620.	2948502.

APPENDIX C

EVALUATION ANALYSIS OF ALTERNATIVES
CITY OF ODESSA, TEXAS

Appendix C presents an evaluation of the four most viable alternatives with respect to environmental, social, economic, technological, and resource conservation considerations. In order to maintain the time schedule allotted for the study, the investigations of the foregoing features were conducted in a general manner with emphasis on their relation to the overall system evaluation. While detailed studies were not made on the specific features, these items were investigated to a degree that would uphold the integrity of the validity of the alternative evaluation process. The current status of the existing wastewater treatment facility was used as the base condition from which the evaluations were made.

ODESSA, TEXAS

Evaluation Analysis

	ALTERNATIVE 1: Expand existing secondary system in 1975 and 1990. Effluent to be sold to industry or local irrigation operations.	ALTERNATIVE 2: Construct physical/chemical tertiary system by 1975 to produce effluent of such quality that no reuse restrictions are encountered.	ALTERNATIVE 3: Expand existing secondary system in 1975 and 1990. Effluent to be used for spray irrigation.	ALTERNATIVE 4: Expand existing secondary system in 1975 and 1990. Effluent to be used for irrigation by rapid infiltration.
A. Environmental Quality				
1. Water Resource				
a. Effluent Quality	Effluent quality to industry would have BOD and TSS removals of approximately 90%. No eventual discharge would be anticipated.	Removal of BOD/TSS would approach 98%.	Removal of BOD and TSS would approach 100% and would be higher than attainable by other land disposal techniques. High removal of nutrients. Best removal of phosphorus.	Removal of BOD and TSS would approach 100%.
b. Groundwater	Positive potential for recharge. For this alternative, probably will not be used for recharge, instead for industrial reuse.	Positive potential for recharge. For this alternative, probably will not be used for recharge, instead for industrial reuse.	Positive potential for recharge. No detrimental effect due to high quality water.	Positive potential for recharge.
c. Streamflow	No change from existing. No flow to streams.	Increase in streamflow or no change. Depends upon amount of reuse for municipality or industry.	No change from existing. No flow to streams other than small flow from percolation.	No change from existing. No flow to streams other than small flow from percolation.
2. Air Resource				
a. Odors	No odor problems anticipated.	Aerosol potential slight.	No odor problem anticipated.	No odor problem anticipated.
b. Other Sources	Aerosol potential slight.	Carbon regeneration could cause problems.	Aerosol potential slight.	Aerosol potential slight.
3. Land Resource				
a. Land Quality	Land released for other uses.	Land released for other uses.	Increased productivity.	Some increased productivity, but only as secondary benefit.
b. Land Utilization	Small land requirements.	Small land requirements.	Large area requirement. Area committed for long period of time.	Less land requirement than spray irrigation. Additional land released for other uses.

ODESSA, TEXAS

Evaluation Analysis (Cont'd.)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4
A. Environmental Quality (Cont'd.)				
4. Biological				
a. Zoological	Change depends upon use of land not utilized for a land disposal operation.	Change depends upon use of land not utilized for a land disposal operation.	Would change wildlife habitat characteristics. Probably increase species diversity and total number.	Would change wildlife habitat characteristics but impact would be less than spray irrigation due to reduced land requirement.
b. Botanical	Change depends upon use of land not utilized for a land disposal operation.	Change depends upon use of land not utilized for a land disposal operation.	Land requirements could cause destruction of trees, etc. Change species of grasses. Destruction of vegetation during land clearing.	Land requirements could cause destruction of trees, etc. Change species of grasses. Destruction of vegetation during land clearing.
5. Geological	Change depends upon use of land not utilized for a land disposal operation.	Change depends upon use of land not utilized for a land disposal operation.	If land disposal site was within the outcrop of an aquifer, irrigation could affect the rate of recharge.	If land disposal site was within the outcrop of an aquifer, irrigation could affect the rate of recharge.
B. Social				
1. Manpower	No additional manpower requirements.	Additional personnel required. Highly skilled technical personnel may not be available locally.	Additional personnel required. Non-technical for land disposal system locally available.	Additional personnel required. Non-technical for land disposal system locally available.
2. Aesthetics	No problems due to remoteness of plant from populated areas.	No problems due to remoteness of plant from populated areas.	Land disposal site could be used to influence direction of growth —utilized as green belt.	Land disposal site could be used to influence direction of growth —utilized as green belt.
3. Political Acceptability	System presently utilized and accepted.	May not be acceptable because of change in water use patterns and loss of revenue.	Possible objections to increase of city owned land if leasing is not available.	Possible objections to increase of city owned land if leasing is not available.
C. Economic	Existing industrial contract is economically attractive.	May not be acceptable because of change in water use patterns and loss of revenue.	Increased agricultural revenue. Additional employment required. Loss of current industrial sales.	Increased agricultural revenue. Additional employment required. Loss of current industrial sales.

ODESSA, TEXAS

Evaluation Analysis (Cont'd.)

	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4
D. Technology 1. Reliability/ Flexibility	More reliable. Effluent quality not as susceptible to load variations or influent quality.	More flexible. Effluent available directly for many uses.	More reliable. Effluent quality not as susceptible to load variations or influent quality.	More reliable. Effluent quality not as susceptible to load variations or influent quality.
2. Construction Effects	No effect.	Less detrimental because of smaller land requirements.	Construction of land disposal system would disrupt rural community by increasing noise, dust. Extensive destruction of existing vegetation possible.	Construction of land disposal system would disrupt rural community by increasing noise, dust. Extensive destruction of existing vegetation possible.
E. Institutional Arrangements	No change required.	Change could be required to restructure functions and responsibilities of public works departments.	Some change required if city operates land disposal systems. Difficulties could be encountered if city contracts with farmer(s) for operation of irrigation systems.	Some change required if city operates land disposal systems. Difficulties could be encountered if city contracts with farmer(s) for operation of irrigation systems.
F. Resource Conservation	Method optimizes reuse of the water resource.	Chemical requirements would commit large quantities of non-renewable resources.	Large land areas would be committed for many years. Energy requirements are higher than Alternative 4.	Large land areas would be required for many years but not as great as Alternative 3.

AREAWIDE PLAN
FOR
ANDREWS, TEXAS

The City of Andrews, an incorporated home rule municipality, is located in central Andrews County at the intersection of U.S. Highway 385 and S.H. 155, approximately 35 miles north of Odessa, Texas. The incorporated area of the City encompasses approximately 2,100 acres. Andrews, the county seat of Andrews County, is located within the jurisdiction of the PBRPC.

The City has little topographical relief, with elevation variations of approximately 25 feet throughout the City. Sloping eastward, the City is drained by playa lakes. Andrews is underlain by soils of the Amarillo-Brownfield type. This type has a friable, neutral, fine sandy loam to sandy clay loam surface 6 to 15 inches thick, over friable, coarse, prismatic and granular, porous, neutral, sandy, clay loam or light sandy clay. Permeabilities range from 2.0 to 6.3 inches per hour, imposing only slight restrictions on septic tanks and moderate limitations on sewage lagoons.

Population data developed by the TWDB for use in this study indicated that a slight increase in population is expected for Andrews over the next fifty years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	8,625	8,780	8,970	9,070

Land use for Andrews is characterized by residential areas surrounding the commercial area located on the major thoroughfares. This commercial area is large, due to the petroleum marketing center the City has become. Oil fields abound in the periphery of the City and the resultant service industries to petroleum production substantially boost the City's economy through employment and tax revenue. There is also significant agricultural contribution to the City's economy, providing the multifaceted economic base so vital for significant growth. Accessible via three major highways (U.S. 385, and State Highways 175 and 115) and several farm-to-market roads, Andrews also has an airport with commercial service to further provide favorable growth potential, however slight, as population projections indicate.

The municipal water supply consists exclusively of a ground water source drawn by 17 wells with an estimated total yield of 7 mgd. Storage is provided in several ground storage tanks with a total capacity of approximately 1.36 mg, and two elevated reservoirs with a total storage capacity of 0.60 mg. The water supply treatment consists solely of chlorination at the pump station sites. The projected water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections
(in mgd)

	Year 1970	1980	1990	2020
Municipal Use	1.97	2.14	2.24	2.45
Industrial Use	0.23	0.25	0.27	0.31

Municipal wastewater return flows, projected by the TWQB, are as follows:

Waste Load Projections

	Year 1970	1980	1990	2020
Flows in mgd	0.73	0.75	0.76	0.77
BOD in lb/day	1,466	1,580	1,615	1,723
TSS in lb/day	1,725	1,844	1,973	2,086

The existing wastewater collection system is illustrated on Plate PB-1. The existing system, with some minor extensions and replacement as needed, is adequate for present needs and should serve the slight population increase. Existing land-use data indicate two areas of development which are not presently served by the collection system. Immediately north of the city limits adjacent to U.S. 385 is an area of industrial development which can easily be added to the system, and a mile north of that about thirty homes which could possibly be served at a later date. Southeast of town about one-half mile from the existing city limits is an area of approximately fifty residences. Field investigations reveal no immediate plans to annex or serve these areas; however, if service is extended, it could be accomplished by the proposed lines shown. The total project cost for these extensions is estimated to be $70,100, including engineering and contingencies.

The City's existing sewage treatment plant, placed in operation in 1972, is located southeast of town on a 150-acre tract as shown on Plate PB-1. It is an extended aeration type plant with a design capacity of 1.2 mgd, presently handling an average flow rate of 0.80 mgd from a contributing population of approximately 8,000. The plant's components consist of a bar screen, concrete oxidation channel, final clarifier, sludge drying beds, chlorination facilities, flow measurer, seven lagoons, and a storage tank for irrigation-destined effluent. Dried sludge disposal is by sanitary landfill, while effluent is temporarily detained in storage to be used in daily irrigation of the municipal golf course. The treatment plant is in excellent condition and well maintained. Available sampling data published by the TWQB indicate the treatment levels to be excellent.

Although no significant industrial waste contribution exists now, a vacuum cleaner plant served by City facilities is to undertake an aluminum casting process that will produce waste that will require significant pretreatment before discharging into the municipal sewage system.

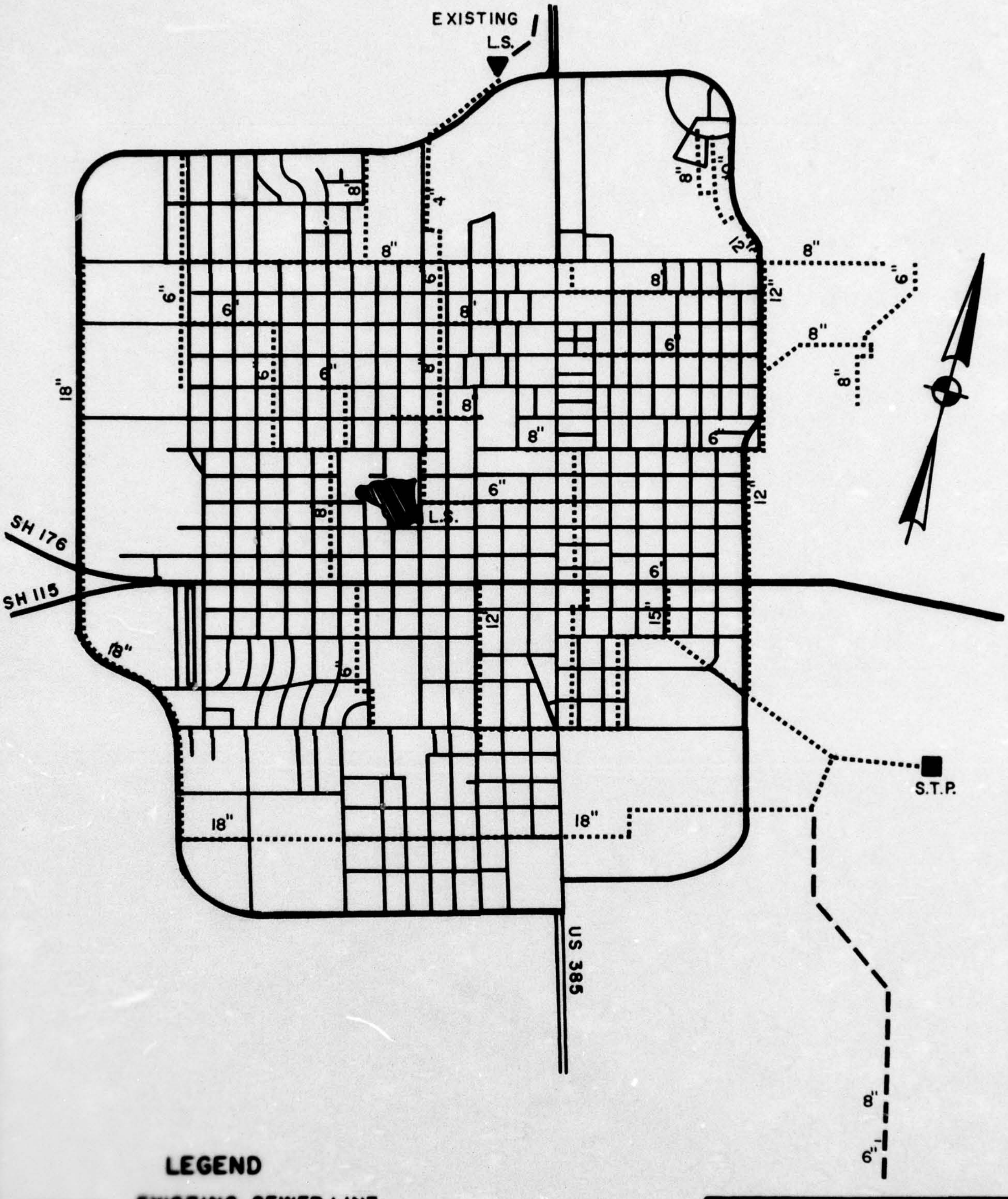
Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of wastewater by 1977 and the best practicable waste treatment technology by 1983. Under the present interpretation of this law, land disposal of effluent meets all requirements of the law so long as the disposal is carried out in an approved manner, and so long as no effluent is discharged into the surface or ground water resource either directly, as runoff, or by direct percolation.

Considering the value of water in the Andrews area and the present status of the City's land disposal facilities, this method of wastewater treatment is highly desirable so long as it is applied in a manner approved by the TWQB, the TSDH, and the EPA. In the semi-arid High Plains region, land disposal of wastewater provides a valuable reuse of a limited resource and can greatly enhance the local environment until local economics dictate a greater need for this water source.

It is therefore recommended that the aforementioned no-discharge plan be continued. However, should the City of Andrews wish to implement a discharge plan, the following items would be required:

1. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $307,000, including engineering and contingencies.

2. By 1985, construct tertiary treatment facilities, including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $270,000, including engineering and contingencies.



LEGEND

EXISTING SEWER LINE

PROPOSED SEWER LINE

MAJOR COLLECTORS ARE SHOWN

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

ANDREWS, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 2000'	PLATE: PB-1

AREAWIDE PLAN
FOR
LAMESA, TEXAS

The City of Lamesa is an incorporated, home rule municipality located in the center of Dawson County at the intersection of U.S. Highways 87 and 180, approximately 45 miles northwest of Big Spring, Texas. The incorporated area of the City encompasses approximately 5,200 acres. Lamesa is the county seat of Dawson County and is located within the jurisdiction of the PBRPC.

The City has moderate topographic relief and is drained by playa lakes and Sulphur Springs Draw. The northern part of Lamesa drains into playa lakes. While the central portion drains into Sulphur Springs Draw from the northeast, the southern portion drains into the same draw from the southwest. The City is underlain by Amarillo fine sandy loam and Mansker-Potter soil types. The Amarillo soil has a friable, neutral, fine, sandy loam to sandy clay loam surface, 6 to 15 inches thick, over friable, coarse, prismatic and granular, porous, neutral, sandy, clay loam or light sandy clay. Permeabilities range from 0.63 to 2.0 inches per hour, imposing slight limitations on septic tanks and moderate limitations on sewage lagoons. The Mansker-Potter soils have a friable loam to clay loam surface, over friable, granular, clay loam, sometimes underlain by semi-hard caliche several feet thick. Permeabilities range from 0.20 to 0.63 inch per hour. There are severe limitations on septic tanks due to the permeability and severe limitations on sewage lagoons due to the presence of the caliche layer.

Population data developed by the TWDB for use in this study indicate a moderate decrease in population is expected for Lamesa over the next fifty years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	11,559	10,910	10,270	7,940

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural, with industrial contribution consisting mainly of processing plants for agricultural products. There is some contribution from local oil field activity. Accessible by two U.S. highways and a State highway, the City is served by the Atchison, Topeka, and Santa Fe Railroad and by an airport suitable for commuter service to nearby metropolitan areas.

The municipal water supply, obtained from ground water sources, is drawn by fifteen wells with a total maximum capacity of 4.3 mgd. The City also obtains water from the Canadian River Municipal Water Authority. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections
(in mgd)

	Year 1970	1980	1990	2020
Municipal Use	1.34	1.42	1.41	1.28
Industrial Use	0.01	0.01	0.01	0.02

Municipal wastewater return flows, projected for the City by the TWQB, are as follows:

Waste Load Projections

	Year 1970	1980	1990	2020
Flows in mgd	0.98	0.93	0.87	0.67
BOD in lb/day	1,965	1,964	1,849	1,509
TSS in lb/day	2,312	2,291	2,259	1,826

The existing wastewater collection system is illutrated on Plate PB-2. The existing system is apparently adequate to meet present needs, and with minor extensions and replacement as needed, should meet the future needs of the declining population. Existing land use indicates there are three areas of town in which septic tanks are still the primary means of sewage disposal. These areas are those served by the proposed lines on Plate PB-2, although the City has no immediate plans to extend service to these areas. It is estimated the total project cost to serve these areas would be approximately $87,400, including engineering and contingencies.

The sewage treatment plant is also shown on the Plate as south of town on the bank of Sulphur Springs Draw. The plant is of the trickling-filter type and consists of a lift station, comminutor, primary clarifier, high-rate trickling filter, final clarifier, chlorination facilities, seven oxidation ponds, a sludge digester, sludge drying beds, and a gas burner. Sludge can be recycled from the final clarifier to the head of the plant. The plant was constructed in 1963 and has been maintained in excellent physical condition. It was designed for a flow of 1.84 mgd and presently serves about 11,400 people as estimated by the TWQB. At 85 gallons per capita per day, the theoretical present load on the plant would be 1.105 mgd, which is well under the load for which the plant was designed. Available sampling data published by the TSDH and the TWQB are as follows:

Influent-Effluent Data (mg/1)

	TSDH (1970)	TWQB (1969)
Raw BOD	380	360
Raw TSS	340	116
Final BOD	45	35
Final TSS	24	10

Lamesa has three slaughterhouses which discharge into the City's sanitary sewers without significant pretreatment. This could be the cause of the high readings for influent BOD 5.

Effluent is not discharged from the oxidation ponds; it is used to irrigate two golf courses and two City parks. This irrigation water is used whenever necessary, regardless of season, in order to insure that no wastewater will be discharged. Dried sludge is used as fill.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of wastewater by 1977 and the best practicable waste treatment technology by 1983. According to the present interpretation of this law, land disposal of effluent as practiced by the City of Lamesa meets all requirements when the disposal is executed in an approved manner and when no effluent is introduced directly into the surface or ground water resources either by runoff or percolation without adequate treatment time.

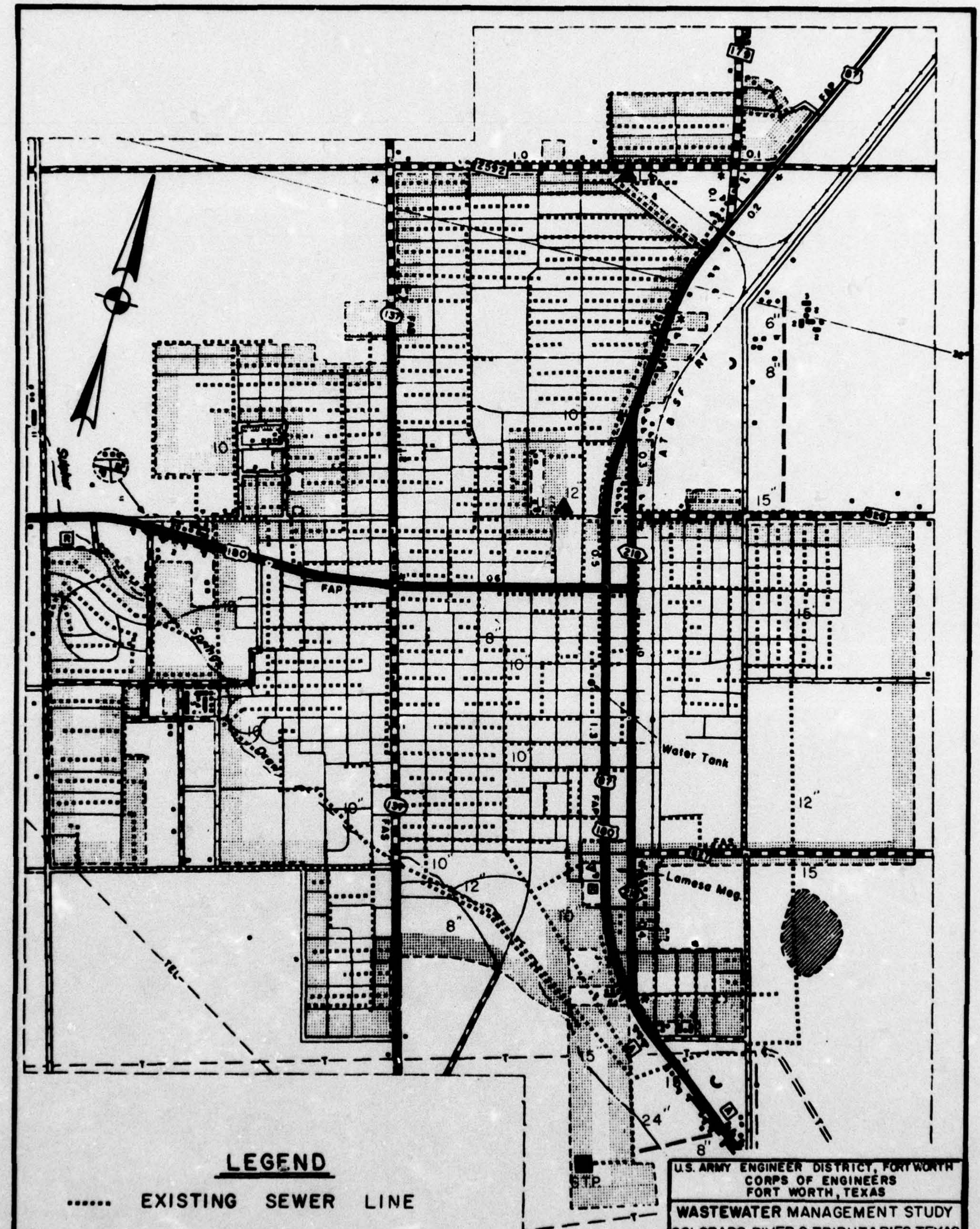
Considering the value of water in the area around Lamesa and the investment made by the City in its present land disposal facilities, the present method of wastewater treatment and disposal should be continued so long as it is carried out in a manner approved by the TWQB and the EPA. In the semi-arid High Plains region, land disposal of wastewater can greatly enhance the local environment until local economics dictate a greater need for this water source. It is suggested the City consult with the TSDH and the TWQB in regard to their possible recommendations as to rechlorination of effluent prior to irrigation on areas accessible to the public, and take all necessary steps to insure safe operation.

It is therefore recommended that the aforementioned no-discharge plan be continued. However, should the City of Lamesa wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility of the activated-sludge type at an approximate capital cost of $627,500, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $343,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities, including total filtration, denitrification, and further phosphorus reduction facilities at an approximate capital cost of $244,000, including engineering and contingencies.


LEGEND
EXISTING SEWER LINE
PROPOSED SEWER LINE
NOTE: UNMARKED LINES ARE 6" OR 8"
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
LAMESA, TEXAS
TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR
SCALE: 1" = 2000'
PLATE: PB-2
Water Tank
Lamesa Mem.
STP
FAP
TEL
15"
12"
10"
24"
8"
6"

AREAWIDE PLAN
FOR
GOLDSMITH, TEXAS

The City of Goldsmith is an incorporated, general law municipality located in the northwest quadrant of Ector County at the intersection of S.H. 158 and F.M. 866, approximately 20 miles northwest of Odessa, Texas. The incorporated area of the City encompasses approximately 200 acres. Goldsmith is located within the jurisdiction of the PBRPC.

The City has moderate topographical relief and is drained by numerous playa lakes. The town varies in elevation approximately 50 feet and drainage is generally in a southeasterly direction. The City is predominantly underlain by soils of the Kimbrough and Stegall types. The Kimbrough-Stegall soils generally have a brown, friable, clay loam surface, 2 to 10 inches thick. Underlying the loam is hard rock-like caliche at depths of 10 to 36 inches beneath the surface. Permeabilities range from 0.2 to 0.63 inch per hour. Septic tanks have severe limitations due to the shallow depth of the hard caliche.

Population data developed by the TWDB for use in this study indicate that a slight increase in population is expected for Goldsmith ovver the next fifty years. Those population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	387	370	380	400

These projections are representative of only the population within the present city limits which would remain quite static, as shown, were it not for the effect of a nearby population concentration and the impact sanitary service availability could have on municipal growth. According to local officials, oil field activity has created a concentration of approximately 100 homes one-half mile west of the present city limits. Some interest has been shown by this area to enter the jurisdiction of the City, and intense interest has been shown to obtain sanitary service should Goldsmith construct a system. This satellite population must therefore be considered in the overall population of the City.

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural, with some contribution from a large, active oil field near the City and from a sizable gasoline plant to the east. The City is accessible by two U. S. highways but has no rail service. Anticipated growth potential for Goldsmith is fair due to its proximity to Odessa, Texas. It is felt by local officials that due to this proximity, availability of sanitary service will encourage migration to Goldsmith by Odessa residents who are now discouraged by the cost of septic tank installation.

The municipal water supply, obtained from ground water sources, is drawn by six wells, two with capacities of 30 gpm and the remainder with capacities of 20 gpm. Storage is provided by two slightly elevated reservoirs with capacities of 0.0105 mg, a ground reservoir with 0.21 mg capacity, and a pressure reservoir with a capacity of 0.003 mg. The anticipated water use, a reflection of the population trend without the aforementioned growth factors, has been projected by the TWDB to be as follows:

Water Use Projections (in mgd)

	Year			
	1970	1980	1990	2020
Municipal Use	0.05	0.05	0.05	0.05
Industrial Use	None	None	None	None

Municipal wastewater return flows projected for the City by the TWQB are as follows. These projections again are exclusive of the growth factors mentioned.

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flows in mgd	0.03	0.03	0.03	0.03
BOD in lb/day	66	67	68	76
TSS in lb/day	77	78	84	92

Presently, Goldsmith has neither sewage collection nor wastewater treatment facilities. The proposed collection system shown on Plate PB-3 would serve the inhabited area indicated in a 1965 land-use survey. The cost of the proposed collection system is estimated to be $271,900, which includes 5,400 feet of 6-inch and 19,300 feet of 8-inch line. With only minor extensions and expansions as needed, the proposed collection system would be adequate through the planning period.

The City has under consideration a preliminary design report for a proposed extended aeration "race track" treatment plant with a capacity of 0.08 mgd. Although population and waste load projections accomplished for this study would not justify construction of a 0.08-mgd facility at this time, the capacity appears justified in light of the anticipated contribution mentioned above. It should be noted that by the nature and economics of the activated-sludge treatment methods, the extended aeration process is not as efficient as the contact-stabilization process in the range of 0.08 mgd. Further, initial construction of a "race track" type facility to that capacity would not allow a process change as the waste load increased, as would other modular-type facilities.

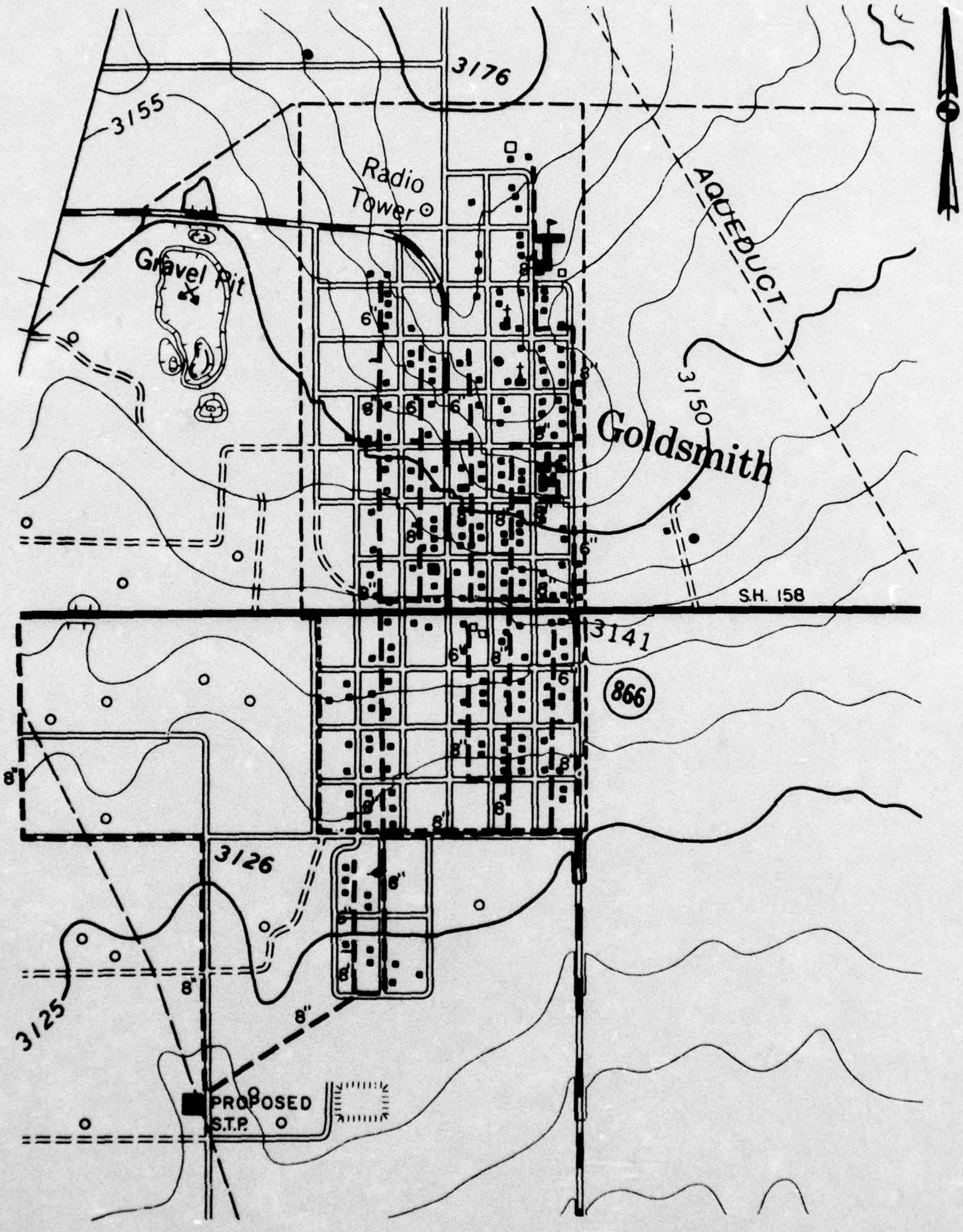
Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of wastewater by 1977 and the best practicable waste treatment technology by 1983. A secondary treatment plant which the City presently has under consideration will meet the 1977 requirements of the law; however, the preliminary design calls for disposal of the secondary effluent by evaporation and percolation from lagoons. Evaporation is an acceptable, although expensive and wasteful means of disposal, but continuous percolation will probably not be acceptable due to ground water contamination possibilities. In addition, at the average net evaporation rate of 70 inches per year for the Goldsmith area, the total pond surface area of 5.75 acres would be needed for total evaporation of effluent instead of the 2.5 acres proposed in the preliminary report. As an alternative to evaporation, disposal of secondary effluent by irrigation is acceptable under the present interpretation of the law when the disposal is executed in a manner which does not allow effluent to enter directly into a surface or ground water source without adequate treatment. In the case of Goldsmith, with its arid climate, such disposal would probably involve only negotiation of a contract with local farmers to insure dependable year-round operation. The value of the effluent for irrigation or other uses cannot be ignored in such an arid region. It is therefore proposed that the City consider a contact stabilization unit of 0.08-mgd capacity unless the extended aeration mode can be justified locally. The estimated cost of this secondary treatment facility is $103,700, including engineering and contingencies. A lined one-acre holding pond would be required to provide 60 days storage prior to irrigation. The estimated cost of this holding pond is $17,600, including engineering and contingencies.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Goldsmith wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a 0.08-mgd conventional secondary treatment facility at an approximate capital cost of $103,700, including engineering and contingencies.

2. By 1983, construct total filtration, phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $72,400, including engineering and contingencies.

3. By 1985, construct denitrification and further phosphorus reduction facilities at an approximate capital cost of $58,000, including engineering and contingencies.



LEGEND

— — — PROPOSED SEWER LINE

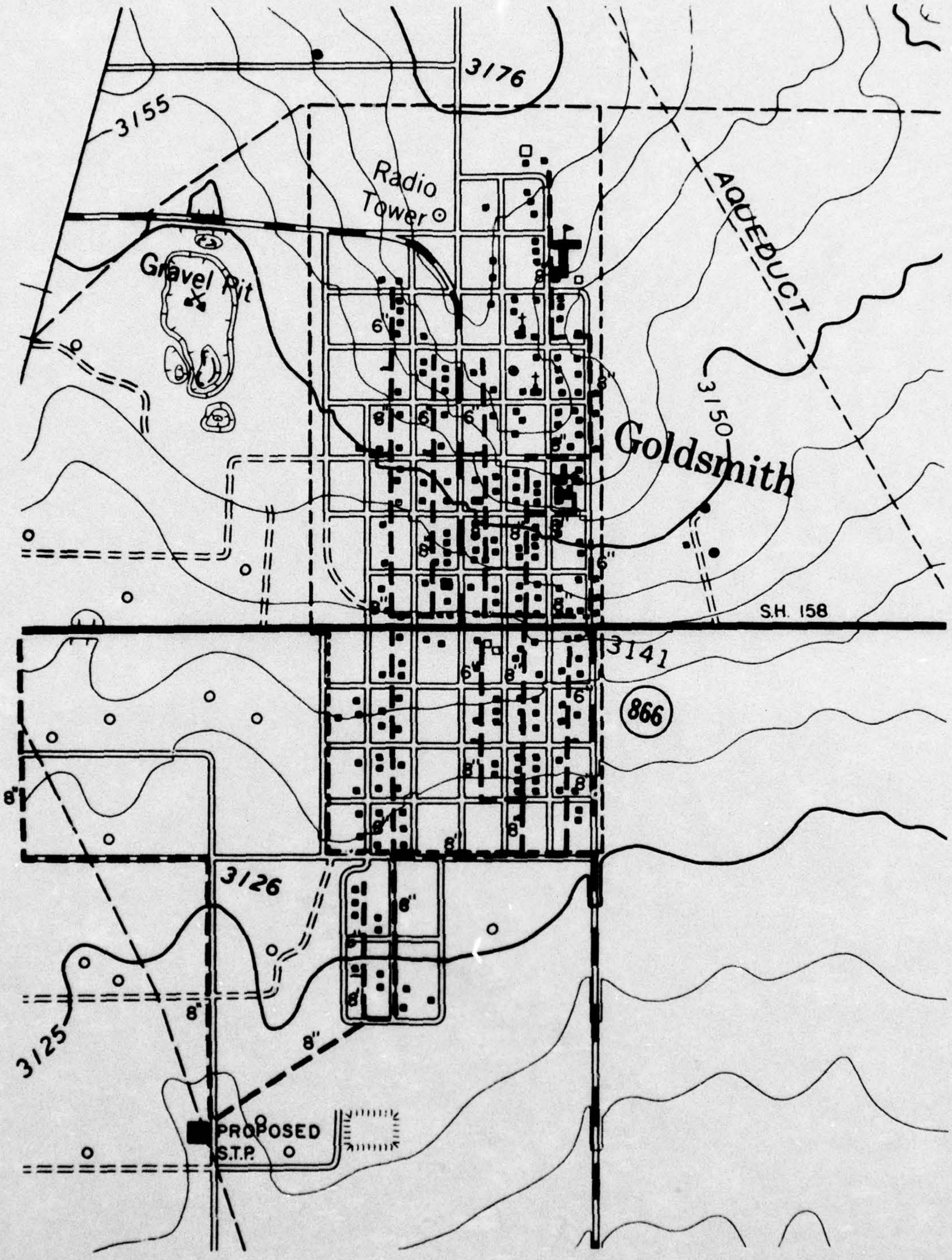
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

GOLDSMITH, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 1000' | PLATE: PB-3



LEGEND

PROPOSED SEWER LINE

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

GOLDSMITH, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 1000'	PLATE: PB-3

AREAWIDE PLAN
FOR
SEAGRAVES, TEXAS

The City of Seagraves is an incorporated, general law municipality located in the north-central portion of Gaines County at the intersection of U.S. 385 and S.H. 83 approximately 65 miles southwest of Lubbock, Texas. The incorporated area of the City encompasses approximately 950 acres. Seagraves is within the jurisdictional boundaries of the PBRPC.

The City has very little topographic relief. Drainage for the City is generally in a southeasterly direction and into numerous small playa lakes. The City is underlain by soils of the Amarillo-Brownfield and Arvana types. These soils generally have a friable, neutral, fine, sandy loam to sandy clay loam surface, 6 to 15 inches deep, over a several feet thick layer of reddish-brown, friable, sandy, clay loam. The southwest edge of Seagraves is underlain by a thin layer of Arvana fine sandy loam over indurated caliche. Permeabilities range from 0.63 to 2.0 inches per hour. In most parts of Seagraves, soil conditions pose no limitations on septic tanks, but sewage lagoons have moderate limitations due to the high permeability.

Population data developed by the TWDB for use in this study indicate that a decrease in population is expected for Seagraves over the next fifty years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	2,440	2,280	2,250	1,860

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural, with some contribution from local oil field activity. Industrial contribution to the economy consists of petroleum and carbon black plants. Accessible by a U.S. highway and a State highway, Seagraves is served by a branch line of the Panhandle and Santa Fe Railroad.

The municipal water supply, solely obtained from ground water sources, is drawn by six wells: two with capacities of 300 gpm, two with capacities of 450 gpm, one with a 350-gpm capacity, and one with a 250-gpm capacity. Storage is provided by a standpipe reservoir with a 0.09-mg capacity, two elevated reservoirs with capacities of 0.15 mg, 0.050 mg, and three ground reservoirs with capacities of 0.50 mg, 0.17 mg, and 0.12 mg. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections
(in mgd)

	Year			
	1970	1980	1990	2020
Municipal Use	0.37	0.35	0.34	0.28
Industrial Use	None	None	None	None

Municipal wastewater return flows, projected for the City by the TWQB are as follows:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flows in mgd	0.21	0.19	0.19	0.16
BOD in lb/day	415	410	405	353
TSS in lb/day	488	479	495	428

The existing wastewater collection system for Seagraves is shown on Plate PB-4. According to land-use information available from "The Seagraves Plan" and from data obtained through field investigations, the developed areas of town are generally served by the system, except for one area southeast of the railroad tracks which is a mixed residential-industrial tract. Although the City has no immediate plans to extend service to the area, the proposed line shown on Plate PB-4 would serve the area at an estimated cost of $38,400, including engineering and contingencies. Some scattered residences still utilize septic tanks, but minor extensions of the existing laterals would service all of them. Considering the slow decline in population projected for Seagraves, the existing collection system should be adequate through the planning period, with minor extension and repair as needed.

The existing sewage treatment plant for the City of Seagraves is located east of town as shown on Plate PB-4. The plant, serving 2,400 people, was expanded and altered in 1967 to an extended aeration "race track" type facility with a design capacity of 0.35 mgd. The unit consists of a bar screen, Parshall flume with flow recorder, oxidation channel, clarifier (converted Imhoff tank), sludge drying beds, and five oxidation ponds. Available sampling data published by the TSDH are as follows:

Influent-Effluent Data (mg/1)

	TSDH 1/27/72
Raw BOD	120
Raw TSS	130
Final BOD	15
Final TSS	27

The plant is in good physical and operating condition except for the modified Imhoff tank being used for a clarifier. Effluent from the ponds is used for irrigation of private farmland, and sludge is used for onsite landfill.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of wastewater by 1977 and the best practicable waste treatment technology by 1983. According to the present interpretation of the law, land disposal of effluent meets all requirements when the disposal is executed in an approved manner and when no effluent is directly discharged into the surface or ground water resources as runoff or by perolation without adequate treatment time. Considering the high value of water in the Seagraves area, disposal of effluent by irrigation appears to fulfill all requirements when it is executed in a manner approved by the State and Federal agencies concerned.

To meet the present requirements, Seagraves would need to initiate a few minor changes in its present method of treatment and disposal. These changes include:

1. Modification of the existing Imhoff tank to insure proper clarification of the effluent or replacement with a primary clarifier and digestion facilities. Replacement costs would be $275,900, including engineering and contingencies, with $17,600 per year for operation and maintenance.

2. Organization of the irrigation practices under contract to insure dependable year-round operation.

In the semi-arid High Plains region, the use of effluent for irrigation can greatly enhance the local environment, in addition to providing a dependable source of valuable water.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Seagraves wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility of the contact-stabilization type at an approximate capital cost of $252,210, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen reduction facilities at an approximate capital cost of $122,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities, including total filtration, denitrification and further phosphorus reduction

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WASTEWATER MANAGEMENT PLAN. COLORADO RIVER AND TRIBUTARIES, TEX--ETC(U)
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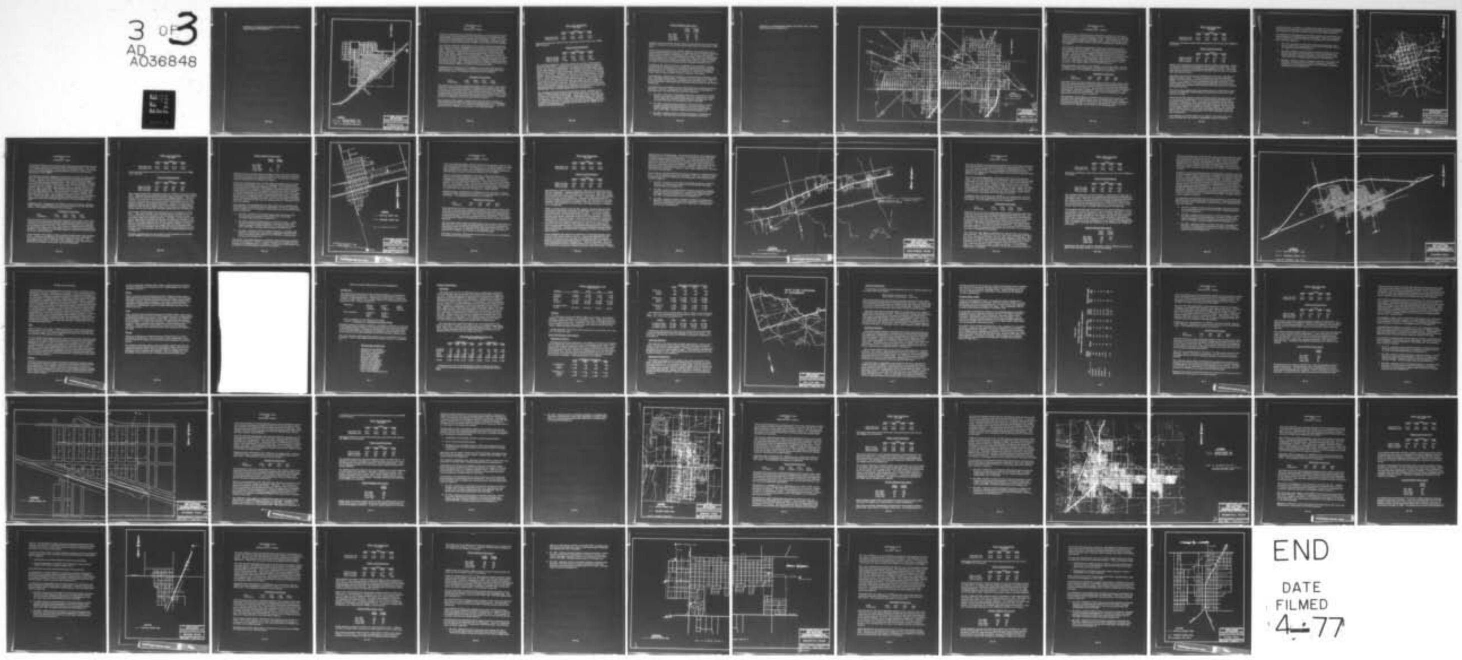

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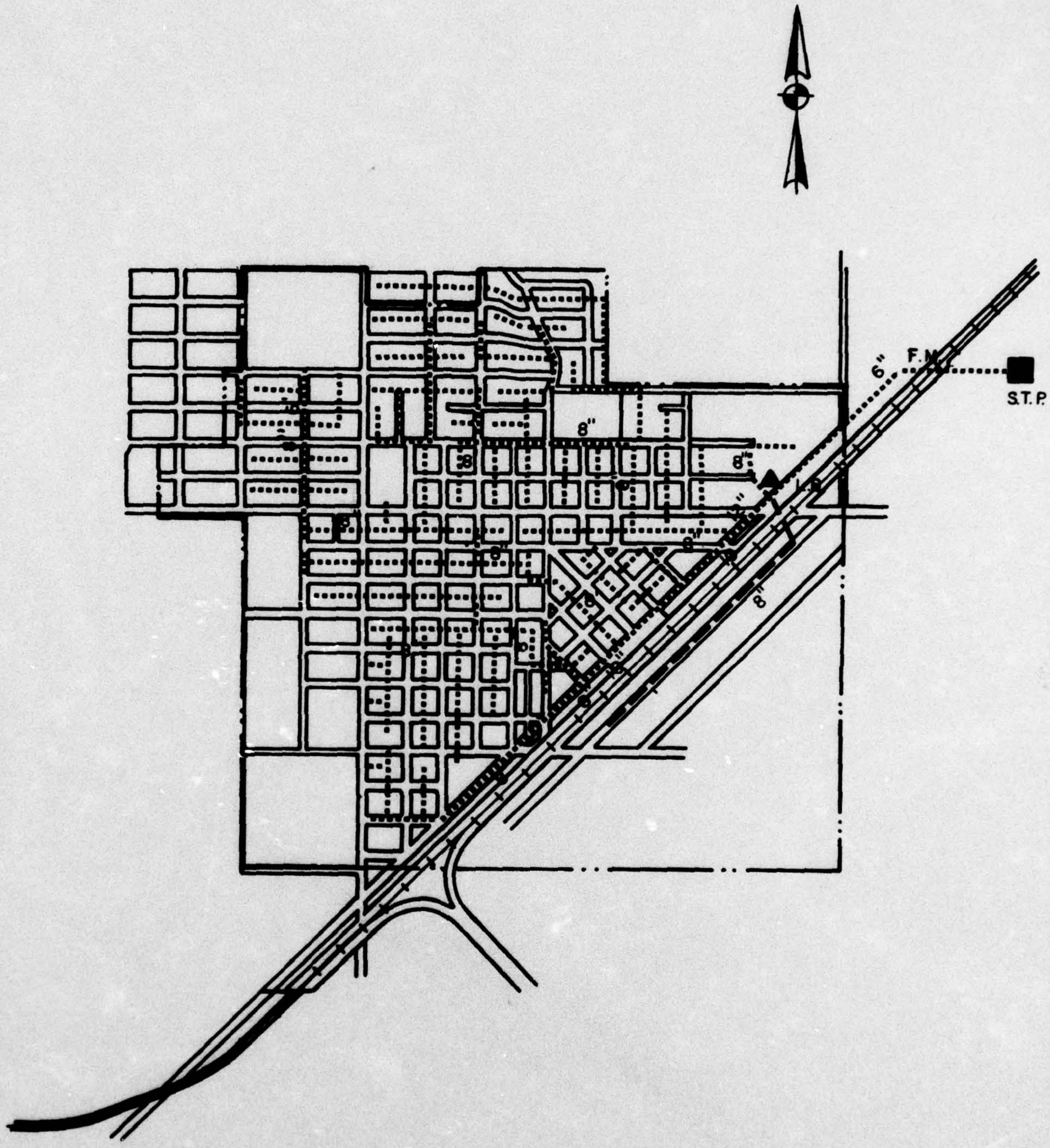
facilities at an approximate capital cost of $84,000, including engineering and contingencies.



LEGEND

•••••••••••••• EXISTING SEWER LINE

— — — — PROPOSED SEWER LINE

NOTE: ALL UNLABELED LINES ARE 6".

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

SEAGRAVES, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 1000' | PLATE: PB-4

AREAWIDE PLAN
FOR
SEMINOLE, TEXAS

The City of Seminole is an incorporated, home rule municipality located in the center of Gaines County at the intersection of U.S. Highways 62, 180 and 385, approximately 60 miles north of Odessa, Texas. The incorporated area encompasses approximately 1,250 acres. Seminole is the county seat of Gaines County and is within the jurisdiction of the PBRPC.

The City has moderate topographical relief and is drained by Wordswell Draw and playa lakes. Drainage to the west and south is provided by the draw, and to the east by the slope of the land into several small playa lakes. The City is underlain by soils of the Simona, Kimbrough, and Brownfield types. These soils are characterized by a brown, friable, fine, sandy loam surface, 6 to 12 inches thick. Underlying the loam is hard, platy caliche. Surface permeabilities range from 1.0 to 2.0 inches per hour, and thus septic tanks would have only slight limitations in the surface soils alone. The underlying caliche, however, greatly interferes with septic tank drainage. Sewage lagoons have moderate limitations due to the moderately-rapid permeability of the surface soils.

Population data developed by the TWDB for use in this study indicate a slight increase, culminating in a moderate decrease in population over the next fifty years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	5,007	5,130	5,230	5,080

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural, with some contribution from local oil field activity. The industrial contribution is derived from petrochemical plants. Accessible by two U.S. highways, the City is served by an airport.

The municipal water supply, obtained from ground water sources, is drawn from eleven wells with a total well pumping capacity of 6,605 gpm. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as shown on the following page.

Water Use Projections
(in mgd)

	Year 1970	1980	1990	2020
Municipal Use	1.02	1.04	1.06	1.04
Industrial Use	None	None	None	None

Municipal wastewater return flows, projected for the City by the TWQB are as follows:

Waste Load Projections

	Year 1970	1980	1990	2020
Flows in mgd	0.43	0.44	0.44	0.43
BOD in lb/day	851	923	941	965
TSS in lb/day	1,001	1,077	1,151	1,168

The existing wastewater collection system for the City of Seminole is shown on Plate PB-5. It appears from land-use information supplied by the City that the existing system is adequate for present needs with some minor extension and repair. Two areas of town still utilize septic tanks as the primary means of sewage disposal, but both are outside the present city limits. Although the City has no immediate plans to extend service, these areas are shown as served by the proposed lines on Plate PB-5. The area northwest of town along the draw would be quite expensive to serve, since a lift station would be required. Fortunately, this is the one area of town where the soils are sandy and deep enough for septic tanks to function properly. Should the City decide to extend service to the northwest areas, the estimated cost would be $70,900 including engineering and contingencies; estimated cost to serve the south area would be $21,500, including engineering and contingencies.

The existing treatment plant is located east of town, as shown on the Plate. Constructed about 1948 with a stated capacity of 0.52 mgd, it currently serves about 5,000 people. Treatment units consist of a bar screen, two Imhoff tanks in parallel, sludge drying beds, open ditches for oxidation, and a 38-acre playa lake for effluent disposal. Effluent is drawn from the lake by a private operator for use as irrigation water. Available sampling data, published by the TSDH and the TWQB are as shown on the following page.

Influent-Effluent Data (mg/l)

	TSDH (1972)	TWQB (1968)
Raw BOD	170	210
Raw TSS	130	258
Final BOD	65	50
Final TSS	34	77

Seminole has no industrial wastes which are discharged into the municipal sewers, and there are no other permitted discharges of wastewater in the area.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of wastewater by 1977 and the best practicable waste treatment technology by 1983. According to the present interpretation of this law, land disposal of effluent meets all requirements when the disposal is executed in an approved manner and when no effluent is discharged into the surface or ground water resource either directly, as runoff, or by direct percolation without adequate treatment time.

Considering the value of water for irrigation in the Seminole area and the potential for expansion of the existing irrigation facilities, land disposal can meet all anticipated requirements for wastewater disposal in the Seminole area. There is need, however, to renovate the existing Imhoff tanks to insure proper primary treatment in the plant.

Land disposal of effluent by irrigation is a sound economic practice in the semi-arid High Plains region. It enhances the otherwise dry environment and is generally accepted by the residents of the Seminole area. Such practice should be encouraged until a greater need develops for the treated wastewater.

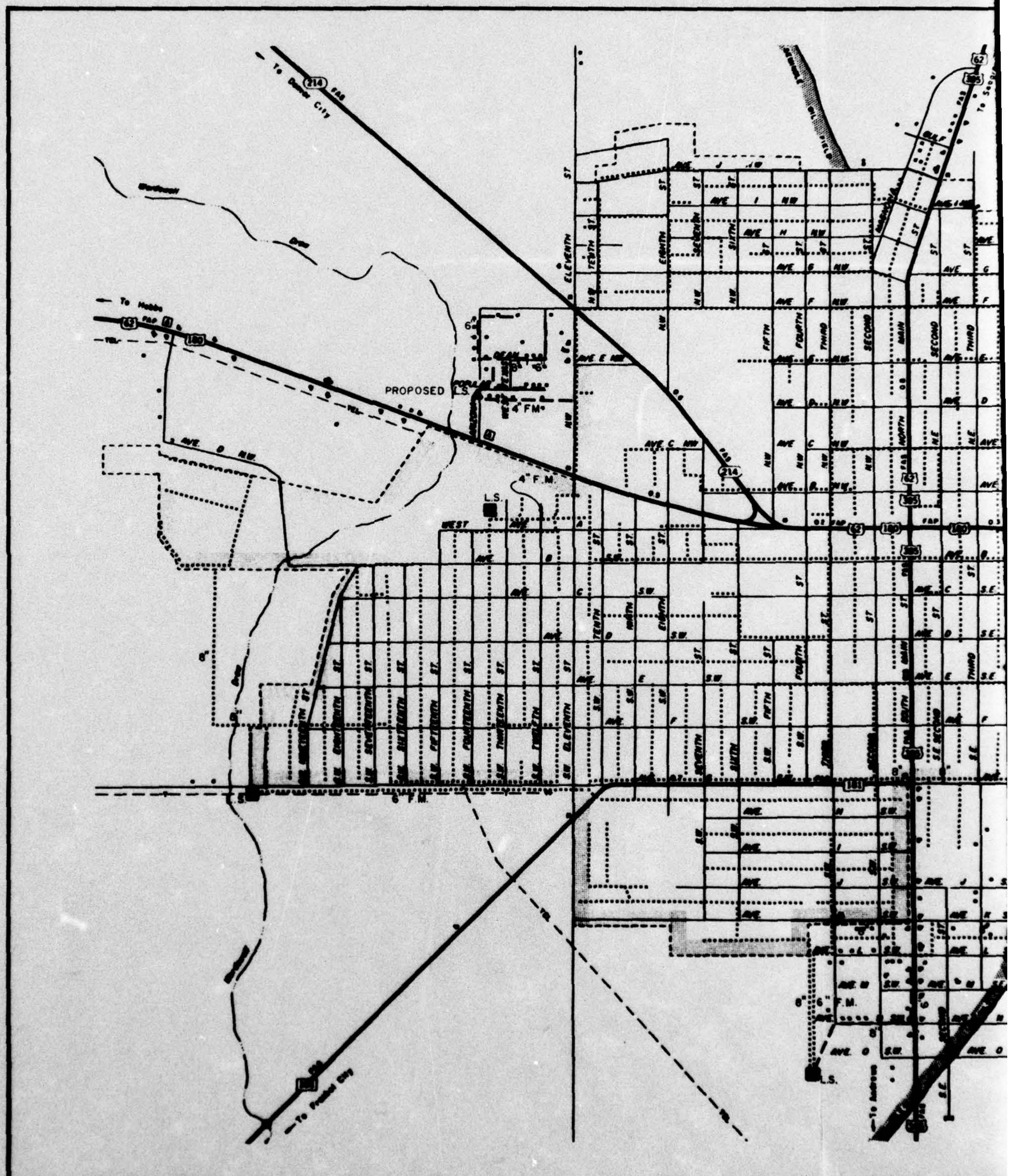
It is therefore recommended that the aforementioned no-discharge plan be continued. However, should the City of Seminole wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a 0.50-mgd conventional secondary treatment facility of the contact-stabilization type at an approximate capital cost of $358,500, including engineering and contingencies, with an annual operation and maintenance cost of $29,000.

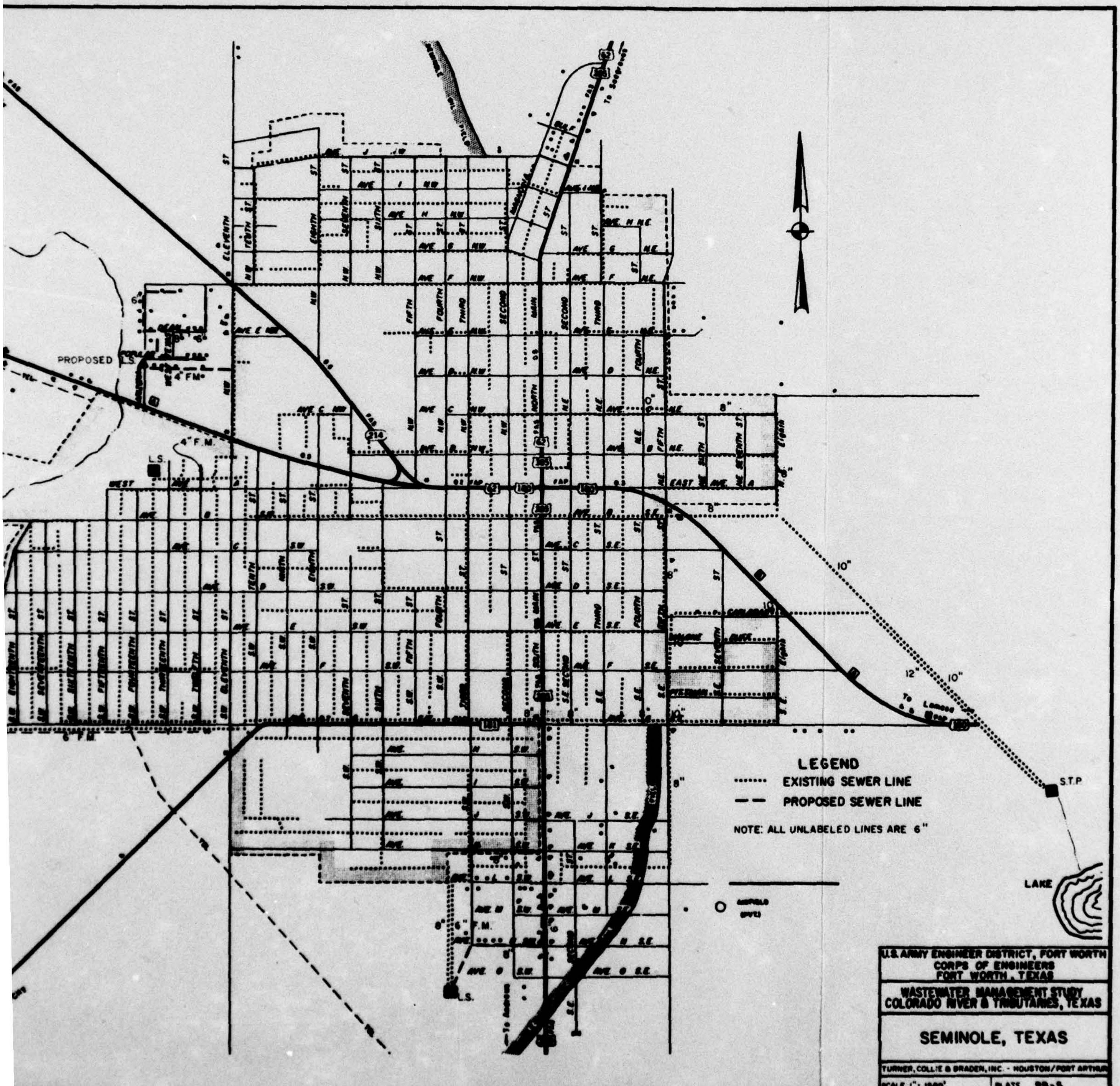
2. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $182,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction

facilities at an approximate capital cost of $141,000, including engineering and contingencies.



To Hobbs
PROPOSED L.S.
4" FM
4" F.M.
L.S.
6" F.M.
6" F.M.
L.S.
ELEVENTH ST
AVE. C NW
AVE. O NW
WEST


PROPOSED L.S.
L.S.
S.T.P.
LAKE
To Seagraves
To Lamesa
LEGEND
EXISTING SEWER LINE
PROPOSED SEWER LINE
NOTE: ALL UNLABELED LINES ARE 6"
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
SEMINOLE, TEXAS
TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR
SCALE 1" = 1600'
PLATE PB-5

2

AREAWIDE PLAN
FOR
GARDEN CITY, TEXAS

Garden City is an unincorporated municipality located in the center of Glasscock County at the intersection of S.H. 158 and F.M. 33, approximately 40 miles southeast of Midland, Texas. The inhabited area of the City encompasses approximately 250 acres. Garden City is the county seat of Glasscock County and is within the jurisdictional boundaries of the PBRPC.

The City has moderate topographical relief and is drained by a draw which drains into Lacy Creek. The general direction of drainage is to the southeast into the draw, which runs north-south on the east side of the City. The City is predominantly underlain by soils of the Ector, Rowena, and Mereta types. These soils generally have a brownish-gray, friable, calcareous, gravelly or stony, loam surface, 3 to 12 inches thick, over limestone. Permeabilities range from 0.63 to 2.0 inches per hour. Both septic tanks and sewage lagoons have severe restrictions due to the shallow depth of the limestone bedrock.

Population data, developed by the TWDB for use in this study, indicate a moderate increase in population is expected for Garden City over the next fifty years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	286	330	400	600

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural, with some contribution from local oil field activity. There is no known industrial contribution. The City is accessible by a State highway but is not served by a railroad.

The municipal water supply is obtained from ground water sources, specifically from individual privately-owned wells and from three wells owned by the school district which serve the school and eleven residences. The projected water use, a reflection of the population trend, has been projected by the TWDB, and is shown on the following page.

Water Use Projections (in mgd)

	Year 1970	1980	1990	2020
Municipal Use	0.02	0.02	0.04	0.06
Industrial Use	None	None	None	None

Municipal wastewater return flows projected for the City by the TWQB are as follows:

Waste Load Projections

	Year 1970	1980	1990	2020
Flows in mgd	0.02	0.03	0.03	0.05
BOD in lb/day	49	59	72	114
TSS in lb/day	57	69	88	138

Garden City presently has no publicly-owned treatment facilities. Domestic sewage is handled by individual private systems, mostly septic tanks, and there are no permitted industrial discharges in the area. Due to the arid climate and types of agriculture involved, there is little or no significant agricultural runoff.

The soils in the area seem to be unsuitable for the proper operation of septic tank filter fields. The Ector and Mereta soils are extremely shallow over hard caliche, and the Rowena soils have very low permeabilities. In the light of these conditions and keeping in mind the anticipated growth of the town, it appears that Garden City will need to construct wastewater collection and treatment facilities at some time during the planning period.

The cost of the proposed collection system shown on Plate PB-6 is estimated to be $209,500, which includes 8,400 feet of 6-inch and 11,200 feet of 8-inch line.

Under PL 92-500, publicly-owned treatment works must provide secondary treatment of wastewater by 1977, and the best practicable waste treatment technology by 1983. According to the present interpretation of this law, Garden City could meet all requirements of the law by construction of conventional secondary treatment facilities and then using the secondary effluent to irrigate surrounding cropland. The estimated cost for construction of a 0.03-mgd conventional secondary treatment facility and a one-acre holding pond is $14,700, including engineering and contingencies.

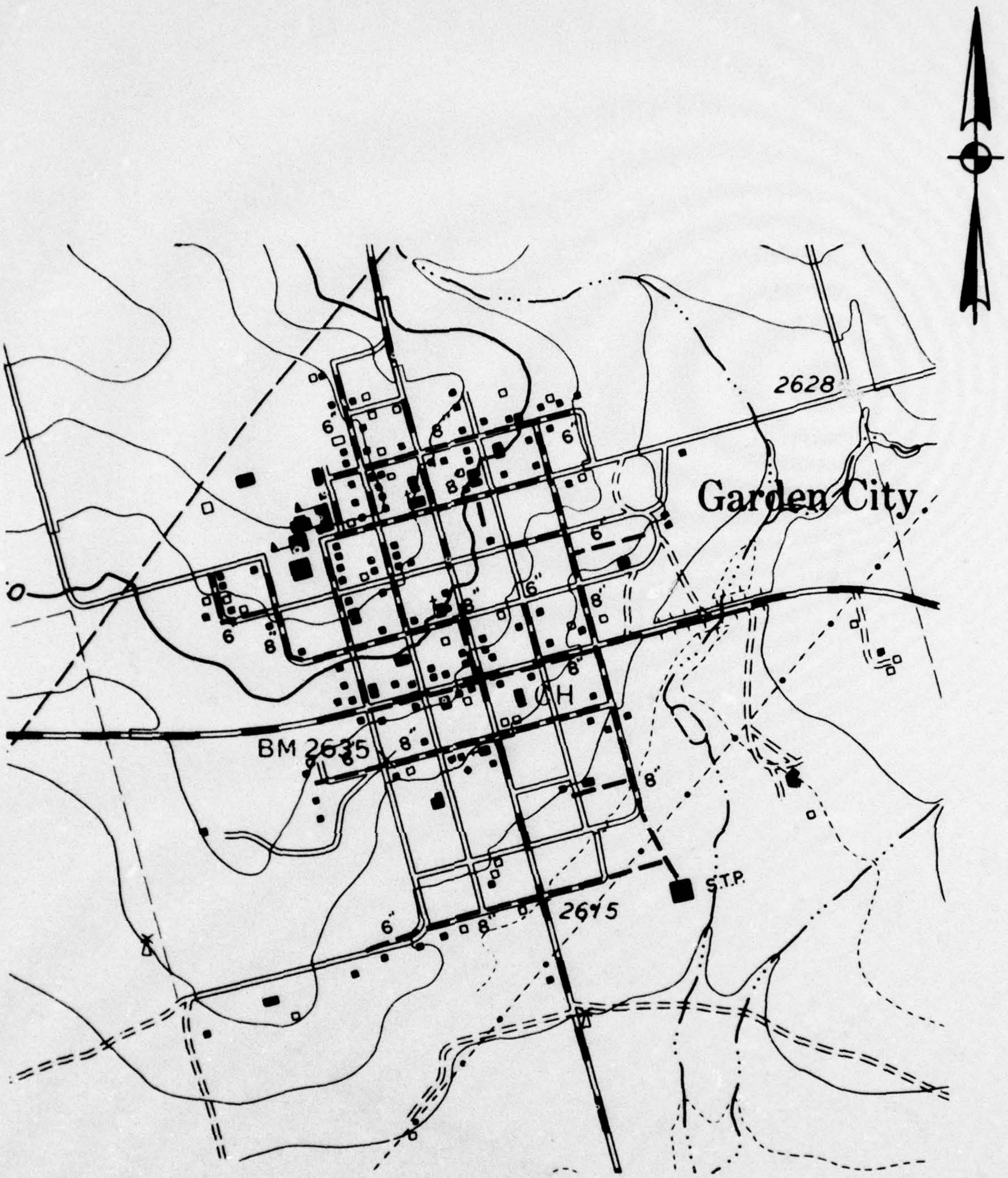
Land disposal of treated effluent by irrigation in the semi-arid area around Garden City can provide a dependable source of valuable irrigation water, in addition to enhancing the otherwise dry environment. Such practice is generally accepted in surrounding regions and should be encouraged until a greater need develops for the treated wastewater.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Garden City wish to implement a discharge plan the following items would be required:

1. By 1977, construct a 0.03-mgd conventional secondary treatment facility at an approximate capital cost of $74,700, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $67,200, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities, including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $56,000, including engineering and contingencies.



LEGEND

— — — PROPOSED SEWER LINE

U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS	
WASTEWATER MANAGEMENT STUDY COLORADO RIVER & TRIBUTARIES, TEXAS	
GARDEN CITY, TEXAS	
TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR	
SCALE: 1" = 1000'	PLATE: PB-6

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AREAWIDE PLAN
FOR
COAHOMA, TEXAS

The City of Coahoma is an incorporated, general law municipality located in the eastern portion of Howard County at the intersection of I.H. 20 and F.M. 820, approximately 110 miles south of Lubbock, Texas. The incorporated area encompasses approximately 830 acres and is within the jurisdiction of the PBRPC.

The City has moderate topographic relief and is drained by Guthrie Draw. The town slopes to the southwest with elevations varying approximately 50 feet. Drainage is by way of Guthrie Draw, which flows into Beals Creek and then into the Colorado River. The City is primarily underlain by soils of the Amarillo-Portales type. This soil has a friable, neutral, fine, sandy loam to sandy, clay loam surface, 6 to 15 inches thick, over friable, coarse, prismatic and granular, porous, neutral, sandy, clay loam or light, sandy clay. The western portion of the City is underlain by Tivoli-Brownfield soils. These soils have a neutral to weakly alkaline, fine sand surface, 4 to 10 inches thick, over loose, neutral, fine sand several feet thick. Permeabilities range from 2.0 to 6.3 inches per hour. There are only slight limitations on septic tanks, but there are moderate limitations on sewage lagoons due to the permeability of the soil.

Population data, developed by the TWDB for use in this study, indicate a slight increase in population is expected for Coahoma over the next fifty years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	1,158	1,090	1,140	1,200

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with some contribution from the processing of agricultural products. Accessible by an interstate highway, Coahoma is served by the Texas and Pacific Railroad.

The municipal water supply is from a surface water source--the Colorado River. Storage is provided by one ground reservoir with a capacity of 0.25 mg and an elevated reservoir with a capacity of 0.05 mg. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as shown on the following page.

Water Use Projections
(in mgd)

	Year 1970	1980	1990	2020
Municipal Use	0.16	0.15	0.16	0.16
Industrial Use	None	None	None	None

Municipal wastewater return flows projected for the City by the TWQB are as follows:

Waste Load Projections

	Year 1970	1980	1990	2020
Flows in mgd	0.10	0.09	0.10	0.10
BOD in lb/day	197	196	205	228
TSS in lb/day	232	229	251	276

The existing wastewater collection system for Coahoma is shown on Plate PB-7. Existing land-use information shows only one area of town in which septic tanks are still the primary means of sewage disposal. This area is shown to be served by the proposed lines and lift station on the map; however, the potential of the area for further development may not warrant the expense of the proposed expansion. Soils in the area show only slight to moderate restrictions to the proper operation of septic tanks. Should the City decide to extend service to the area, the estimated total project cost would be $64,700, including engineering and contingencies.

The sewage treatment plant is located south of town as shown on Plate PB-7. The plant consists of six oxidation ponds, arranged so that the two primary ponds are operated on an alternating cycle and the four secondary ponds are operated in series. The plant, constructed in 1959, serves about 400 connections and has been maintained in excellent condition. The design capacity is not known, but the existing ponds provide about 35 to 40 days detention time for the present loading. In order to provide sufficient surface area to comply with current oxidation pond criteria, it is recommended that the City provide an additional 0.5-acre of pond area at an estimated cost of $10,700, including engineering and contingencies.

Available sampling data for the present facility published by the TSDH and the TWQB are shown on the following page.

Influent-Effluent Data (mg/l)

	TSDH (1970)	TWQB (1972)
Raw BOD		210
Raw TSS		250
Final BOD	25	7
Final TSS	136	11

Effluent from the ponds is used to irrigate the City cemetery and about twenty-five acres of cotton and pastureland. Other farmers in the area have shown an interest in using the water also, so that more irrigation land is available than the effluent can supply.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of wastewater by 1977 and the best practicable waste treatment technology by 1983. According to the present interpretation of this law, land disposal of effluent meets all requirements when it is executed in an approved manner and when no effluent is directly discharged into the surface or ground water resources either as runoff or by percolation without adequate treatment time. Considering the value of irrigation water around Coahoma and the present status of the existing land disposal facilities, and with an increase in oxidation pond area, this facility will meet all requirements for wastewater treatment and disposal.

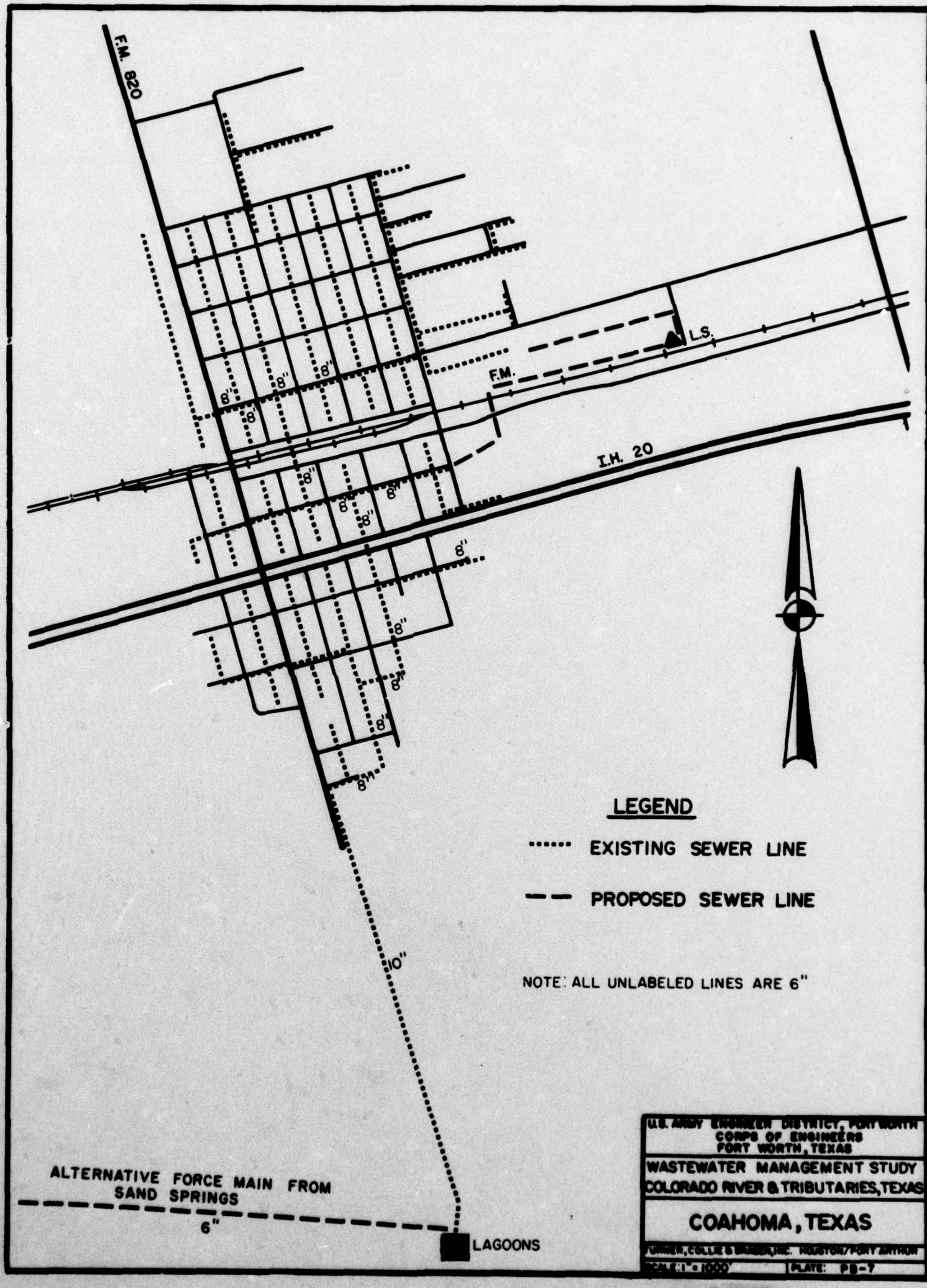
It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Coahoma wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a 0.10-mgd conventional secondary treatment facility at an approximate capital cost of $133,650, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $96,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities, including total filtration, dentrification and further phosphorus reduction facilities at an approximate capital cost of $92,500, including engineering and contingencies.

The nearby area of Sand Springs is presently without sewerage facilities and, as an alternative, could use Coahoma's plant as a regional facility at little or no additional cost to Coahoma. Details of this alternative are presented in the Sand Springs section of this report.



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AREAWIDE PLAN
FOR
SAND SPRINGS, TEXAS

The City of Sand Springs is an unincorporated municipality located in the east-central portion of Howard County on I. H. 20 approximately ten miles east of Big Spring, Texas. The inhabited area stretches along I. H. 20 approximately three miles and encompasses approximately 2,200 acres. Sand Springs is located within the jurisdiction of the PBRPC.

The City has slight topographic relief and is generally rolling, but broken by numerous small draws and ridges. The general direction of drainage is to the southeast into Beals Creek. The City is primarily underlain by the Tivoli-Brownfield soils. These soils have a fine sand surface, 4 to 10 inches thick, either over neutral, fine sand several feet thick or over friable, sandy, clay loam several feet thick. Permeabilities range from 2.0 to 6.3 inches per hour, imposing slight limitations on septic tanks and moderate limitations on sewage lagoons.

Population data, developed by the TWDB for use in this study, indicate a slight increase in population is expected for Sand Springs over the next fifty years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	903	840	870	920

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economy is primarily based on oil and gas production, with some contribution from agriculture. Accessible by an interstate highway, Sand Springs is served by the Texas and Pacific Railroad.

The municipal water supply is obtained solely from surface water sources. The City receives its water from Big Spring, which in turn is supplied with surface water by the Colorado River Municipal Water District. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as shown on the following page.

Municipal wastewater return flows projected for the City by the TWQB are also shown on the following page.

Water Use Projections
(in mgd)

	Year 1970	1980	1990	2020
Municipal Use	0.12	0.11	0.12	0.13
Industrial Use	None	None	None	None

Waste Load Projections

	Year 1970	1980	1990	2020
Flows in mgd	0.08	0.07	0.07	0.08
BOD in lb/day	154	151	157	175
TSS in lb/day	181	176	191	212

Sand Springs presently has no municipal collection and treatment facilities for wastewater. Sewage disposal is primarily by septic tanks which operate moderately well in the soils found in the area. However, population densities are increasing to the point where septic tanks concentrating in the area may become offensive. A proposed collection system for sanitary sewage is presented on Plate PB-8. The estimated cost of this proposed collection system, including 27,600 feet of 6-inch, 47,100 feet of 8-inch, and 5,000 feet of 10-inch line, and engineering and contingencies, is $859,400.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of wastewater by 1977 and the best practicable waste treatment technology by 1983. To meet the requirements of the law, four alternatives are available. The first, and probably the most viable, alternative would be for Sand Springs to construct pump stations and a force main to carry the raw sewage to Coahoma for treatment at a regional facility. The estimated cost for this alternative including three lift stations, 5,000 feet of 4-inch force main, 21,000 feet of 6-inch force main and Sand Spring's share of the expansion required for the Coahoma plant, and including engineering and contingencies, is $326,970. Coahoma presently has an excellent disposal scheme and has the potential to expand their irrigation facilities to handle additional effluent.

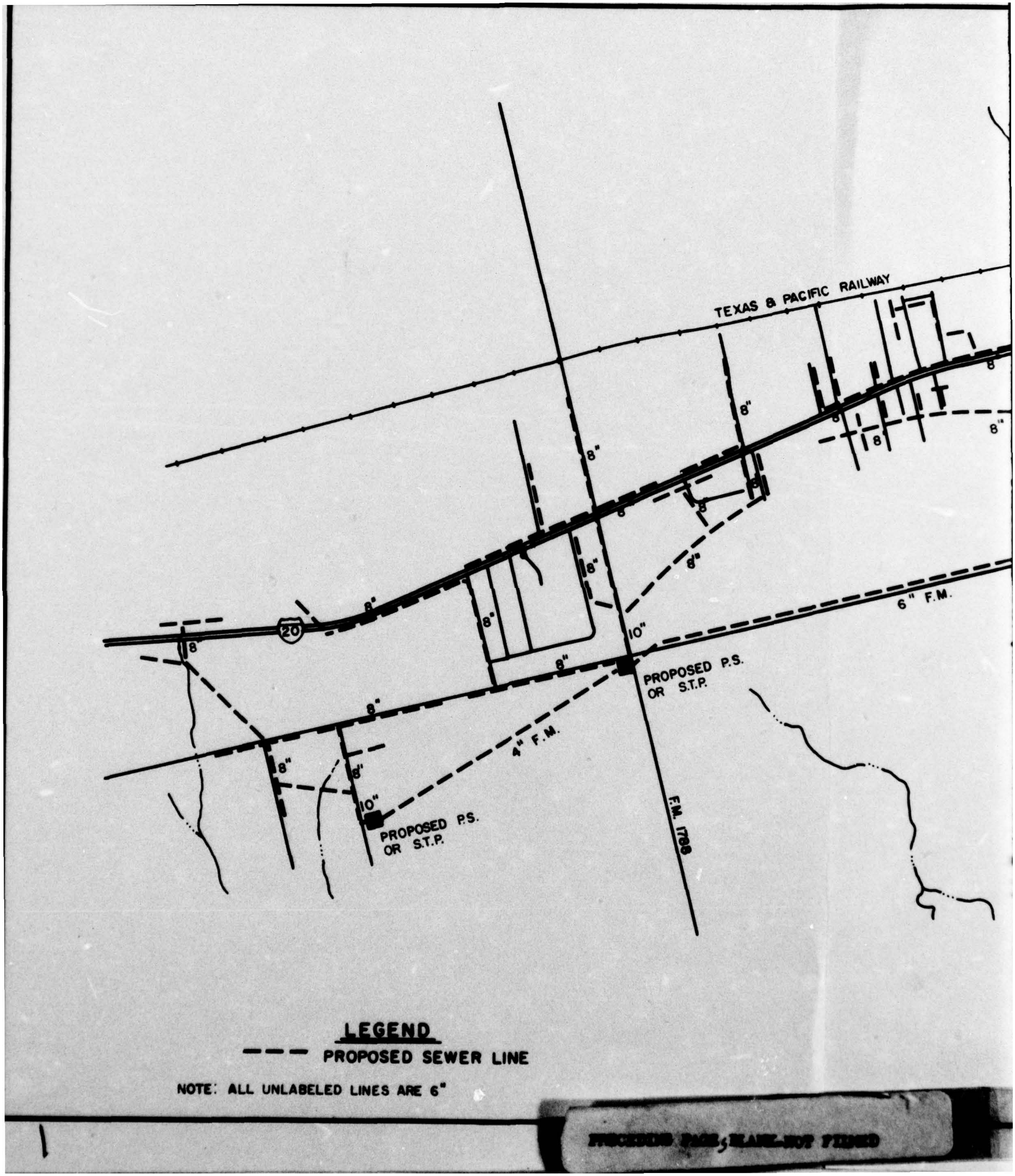
Three additional alternatives are available by which Sand Springs could meet the 1977 requirements of the law. The second alternative would include construction of a 0.12-mgd conventional secondary treatment plant of the contact-stabilization type at an approximate cost of $133,650 including engineering and contingencies. The third alternative would include construction of three oxidation ponds with capacities of 0.015 mgd, 0.05 mgd and 0.05 mgd at an estimated capital cost of $102,600, including engineering and contingencies. The fourth alternative would include construction of a 0.12-mgd oxidation pond at an estimated cost of $87,600, including engineering and contingencies. The costs presented for the second and fourth alternatives do not include $176,700 that would be required for construction of lift station and force mains that would be required to centralize treatment facilities. Although costs for the second, third and fourth alternatives are shown in Volume I, Basin Plan, as expenditures to be borne by Coahoma, these costs would have to be borne entirely by Sand Springs.

It is therefore recommended that all steps necessary to implement Alternative 1, the no-discharge plan, be undertaken. However, should the City of Sand Springs wish to implement a discharge plan, the following items would be required.

1. By 1977, construct a 0.12-mgd conventional secondary treatment facility at an approximate capital cost of $130,540, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $87,500, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $81,000, including engineering and contingencies.



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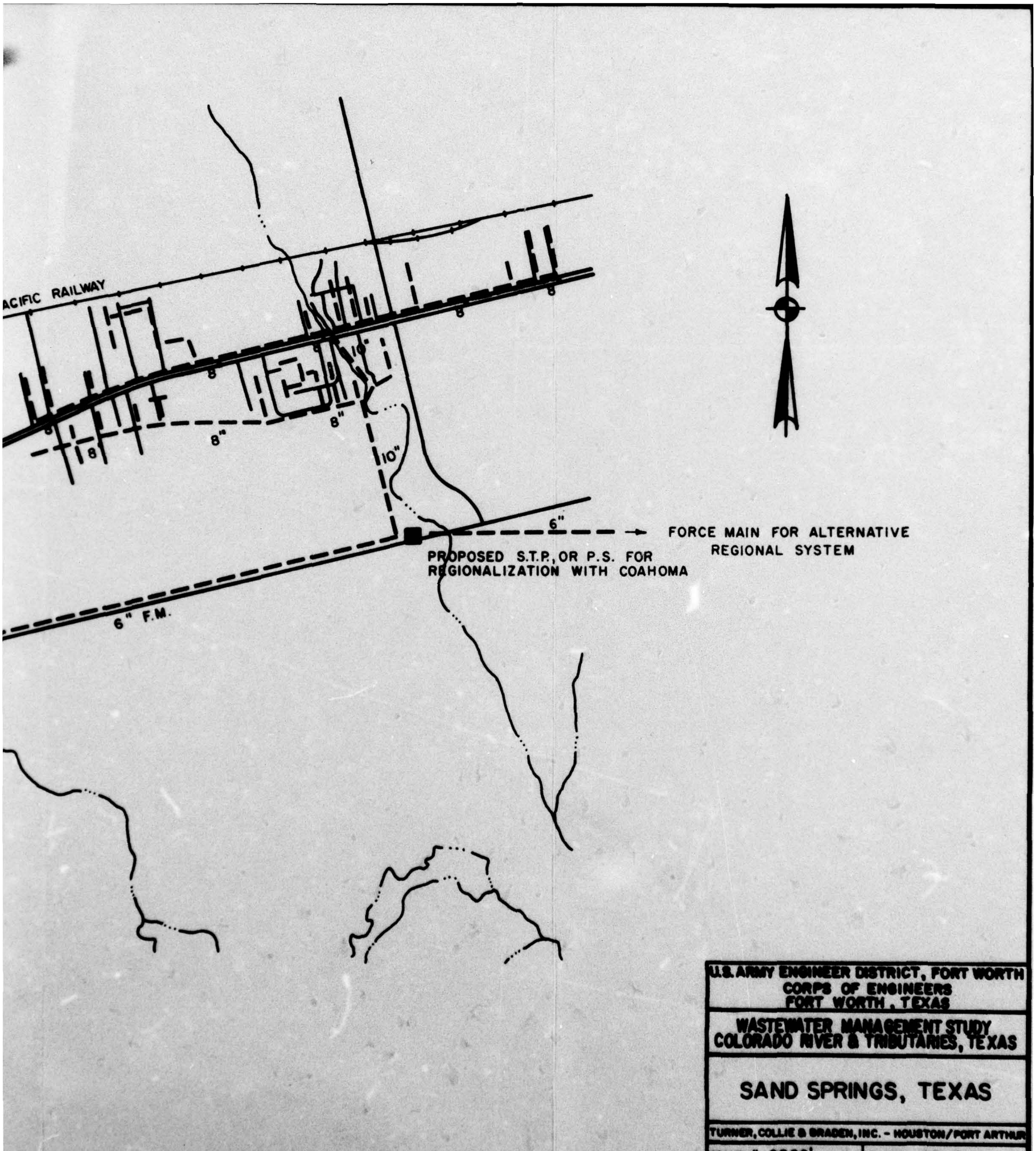


U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

SAND SPRINGS, TEXAS

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 2000'	PLATE PB-8

AREAWIDE PLAN
FOR
STANTON, TEXAS

The City of Stanton is an incorporated general law municipality located in the southeast portion of Martin County at the intersection of I.H. 20 and S.H. 137, approximately 20 miles southeast of Big Spring, Texas. The incorporated area of the City encompasses approximately 910 acres. Stanton is the county seat of Martin County and is located within the jurisdiction of the PBRPC.

The City has little topographic relief and is drained by several playa lakes. The town is built partly in a depression, and the general direction of drainage is to the southeast portion of town. The City is underlain by soils of the Amarillo type. Amarillo soils, generally 6 to 15 inches thick, are characterized by a brown, friable, fine, sandy loam surface. Underlying the loam is reddish-brown, friable, porous, sandy, clay loam. Permeabilities range from 0.63 to 2.0 inches per hour. While the soil conditions pose only slight limitations for septic tanks, sewage lagoons have moderate limitations due to the high permeability.

Population data, developed by the TWDB for use in this study, indicate a moderate increase in population is expected for Stanton over the next fifty years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	2,117	2,440	2,640	3,070

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural, with some contribution from local oil field activity. Industrial contribution is derived from a cotton compress and two grain elevators. The county hospital is also located here. Accessible by an interstate highway, the City is served by the Texas and Pacific Railroad. Anticipated growth potential is fair due to the proximity of the metropolitan areas of Big Spring and Midland.

The municipal water supply is obtained from ground water and surface water sources. The City has five wells, three with capacities of 50 gpm, one with a capacity of 100 gpm, and one with a capacity of 200 gpm. Surface water is obtained from the Colorado River Municipal Water District. Storage is provided by three ground reservoirs with capacities of 0.05, 0.075 and 0.10 mg, an elevated reservoir with a 0.075-mg capacity, and a clearwell reservoir with a 0.009-mg capacity. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as follows:

Water Use Projections
(in mgd)

	Year 1970	1980	1990	2020
Municipal Use	0.19	0.23	0.26	0.33
Industrial Use	None	None	None	None

Municipal wastewater return flows projected for the City by the TWQB are as follows:

Waste Load Projections

	Year 1970	1980	1990	2020
Flows in mgd	0.18	0.21	0.22	0.26
BOD in lb/day	360	439	475	583
TSS in lb/day	423	512	581	706

The existing wastewater collection system is illustrated on Plate PB-9. The system as shown serves all existing development and is adequate for immediate needs. With the expansions shown and replacement as needed, the existing system should serve the City through the planning period. The collection system expansions shown on Plate PB-9 to serve the projected population over the planning period are estimated to have a total project cost of $70,600, including engineering and contingencies.

The sewage treatment plant for Stanton serves about 2,000 people and is located about one-half mile south of town as shown on the Plate. It was constructed in 1940 and expanded in 1957 to a design capacity of 0.2 mgd. The plant presently consists of a lift station, bar screen, grit channel, Imhoff tank, sludge drying beds, five oxidation ponds, a distribution ditch, and a reservoir for irrigation water. It is operating near design load and needs some minor maintenance, which the City is presently planning. Available sampling data published by the TSDH and the TWQB are as follows:

Influent-Effluent Data (mg/l)

	TSDH (1972)	TWQB (1970)
Raw BOD	130	210
Raw TSS	190	184
Final BOD	55	-
Final TSS	43	-

Sludge from the plant is used as fertilizer, and the effluent is used to irrigate cotton and maize fields on a year-round basis.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of wastewater by 1977 and the best practicable waste treatment technology by 1983. Under the present interpretation of this law, land disposal of effluent as practiced by Stanton meets all requirements when the disposal is executed in an approved manner and when no effluent is discharged into the surface or ground water resource either directly, as runoff, or by direct percolation.

In order to meet all requirements for land disposal of effluent, the City of Stanton should make certain minor revisions in its present treatment scheme. These include organization of irrigation procedures under contract to insure dependable year-round operation. In addition, in order to provide sufficient oxidation-pond area to serve the projected population, it is recommended the City add an additional two acres of pond surface area to the existing ponds at an estimated cost of $34,100, including engineering and contingencies. As the waste load increases, the Imhoff tank should be observed for its continued performance and, if necessary, replaced by preliminary treatment and digestion facilities. Disposal of effluent by irrigation can greatly enhance the local environment in a semi-arid region, in addition to providing a valuable reuse of a scarce natural resource.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Stanton wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility at an approximate capital cost of $193,100, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $129,000, including engineering and contingencies.

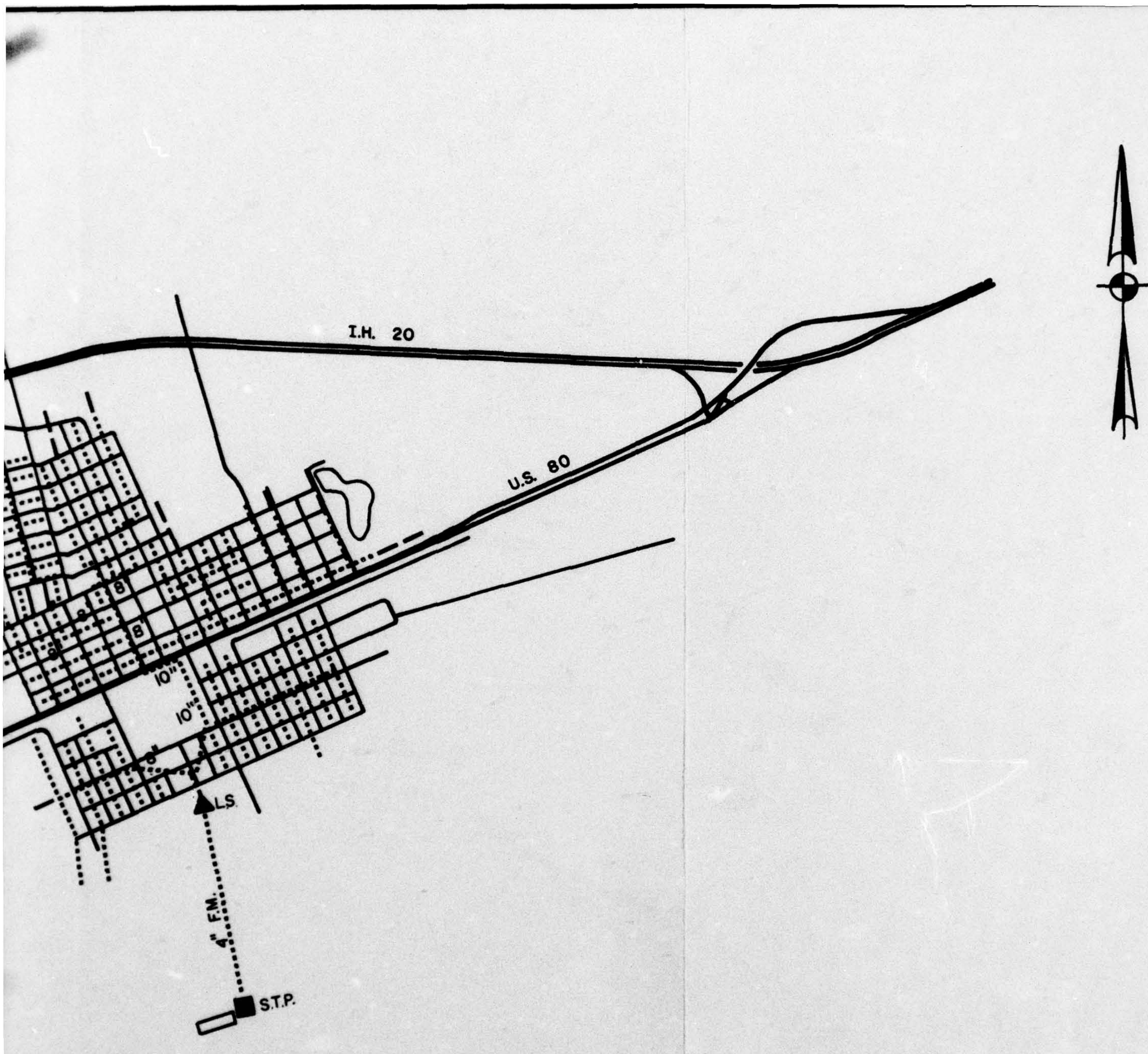
3. By 1985, construct tertiary treatment facilities including total filtration, denitrification, and further phosphorus reduction facilities at an approximate capital cost of $117,500, including engineering and contingencies.

LEGEND

EXISTING SEWER LINE

PROPOSED SEWER LINE

NOTE: ALL UNLABELED LINES ARE 6"



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

STANTON, TEXAS

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 2000' | PLATE PB-9

OTHER COMMUNITIES

The following are communities which, because of size or specific local problems, have been considered in this study. After consideration of the information available, including the population projections furnished by the TWDB, no municipal wastewater systems to replace the existing septic tank system is being proposed. Should any of these towns show significant growth or experience serious local wastewater problems, further investigation into that specific case will be necessary. The economics of scale in construction, operation and maintenance of wastewater facilities make it difficult for smaller communities to support such facilities without unduly taxing local citizens. The traditional solution to this problem is construction of a regional facility to serve several communities, but on the High Plains, distances between towns are usually so great that regionalization is even more expensive than separate facilities. In some cases, however, local circumstances create critical problems which transcend economic priorities, and special institutional or final arrangements must be made to meet the needs. For this reason, these communities are included in this report and should be considered in the continuing planning process.

Gail

Gail is located in the center of Borden County and is the county seat and trade center of that County. At the present time, Gail has a population of about 180 people, but TWDB projections developed for this study predict growth to 340 people by year 2020.

The municipal water supply is drawn from a surface water reservoir west of town, but the anticipated growth could force the town to seek additional supplies in the future. Gail is located in the recharge area of a major freshwater aquifer, and the increasing local wasteload could create serious ground water contamination problems in the local reaches of the aquifer. The Amarillo and Mansker soils in the area impose only moderate restrictions on the proper operation of septic tanks and, at present, Gail has little economically justifiable need for municipal sewerage facilities, but future growth or severe ground water contamination could make such facilities necessary.

Ackerly

Ackerly is located on the boundary between southeastern Dawson County and northeastern Martin County. The town is incorporated and presently has a population of 348, although TWDB projections show a decline to about 200 people by year 2020. Ackerly is large enough and dense enough that present waste disposal methods could create definite health problems due to contamination of the ground water resource from which the local water supply is drawn.

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Careful monitoring of ground water quality could determine if sanitary sewerage facilities are necessary or not, considering the fact that no growth is projected.

Welch

Welch, located in the northwestern portion of Dawson County, has an unincorporated population of about 110 people, although a 1970 land-use map taken from the "Borden and Dawson counties comprehensive plan" indicates a slightly higher population. That same report indicates that a potential for ground water contamination exists and that the local citizenry are undertaking a project to study existing wastewater problems in the area.

Loop

Loop, located in the northeastern portion of Gaines County, has an unincorporated population of 315, but TWDB projections show a slight decline in population to about 240 people by year 2020. General soil conditions show no significant restrictions to septic tank operations, and population distribution -- except near the school -- does not seem to be dense enough to cause significant waste disposal problems using present methods. Unless special local problems cause a need for sanitary sewerage facilities, such facilities would not be economically feasible for Loop.

Forsan

Forsan is located in the southern portion of Howard about 12 miles southeast of Big Spring. It is incorporated, with a population of 237, and is projected to remain about the same size throughout the planning period.

The shallow calcareous soils in the area usually restrict severely the proper operation of septic tanks, but municipal sewage collection and treatment facilities would cost about $234,000 for Forsan, plus over $6,000 per year to operate and maintain. Such an expenditure is not justifiable unless severe local wastewater problems should occur.

SOUTH PLAINS ASSOCIATION OF GOVERNMENTS

Introduction.

The South Plains Association of Governments (SPAG) is a coordination and planning agency serving an area of 13,756 square miles from its Lubbock, Texas headquarters. Established in June 1967, it listed nine member counties and six non-member counties in its planning area as of September 1972. These counties are:

Members:	Bailey	Garza*	Lynn*
	Crosby	King	Motley
	Dickens	Lubbock	Terry*
Non-members:	Cochran *	Hockley	
	Floyd	Lamb	
	Hale	Yoakum*	

*All or partially in the Colorado River Basin
Source: Directory '72 - Regional Councils in Texas

Although lacking any statutory authority, the SPAG's influence is reflected in the widespread acceptance of its recommendations by city governments in the planning region. Through its planning role, the Association deals with matters pertaining to problems and situations that transcend traditional municipal and county boundaries and affect broader regional areas.

The Colorado River Municipal Water District serve the SPAG counties in the Basin. Other water supply and special-purpose districts in the SPAG are:

Member Special Districts

Lubbock County S&WCD
Blackwater Valley S&WCD
Cochran County S&WCD
Hale Center S&WCD
Lamb County S&WCD
Rio Blanco S&WCD
Hockley County S&WCD
Floyd County S&WCD
Yoakum County S&WCD
Garza County S&WCD
Lynn County S&WCD
Duck Creek S&WCD
Lynn County Hospital District

Physical Description.

Hydrology.

This study area has been classified as non-contributing in relation to the Colorado River due to the lack of perennial stream flow throughout the area. Sulphur Springs Draw and Lost Draw traverse the region, but stream flow in these channels is dependent on runoff from precipitation. Although lacking in surface water resources, the SPAG area is underlain by one of Texas' major aquifers -- the Ogallala. This ground water source, however, is at present being severely overmined, and recharge into the aquifer is limited by the lack of precipitation in the outcrop area. Most wells withdrawing water from the Ogallala Aquifer are from 100 to 300 feet deep. The close proximity of the water table to the surface in this area introduces the possibility of ground water contamination, especially in those specific areas where soil permeability rates are high. Effluent use for irrigation purposes is necessary due to the scarcity of water in this region. The contamination consideration particularly applies to irrigation, where rapid percolation of the water into lower soil strata could lead to ground water contamination.

The Canadian River Authority supplies the City of Brownfield with water from Lake Meredith, while other cities in the SPAG region obtain their water from the previously-discussed Ogallala Aquifer. The SPAG area in-Basin industrial and municipal water-use projections for the planning period of this study are illustrated below:

Municipal and Industrial Water Use
(Ac-Ft per Year)

	Municipal				Industrial			
	1970	1980	1990	2020	1970	1980	1990	2020
Cochran	69	73	69	36	201	217	228	266
Hockley	114	105	99	75	917	995	998	1,421
Lynn	27	25	23	18	0	0	0	0
Terry	1,956	2,220	2,446	3,026	537	620	677	881
Yoakum	1,430	1,496	1,534	1,506	3,193	3,679	3,956	4,927
Totals	3,596	3,919	4,171	4,661	4,848	5,471	5,859	7,495

Irrigation water use in the study area is solely from ground water sources and is projected for the planning period as follows on the next page.

Annual Irrigation Water Use
(acre-feet)

County	1970	1980	1990	2020
Cochran	12,043	8,466	5,180	1,566
Hockley	16,023	10,347	5,180	1,566
Lynn	0	0	0	0
Terry	55,542	54,937	54,390	16,443
Yoakum	74,295	51,657	31,080	9,396
In-Basin SPAG Totals	157,903	215,407	95,830	28,971

Geology.

The main soils found in the SPAG region are Amarillo, Brownfield, Mansker, Potter, Portales, Arch and Spur soils. These soil types are discussed individually and more specifically in the following sections on the cities where they occur. Generally, the soils of the High Plains are neutral sandy loams to clay loams with some shallow calcareous clay loams, exhibiting high permeabilities.

Surface geologic formations of the study area are of the Pliocene, Miocene and Oligocene age.

Social and Economic Description.

Population Analysis.

Existing and projected population in the SPAG area have been classified into the urban and rural categories for the purposes of this study. The term "urban" has been applied to cities over 2,500 people, while "rural" categorizes smaller cities under this criteria as well as the population found on farms, ranches, and other dwellings away from the city proper. In the SPAG area, the five-county and total population in the Colorado River Basin from 1970 to 2020 is illustrated from figures previously provided by the TWDB. These projections are as follows:

Population Projections

	1970	1980	1990	2020
Cochran Co.	1,069	950	870	580
Urban	0	0	0	0
Rural	1,069	950	870	580
Hockley Co.	1,640	1,430	1,360	1,110
Urban	0	0	0	0
Rural	1,640	1,430	1,360	1,110

Population Projections (Cont'd)

	1970	1980	1990	2020
Lynn Co.	284	260	250	180
Urban	0	0	0	0
Rural	284	260	250	180
Terry Co.	13,875	14,580	15,370	16,680
Urban	9,647	10,690	11,410	12,840
Rural	4,228	3,890	3,960	3,840
Yoakum Co.	7,334	7,300	7,300	6,700
Urban	4,133	4,500	4,560	4,370
Rural	3,201	2,800	2,740	2,330

As evidenced by the preceding table, Terry County is the most populous. The City of Brownfield is the population center of the in-Basin SPAG area, whose total population is:

Totals	1970	1980	1990	2020
In-Basin SPAG	24,202	24,520	25,150	25,240
In-Basin Urban	13,780	15,190	15,970	17,210
In-Basin Rural	10,422	9,330	9,180	8,030

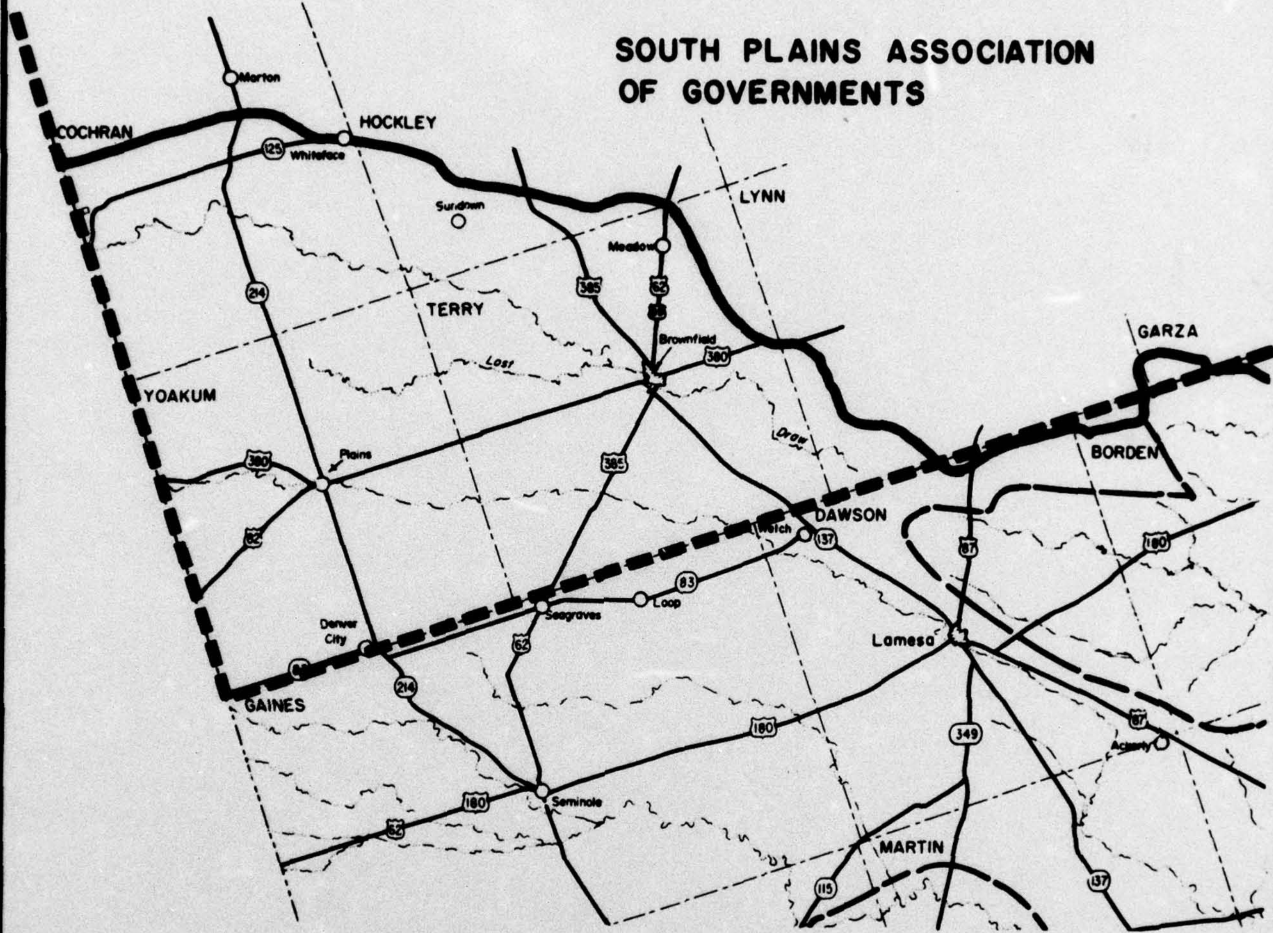
Population projections for each city are presented in the individual municipal discussions found following this section of the report. The projection methodology used by the TWDB is discussed in Appendix A of Volume II.

Land Use Analysis.

The land use in the study area is mostly agricultural, with oil operations in concentrated areas around Denver City and light petroleum activity in the vicinity of Brownfield. Urbanized areas are small in proportion to the total in-Basin SPAG region. The municipal discussions presented further in this report specifically deal with land use in this study as related to municipalities.

Study Area Delineation.

The SPAG's planning area is located in the semi-arid lands of the West Texas High Plains in the area illustrated on the Study Area Map, shown as Plate SP-A. For purposes of this study, only the portion of the SPAG within the Colorado River Basin boundary will be considered. This study area consists of all of Yoakum County, almost all of Terry except the northeast tip, slightly more than half of Cochran, approximately one-third of Hockley, and the southwest tip of Lynn and Garza Counties.



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

SPAG STUDY AREA

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 16 MI. | PLATE: SP-A

Climatic Description.

The average temperature data provided by the U.S. Weather Bureau for the SPAG area is as follows:

Mean Annual Temperature: 62°F
Mean Annual Precipitation: 16 inches

The mean length of the warm season (the period between the last winter freeze and the first fall freeze) is approximately 215 days. Average relative humidity for the planning area ranges from approximately 70 percent at 6 a.m. to 40 percent at 6 p.m. on an average day. Normal net annual evaporation rates in this semi-arid region average about 60 inches.

The study area lies on the High Plains at an elevation in the 3,000 to 4,000-foot range above sea level. The topography changes approximately 350 feet from the western to the eastern reaches of the SPAG region. This slope is southeastward, with the only topographical feature in the area found below the caprock where the topography is rough. This area of rough terrain and notable physical features covers approximately 30 percent of the entire SPAG area. The remainder of the region, approximately 70 percent, is characterized by a flat to gently rolling landscape.

Economic Analysis.

The SPAG region within the Colorado River Basin boundaries derives its income from agricultural, ranching and oil interests and operations. The industrial contribution to the area includes two large oil refineries located in Denver City and a large refining complex about four miles west of Sundown. Another industrial contribution of significance is from Vulcan Materials, Inc. of Denver City, a chlorine and caustic manufacturer. The SPAG area in the Colorado River Basin, then, has a dual economy base: oil and agriculture, whose contributions have different impacts on the regional economic perspective.

The in-Basin SPAG region is served by excellent highways, railroad facilities, air service, and overland commercial carriers. Accessibility to all areas is facilitated by four U.S. highways, four State highways and numerous farm-to-market roads. The area also is near enough to Lubbock to share in its metropolitan transportation services as evidenced by the railroad spur lines serving this study area.

Little increase in population is projected for the area, partially because this region is experiencing the effects of a leveling-off trend in oil development operations. Automation has curtailed the large manpower requirements of agriculture and oil-production processes, thereby effecting a decline in immigration into the area. The region's metropolis, Brownfield, is the only city showing any projected population increase of significance. This is a reflection of the State and national trend of urban populations increasing while rural populations decrease.

Growth potential for the study area seems limited unless future economic priorities in the petroleum industry justify new development or secondary recovery in previously infeasible areas. Major technological advances in transportation or agriculture could also boost the regional economy significantly.

Existing Waste Loads

Within the following SPAG plan, the projected waste loadings as furnished by the TWQB are presented. Those projections, based on census populations and not service populations, were to be used with judgment for planning purposes throughout the study. The methodology utilized in those projections is presented in the Basin Plan.

In an attempt to develop an estimate of the existing influent and effluent loadings for each municipal treatment facility in the Basin, available published sampling data, field visitations, and prior reports were examined. Estimated treatment reductions were developed, and the resultant estimated effluent loadings are the best available approximations of the loadings that would be exerted on Basin waters if the facilities discharged to a receiving stream.

Very little of the available sampling data were consistent or reasonable; therefore, judgment was required in many instances as to what influent loadings could be expected. Treatment reductions were calculated where possible from available data; however, where lacking, the reductions were estimated with typical efficiencies tempered with known operating conditions. As stated previously, with no other data available, best judgment was required in developing the loadings and estimates shown in Table SP-1.

TABLE SP-1

EXISTING WASTE LOADS

SOUTH PLAINS ASSOCIATION OF GOVERNMENTS

City	Estimated Population Served	Discharge	Estimated Influent Loading			Estimated Treatment Reduction	Estimated Effluent Loading	
			Flow mgd	BOD lb./day	TSS lb./day		BOD lb./day	TSS lb./day
WHITEFACE	400	No	0.03	60	25	62% / 40%	20	20
SUNDOWN	1,200	No	0.10	120	170	70% / 60%	40	70
BROWNFIELD	9,600	No	0.80	1,020	610	57% / 67%	440	200
MEADOW	500	No	0.04	60	30	64% / 40%	20	20
DENVER CITY	(2 plants)	No	0.20	300	270	75% / −17%	70	220
		No	0.20	300	270	70% / 50%	90	140
PLAINS	1,100	Yes	0.10	160	120	72% / 68%	40	40

AREAWIDE PLAN
FOR
WHITEFACE, TEXAS

The City of Whiteface is an incorporated general law municipality located in the eastern portion of Cochran County at the intersection of S.H. 116 and F.M. 1780, approximately 50 miles west of Lubbock, Texas. The incorporated area of the City encompasses approximately 170 acres. Whiteface is under the jurisdiction of the SPAG.

The City has little topographic relief and slopes toward the southeast. Drainage is provided by the numerous playa lakes in the area. The City is underlain by soils of the Amarillo type. The Amarillo fine sand loams are generally composed of a reddish-brown, friable, neutral surface, 6 to 15 inches thick, over porous, sandy, clay loams. Permeabilities range from 2.0 to 6.3 inches per hour. The soils pose no limitations on the use of septic tanks, but the high permeability of the soil imposes severe limitations on sewage lagoons.

Population data, developed by the TWDB for use in this study, indicate a slow decline in population is expected for Whiteface over the next fifty years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	394	350	320	210

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with some contribution from local oil field activity, and with no known industrial contribution.

The City is accessible by S.H. 116 and F.M. 1780, and is served by the Atchison, Topeka, and Santa Fe Railroad. Growth in this area is not anticipated due to the lack of adequate economic activity and industrial interest.

The municipal water supply is obtained from ground water sources consisting of two 220-foot wells with pumping capacities of 160 and 230 gpm. A 55,000-gallon elevated tank provides storage for the system. The projected water use is a reflection of the population trend and has been projected by the TWDB to be as shown on the following page.

Municipal wastewater return flows have been projected for the City by the TWQB and are also shown on the following page.

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Water Use Projections
(in mgd)

	Year 1970	1980	1990	2020
Municipal Use	0.02	0.02	0.02	0.01
Industrial Use	None	None	None	None

Waste Load Projections

	Year 1970	1980	1990	2020
Flow in mgd	0.03	0.03	0.03	0.02
BOD in lb/day	67	63	58	40
TSS in lb/day	79	74	70	48

The existing wastewater collection system is shown on Plate SP-1. It appears the system is adequate for present needs and will meet the future needs of the declining population. There are no significant areas within the City that still utilize septic tanks as the primary means of sewage disposal.

The existing sewage treatment plant for the City of Whiteface lies directly north of town and serves about 400 people. It was constructed in 1954 with a design capacity of 0.075 mgd and has been maintained in good physical condition. The plant is of the Imhoff tank-oxidation pond type and consists of an Imhoff tank, sludge drying beds, and a three-acre oxidation pond. Available sampling data published by the TSDH are as follows:

Influent-Effluent Data (mg/l)

	TSDH (1972)
Raw BOD	250
Raw TSS	100
Final BOD	95
Final TSS	59

The sludge from the plant is used for fill, while the effluent is held in ponds to evaporate. Considering the value of irrigation water in the South Plains region, the City of Whiteface should find some means of using the treated effluent for irrigation. Local croplands, the cemetery, city park, or athletic field all offer possibilities for irrigation sites.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of wastewater by 1977 and the best practicable waste treatment technology by 1983. Under the present interpretation of this law, land disposal of effluent meets all requirements of the law so long as no effluent is discharged into the surface or ground water resource either directly as runoff or by direct percolation.

At a local net evaporation rate of 55 inches per year, the existing three-acre evaporation pond loses about 13.6 acre-feet of water per year by evaporation. Since this quantity represents only 40 percent of the yearly flow, about 60 percent of the effluent percolates into the ground. This rapid percolation could eventually result in the contamination of ground water supplies. Irrigation at lower rates will provide a high degree of treatment and lining the oxidation pond would conserve about 23 acre-feet of valuable irrigation water each year while preventing possible ground water contamination.

If irrigation of public areas is effected, chlorination of the 0.075-mgd flow should be initiated to conform to current health requirements. Cost estimates for these revisions by 1977 is $24,200, including chlorination facilities, pond liner, and engineering and contingencies.

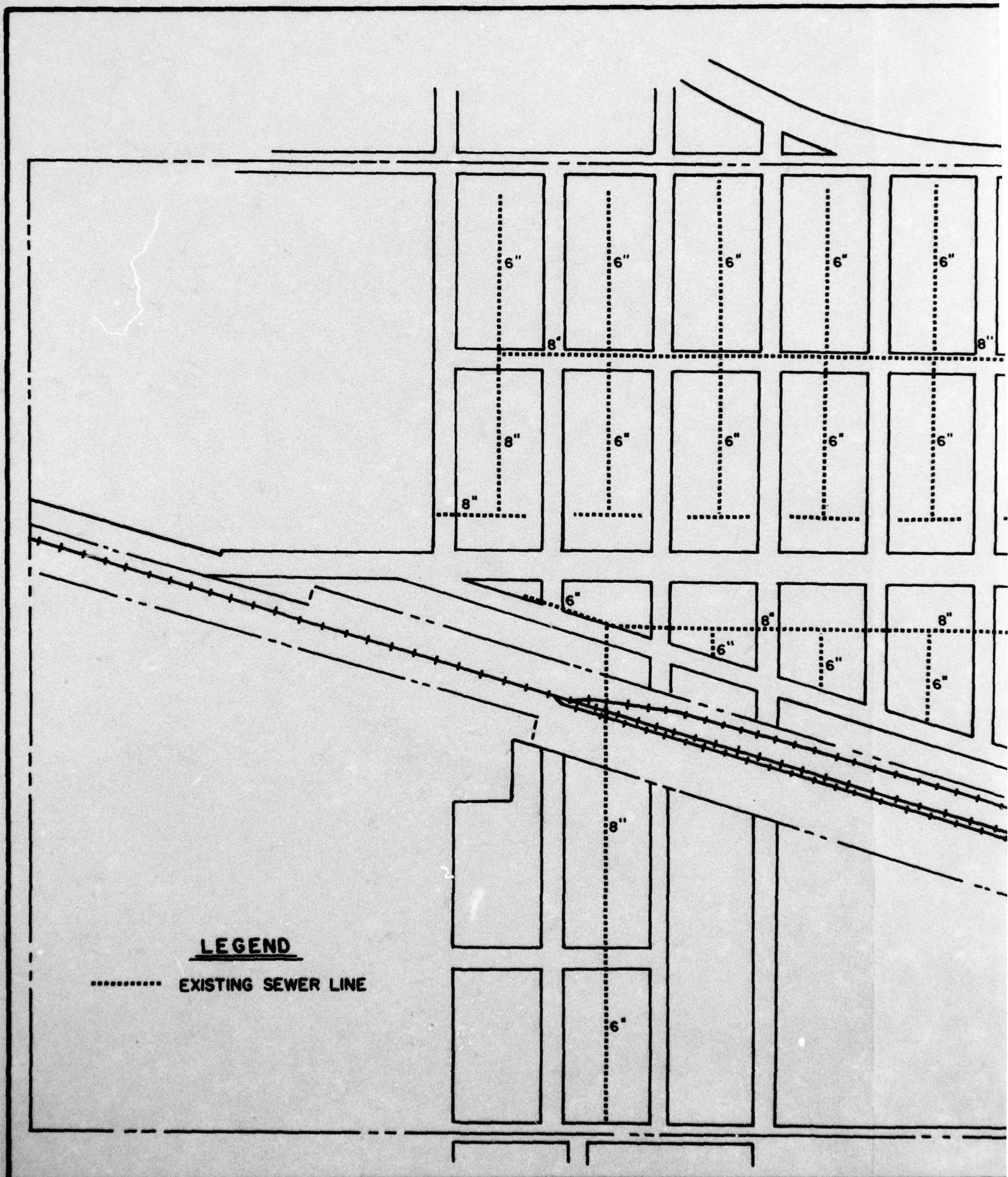
Land disposal of effluent by irrigation in the semi-arid South Plains region can greatly enhance the local environment, in addition to providing a dependable source of valuable irrigation water. This method of disposal is generally accepted in these dry areas and should be encouraged until local economics dictate a greater need for the water.

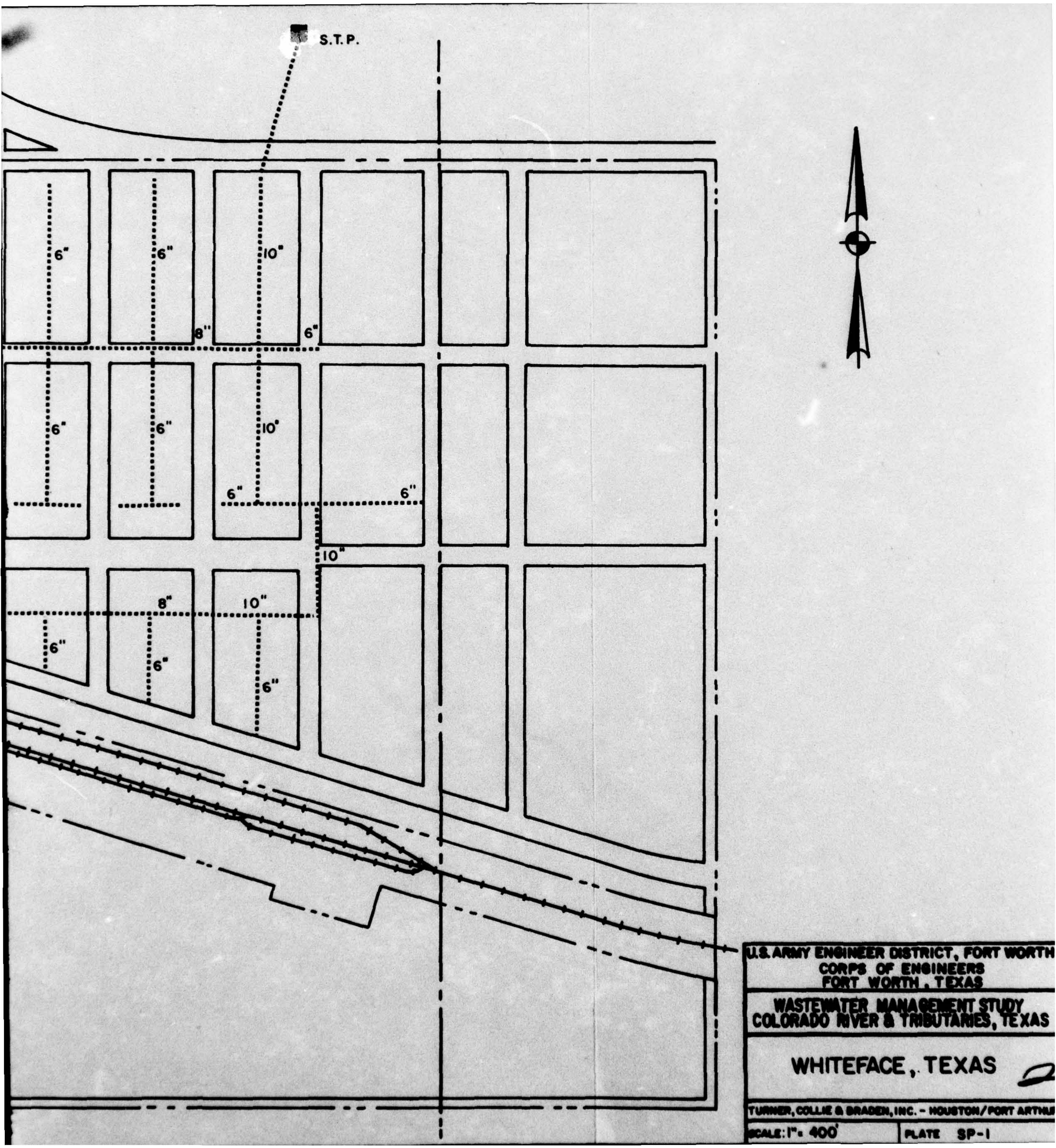
It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Whiteface wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a conventional secondary treatment facility of the extended-aeration type at an approximate capital cost of $57,900, including engineering and contingencies.

2. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $72,400, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities, including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $58,000, including engineering and contingencies.


6"
8"
LEGEND
EXISTING SEWER LINE



S.T.P.
6"
6"
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6"
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
WHITEFACE, TEXAS
TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR
SCALE: 1"= 400'
PLATE SP-1

AREAWIDE PLAN
FOR
SUNDOWN, TEXAS

The City of Sundown is an incorporated general law municipality located in the southwest quadrant of Hockley County at the intersection of F.M. 301 and F.M. 303, approximately 40 miles southwest of Lubbock, Texas. The incorporated area of the City encompasses approximately 580 acres. Sundown is within the jurisdictional area of the Colorado River Municipal Water District and the SPAG.

The City has little topographic relief and is drained by playa lakes to the north and east and by Lost Draw to the south. The general direction of drainage is to the southeast. The soils which underlay the City are the Amarillo fine, sandy loams. These soils have a reddish-brown, friable, loamy, fine sand surface, 6 to 15 inches thick, over a granular, porous, sandy, clay loam. Permeabilities range from 2.5 to 5 inches per hour. The porous soils pose no limitations on septic tanks but do impose severe limitations on sewage lagoons.

Population data, developed by the TWDB for use in this study, indicate a moderate decrease in population is expected for Sundown over the next fifty years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	1,129	990	940	760

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with some contribution from local oil field activity, and with no known industrial contribution.

The City is accessible by F.M. 301 and F.M. 303 and is served by a spur line of the Atchison, Topeka and Santa Fe Railroad. The economy of Sundown is based on oil and agriculture. A majority of the City's work force is employed by the petroleum industry, but agricultural production is increasing in the surrounding area. A large refining complex about four miles west of town contributes significantly to the local economy. No growth for Sundown is anticipated because of the lack of new economic activity in the area.

The municipal water supply is obtained from three 225-foot-deep wells, which have a combined pumping capacity of 1,400 gpm. Storage for the system is provided by a 0.033-mg ground storage tank, a 0.126-mg ground tank, and by a 0.1-mg elevated tank. The projected water use is

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a reflection of the population trend and has been projected by the TWDB to be as follows:

Water Use Projections
(in mgd)

	Year			
	1970	1980	1990	2020
Municipal Use	0.07	0.06	0.06	0.05
Industrial Use	None	None	None	None

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flow in mgd	0.10	0.08	0.08	0.06
BOD in lb/day	192	178	169	144
TSS in lb/day	226	208	207	175

The existing wastewater collection system is shown on Plate SP-2. It appears the system is adequate for present needs, and with only minor extensions will meet the future needs of a declining population. There are no significant areas of the City where septic tanks are utilized for sewage disposal.

The existing treatment plant for the City of Sundown is located northwest of town as shown on the Plate. The plant, which serves about 1,200 people, was constructed in 1950, with a stated design capacity of 0.14 mgd and consists of two primary ponds, three oxidation ponds, and a central playa lake for any overflow. Available sampling data published by the TSDH are as follows:

Influent-Effluent Data (mg/l)

	TSDH (1970)
Raw BOD	150
Raw TSS	200
Final BOD	25
Final TSS	80

Sludge from the primary ponds is used as fill, and effluent from the oxidation ponds is used to irrigate 150 acres of privately-owned land for cotton and sorghum production. Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. According to the present interpretation of this law, land disposal of effluent as practiced by Sundown meets all requirements when the disposal is carried out in an approved manner, and when no effluent is introduced into the surface water or ground water resource either directly, as runoff, or by direct percolation.

Considering the value of irrigation water in the Sundown area and the present status of the existing irrigation facilities, the present treatment scheme can meet all requirements with only minor revisions and upgrading. Necessary revisions include:

1. Installation of screening, and flow measurement facilities.

2. Scum control on primary ponds.

3. Modification of secondary ponds to multi-cell configuration with overflow weirs to control surface area volume ratio for retained wastewater.

Estimated cost for these revisions by 1977 is $12,930, including preliminary treatment facilities, scum control, oxidation pond revisions, and engineering and contingencies.

The proposed extensions to the collection system shown on Plate SP-2 are estimated to cost $16,500, including engineering and contingencies.

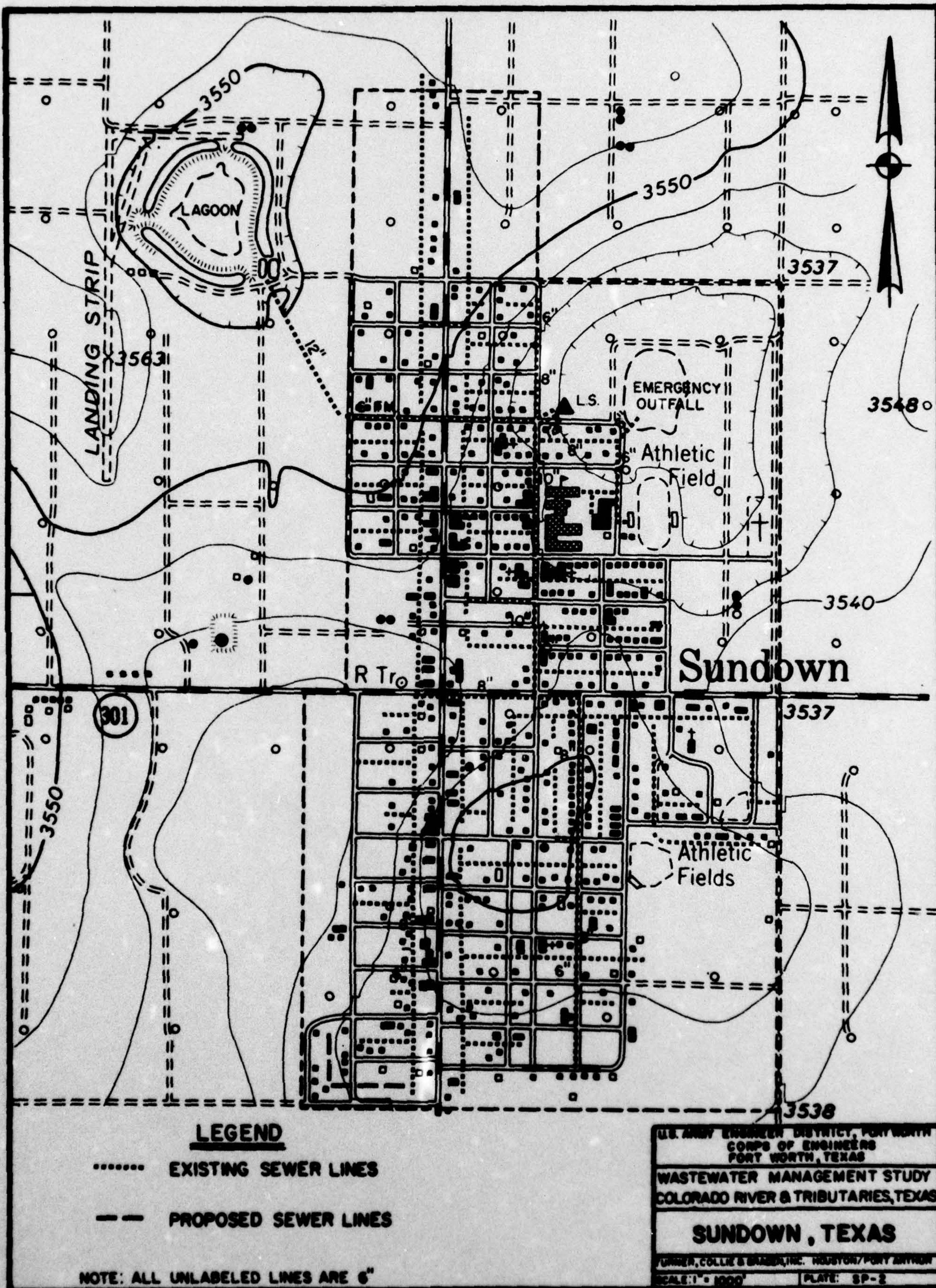
Land disposal of effluent by irrigation in the semi-arid South Plains region can greatly enhance the local environment, in addition to providing a dependable source of valuable irrigation water. Such practice is well accepted in these dry areas and should be encouraged until local economics dictate a greater need for the water.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Sundown wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a 0.10-mgd conventional secondary treatment facility of the contact-stabilization type at an approximate cost of $121,700, including engineering and contingencies, with an annual operation and maintenance cost of $11,000.

2. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $88,000, including engineering and contingencies.

3. **By 1985, construct tertiary treatment facilities, including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $87,500, including engineering and contingencies.**



LAGOON
3550
LANDING STRIP
3563
12"
6"
8"
L.S.
EMERGENCY OUTFALL
Athletic Field
3548
3537
3540
R Tr
301
Sundown
3550
Athletic Fields
3538
LEGEND
EXISTING SEWER LINES
PROPOSED SEWER LINES
NOTE: ALL UNLABELED LINES ARE 6"
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
SUNDOWN, TEXAS
PLATE: SP-2

AREAWIDE PLAN
FOR
BROWNFIELD, TEXAS

The City of Brownfield is an incorporated, home rule municipality located in the center of Terry County at the intersection of U.S. 62 and U.S. 380 approximately 40 miles southwest of Lubbock, Texas. The incorporated area of the City encompasses approximately 3,300 acres. Brownfield is the county seat of Terry County and is located within the jurisdictional boundaries of the SPAG.

The City has moderate topographic relief and slopes from north to south with a drop of about 50 feet. The general direction of drainage is toward the south and southwestern portion of the City into Lost Draw. The City is underlain by Amarillo-Brownfield and Mansker-Potter soils. These soils generally have a reddish-brown, friable, sandy loam surface, 6 to 15 inches thick, over reddish-brown, sandy, clay loam. Permeabilities range from 0.63 to 2.0 inches per hour. The soils pose no limitations on the use of septic tanks, but the high permeability of the soil imposes moderate limitations on sewage lagoons.

Population data developed by the TWDB for use in this study indicate a slight increase in population is expected for Brownfield over the next fifty years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	9,647	10,690	11,410	12,840

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural with some contribution from local oil field activity, and with no known industrial contribution.

Brownfield is accessible by U. S. Highways 62, 82, 380 and 385, and is served by the Terry County Municipal Airfield and the Atchison, Topeka, and Santa Fe Railroad. The City is the business and market center for a large oil and agriculture region. Anticipated growth potential is moderate due to a continued demand for service and supply for oil field and agricultural activity.

Brownfield presently obtains about 90 percent of its water from the Canadian River Municipal Water Authority. The City has a contract to take 2.025 mgd from this source by 1987, and the existing pipeline has a capacity of 2.47 mgd. The projected water use is a reflection of the population trend and has been projected by the TWDB to be as follows:

Water Use Projections
(in mgd)

	Year			
	1970	1980	1990	2020
Municipal Use	1.36	1.62	1.79	2.27
Industrial Use	None	None	None	None

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

Waste Load Projections

	Year			
	1970	1980	1990	2020
Flow in mgd	0.82	0.91	0.97	1.09
BOD in lb/day	1640	1924	2054	2440
TSS in lb/day	1929	2245	2510	2953

The major collectors of the existing wastewater collection system are shown on Plate SP-3. It appears the present system is adequate, and with expansions as shown, the future needs of the projected population will be met. The estimated cost of these extensions is $58,400, including engineering and contingencies.

The existing wastewater treatment plant is located south of town as shown on the Plate. This plant serves about 9,600 people and was constructed in the late 1940's with a design capacity of 0.465 mgd for the Imhoff tank and 1.05 mgd for the oxidation ponds. The facility consists of a bar screen, grit channel, flow measuring device, Imhoff tank, sludge drying beds, and nine oxidation ponds in series. It has been maintained in satisfactory physical condition. Available sampling data published by the TSDH and the TWQB are as follows:

Influent-Effluent Data (mg/l)

	TSDH (1972)	TWQB (1969)
Raw BOD	150	180
Raw TSS	90	168
Final BOD	65	105
Final TSS	29	85

Dried sludge is used as fill, and effluent is used to spray irrigate about 120 acres of sorghum and pastureland on a year-round basis.

The City is currently considering construction of an extended aeration plant of the "race track" or oxidation ditch type. It is characteristic of the activated-sludge process that the extended aeration process is most efficient at a capacity range below that needed by the City. It is therefore recommended that the City construct a secondary treatment facility of the activated-sludge type operated in the modified activated-sludge mode. Effluent from the facility should be discharged into the present oxidation ponds which would remain in service as holding ponds for the irrigation operation. The estimated total project cost for a 1.0-mgd secondary facility which would serve the projected population is estimated to be $627,500, including engineering and contingencies. The annual operation and maintenance cost for this facility is estimated to be $45,600.

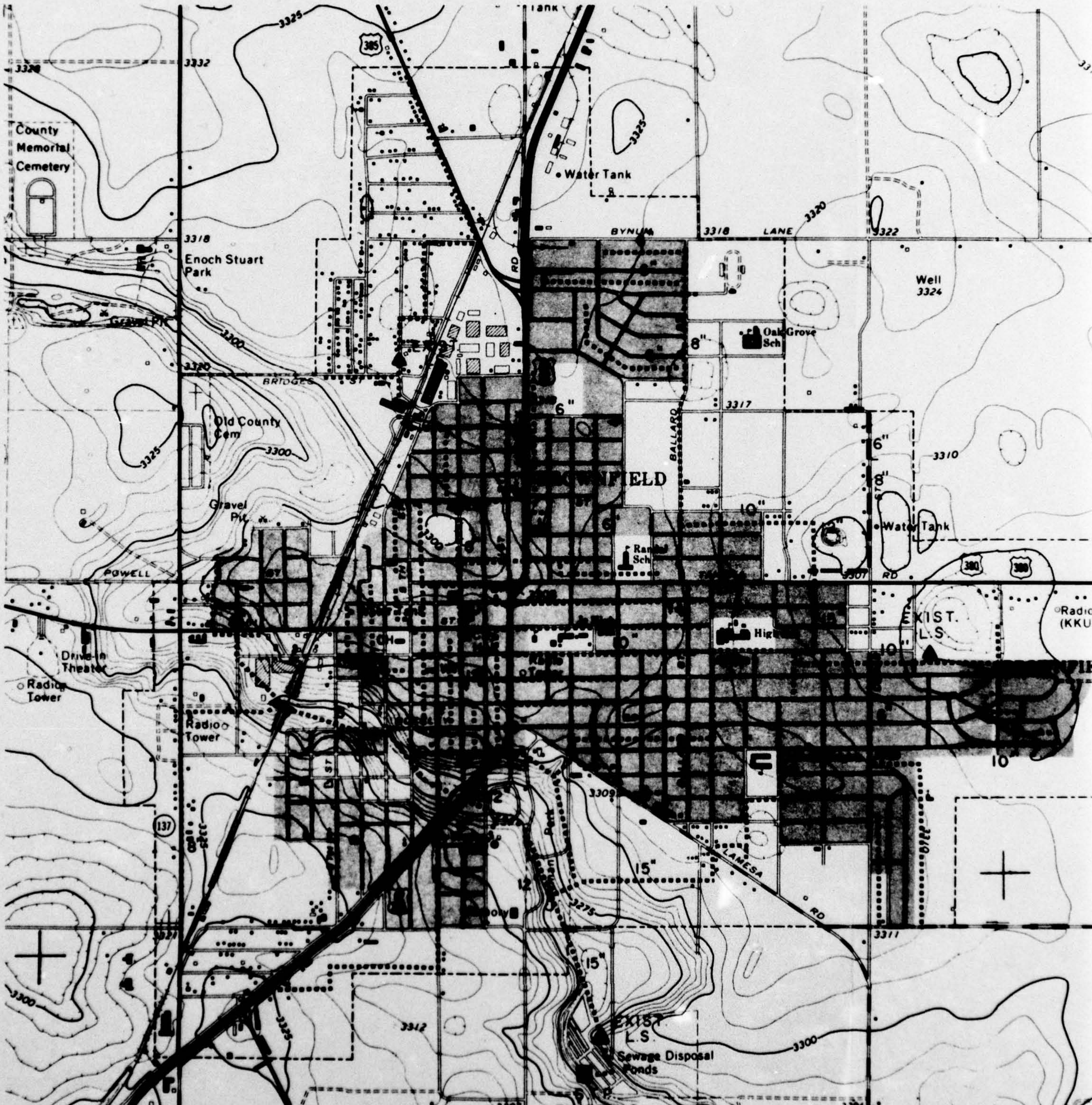
Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. According to the present interpretation of this law, land disposal of effluent as practiced by Brownfield meets all requirements when the disposal is carried out in an approved manner and when no effluent is introduced into the surface water or ground water resource either directly, as runoff, or by direct percolation. Disposal of effluent by irrigation in the semi-arid South Plains region provides valuable irrigation water and greatly enhances the local environment. Such practice is generally accepted in the area and should be encouraged until a more critical use for the water develops.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Brownfield wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a 1.0-mgd conventional secondary treatment facility at an approximate capital cost of $627,500, including engineering and contingencies, with an annual operation and maintenance cost of $45,600.

2. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $343,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $244,000, including engineering and contingencies.



County Memorial Cemetery
Enoch Stuart Park
Gravel Pit
Old County Cem
Gravel Pit
POWELL
Drive-in Theater
Radio Tower
Radio Tower
Water Tank
BYNUM
LANE
Well
3324
Oak Grove Sch
BRIDGES ST
BALLARD
BROWNFIELD
Water Tank
EXIST. L.S.
Radio (KKUB
LAMESA RD
Sewage Disposal Ponds
EXIST L.S
EXISTING
6"
8"
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3325
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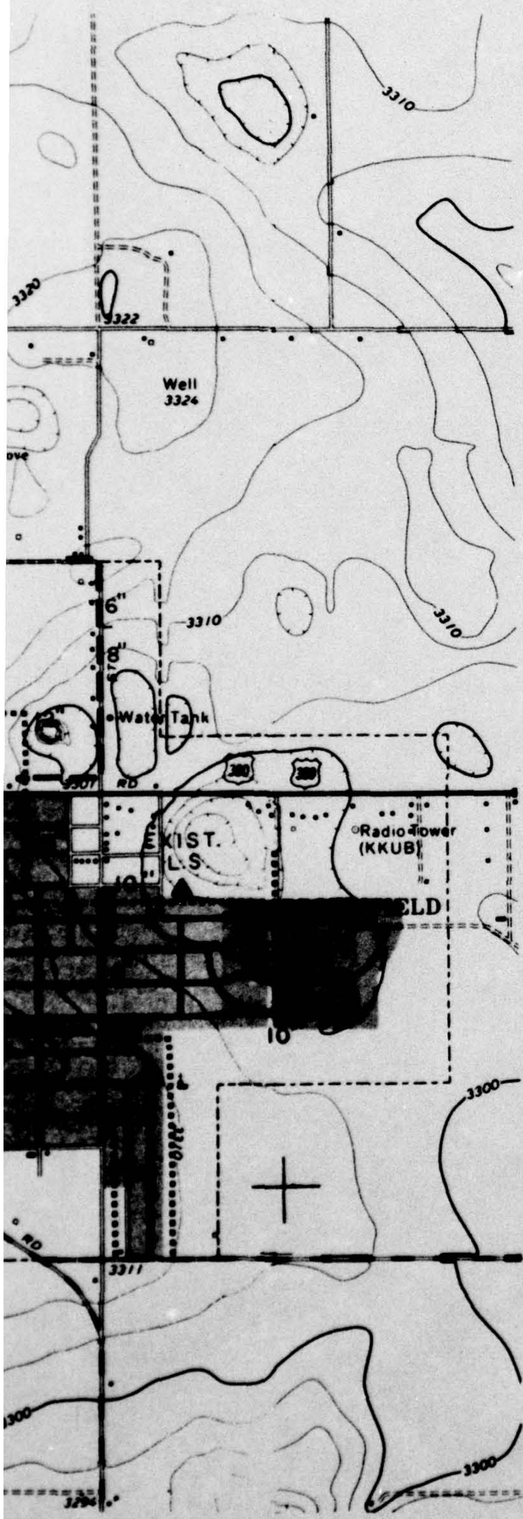

LEGEND

....	EXISTING SEWER LINE
— — —	PROPOSED SEWER LINE

NOTE: ALL UNLABELED LINES ARE 8"

TO AVOID CONFUSION MOST OF THE 6" LINES HAVE NOT BEEN SHOWN.

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

BROWNFIELD, TEXAS

2

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 2000' | PLATE SP-3

AREAWIDE PLAN
FOR
MEADOW, TEXAS

The City of Meadow is an incorporated general law municipality located in the northeast quadrant of Terry County at the intersection of U.S. 62 and F.M. 211, approximately 30 miles southwest of Lubbock, Texas. The incorporated area of the City encompasses approximately 400 acres. Meadow is within the jurisdiction of the SPAG.

The City has very little topographic relief and is drained by small playa lakes. The general direction of drainage is to the southeast. The City is underlain by Amarillo soils. The Amarillo soils generally have a reddish-brown, friable, fine, sandy loam to sandy, clay loam surface, 6 to 15 inches thick, over reddish-brown, granular, porous, sandy, clay loam. Permeabilities range from 0.63 to 2.0 inches per hour. Soil conditions pose no limitations to septic tanks, but sewage lagoons have moderate limitations due to the high permeability.

Population data developed by the TWDB for use in this study indicate a slight decrease in population is expected for Meadow over the next fifty years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	491	470	480	460

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily agricultural, with no known industrial contribution and none anticipated in the near future.

The City is accessible by U.S. 62 and U.S. 82 and F.M. 211. Meadow is served by the Atchison, Topeka and Santa Fe Railroad and is within 15 miles of the County Auxiliary Airfield. No growth is anticipated due to lack of industrial interest or developable natural resource.

The municipal water supply is provided by three wells with capacities of 80, 80 and 380 gpm. Storage is provided by one elevated storage reservoir with a capacity of 0.05 mg. The projected water use is a reflection of the population trend and has been projected by the TWDB to be as shown on the following page.

Municipal wastewater return flows have been projected for the City by the TWQB and are also shown on the following page.

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Water Use Projections
(in mgd)

	Year 1970	1980	1990	2020
Municipal Use	0.04	0.04	0.04	0.04
Industrial Use	None	None	None	None

Waste Load Projections

	Year 1970	1980	1990	2020
Flow in mgd	0.04	0.04	0.04	0.04
BOD in lb/day	83	85	86	87
TSS in lb/day	98	99	106	106

The existing wastewater collection system is illustrated on Plate SP-4. It appears that the system is adequate for present conditions, and with minor extension and repair as needed, the existing collection system should be adequate through the planning period. All but two houses are served by the system and there are no plans to extend service to these homes.

Meadow's existing sewage treatment plant is located northeast of town, as shown on the Plate. It was constructed in 1962 with a design capacity of 0.05 mgd, and currently serves about 500 people and no industries. The plant has been maintained in only fair condition. The plant is of the oxidation-pond type and consists of two primary ponds in parallel and two secondary ponds in series. Available sampling data published by the TSDH are as follows:

Influent-Effluent Data (mg/l)

	TSDH (1972)
Raw BOD	180
Raw TSS	90
Final BOD	65
Final TSS	142

All effluent either evaporates or is used to irrigate adjacent cotton and sorghum fields under contract. Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology economically achievable by 1983. According to the present interpretation of this law, land disposal of effluent meets all requirements when the disposal is carried out in an approved manner and when no effluent is introduced into the surface water or ground water resource either directly, as runoff, or by direct percolation.

To meet all requirements for land disposal of effluent, the City of Meadow should make some minor revisions in its present method of treatment by 1977, including:

1. Installation of screening and flow measurement facilities.

2. General upgrading of operation and maintenance (weed control, sludge removal from primary ponds, etc.).

Cost estimates for these improvements (by 1977) are $5,100.

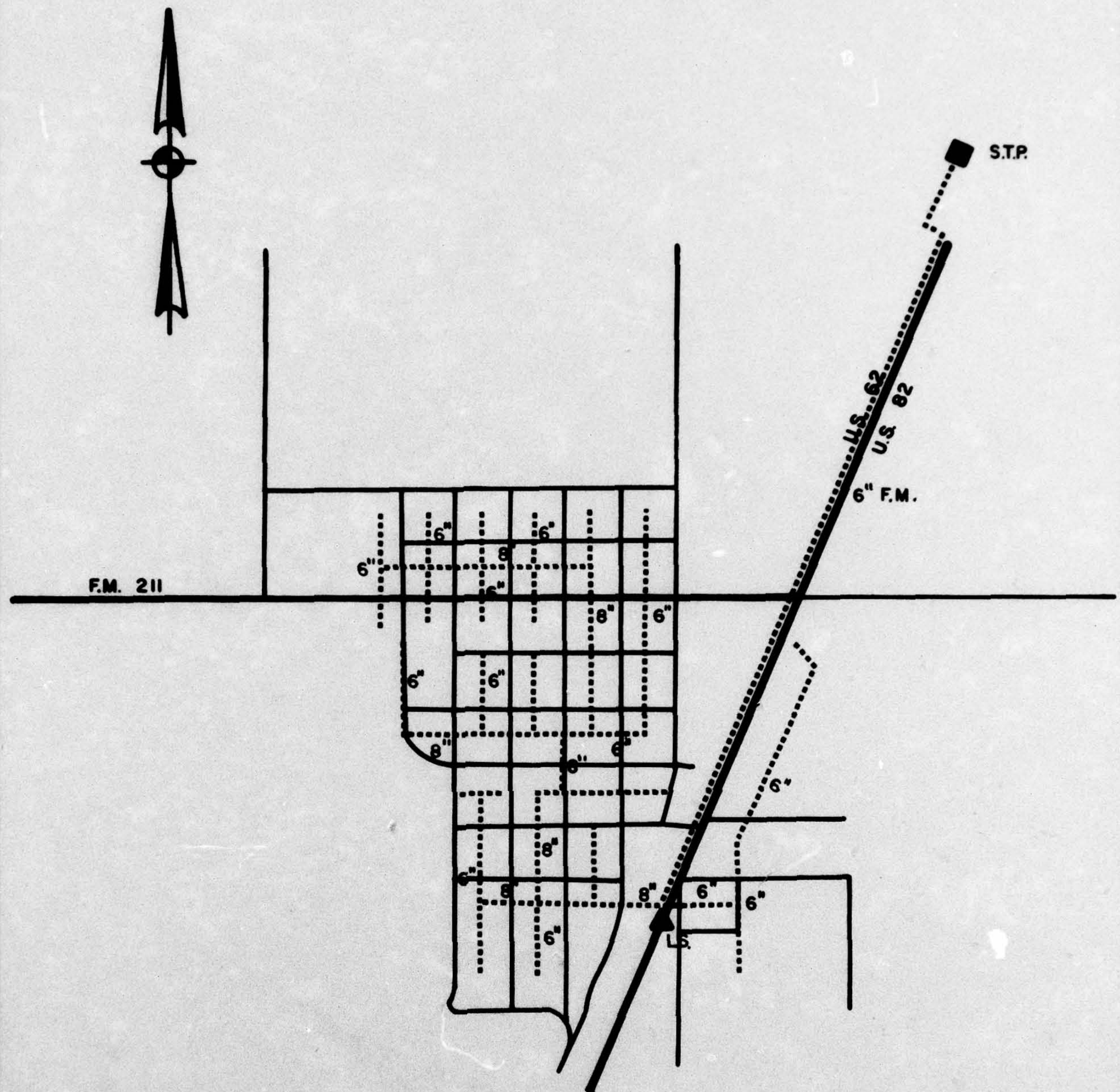
Land disposal of treated effluent by irrigation in the semi-arid South Plains region can greatly enhance the local environment, in addition to providing a dependable source of valuable irrigation water. Such practice is accepted in these dry areas and should be encouraged until local economics dictate a greater need for the treated water.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Meadow wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a 0.04-mgd conventional secondary treatment facility of the extended-aeration type at an approximate capital cost of $57,300, including engineering and contingencies, with an annual operation and maintenance cost of $6,400.

2. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $72,300, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $71,000, including engineering and contingencies.



LEGEND

······· EXISTING SEWER LINE

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

MEADOW, TEXAS

TURNER, COLLIE & BRADEN, INC. HOUSTON/PORT ARTHUR

SCALE: 1" = 1000' | PLATE: SP-4

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AREAWIDE PLAN
FOR
DENVER CITY, TEXAS

The City of Denver City is an incorporated, general law municipality located in the extreme southern portion of Yoakum County at the intersection of S.H. 214 and S.H. 83, approximately 80 miles southwest of Lubbock, Texas. The incorporated area of the City encompasses approximately 900 acres. Denver City is located within the jurisdiction of the SPAG.

The City has little topographical relief and drainage is provided by numerous playa lakes. The town is situated on top of a gentle rise which separates drainage so that the northern half of town drains to the north and the southern half to the south. The City is underlain by soils of the Brownfield and Amarillo types. These soils generally have a reddish-brown, loamy, sand surface, 10 to 28 inches thick, over reddish-brown, friable, sandy clay loam several feet thick. Permeabiilities range from 0.63 to 2.0 inches per hour. General soil conditions pose no limitations on the use of septic tanks, but sewage lagoons have moderate limitations due to the high permeability of the soils.

Population data developed by the TWDB for use in this study indicate a slight increase in population is expected for Denver City over the next fifty years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	4,133	4,500	4,560	4,370

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is primarily oil and gas production, with some contribution from agriculture. The City has two large oil refineries and a hospital. Although accessible by two State highways, the major products of the area are carried by pipeline. The anticipated growth potential for Denver City is slight due to the general leveling-off trend in the petroleum industry.

The municipal water supply consists solely of ground water drawn by 11 wells, with a total capacity of 4.6 mgd. The anticipated water use, a reflection of the population trend, has been projected by the TWDB to be as shown on the following page.

Municipal wastewater return flows, projected for the City by the TWQB, are also shown on the following page.

Water Use Projections
(in mgd)

	Year 1970	1980	1990	2020
Municipal Use	0.79	0.92	0.97	1.00
Industrial Use	0.06	0.07	0.07	0.09

Waste Load Projections

	Year 1970	1980	1990	2020
Flows in mgd	0.35	0.38	0.39	0.37
BOD in lb/day	703	810	821	830
TSS in lb/day	827	945	1,003	1,005

The existing wastewater collection system for Denver City is shown on Plate SP-5. The existing system is generally adequate for present needs. From existing land use information, it appears that numerous commercial establishments and approximately thirty residences located east of town along the highway are not served. All utilities in this area are privately owned and no plans exist to extend City service.

Denver City presently has two wastewater treatment plants as shown on Plate SP-5. The south plant, constructed in 1948, with a design capacity of 0.122 mgd, is of the Imhoff-oxidation pond type and has been maintained in good physical condition. The plant was modified in 1965 with the addition of an oxidation pond, and again in 1971 with the addition of another oxidation pond. The plant consists of a bar screen, Imhoff tank, sludge pit, and three oxidation ponds in series. Available sampling data, published by the TSDH and the TWQB, are as follows:

Influent-Effluent Data (mg/l)

	TSDH (1970)	TWQB (1968)
Raw BOD	200	220
Raw TSS	180	363
Final BOD	60	130
Final TSS	93	92

Sludge disposal consists of utilizing the dried material as fill. Effluent is used to irrigate about 120 acres of cotton fields on a year-round basis.

The northern sewage treatment plant, constructed in 1957, has a design capacity of 0.275 mgd. The plant is maintained in excellent physical condition and was modified in 1958 with the addition of bar screens.

The plant is of the oxidation-pond type and consists of bar screens and three oxidation ponds in series. Available sampling data published by the TSDH and the TWQB is as follows:

Influent-Effluent Data (mg/l)

	TSDH (1970)	TWQB (1968)
Raw BOD	200	220
Raw TSS	180	363
Final BOD	60	130
Final TSS	93	92

Effluent from the oxidation ponds is used to irrigate approximately 32 acres of cotton fields on a year-round basis.

Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. According to the present interpretation of the law, land disposal of effluent meets all requirements when the disposal is executed in an approved manner and when no effluent is introduced directly into the surface or ground water resources, either by runoff or percolation, with adequate treatment.

For the South Plant, proposed improvements include expansion of the sludge drying bed and a 4.6-acre expansion of the oxidation pond. The estimated cost of these improvements is $61,500, including engineering and contingencies.

For the North Plant, proposed improvements include a primary settling pond and a 2.8-acre expansion of the oxidation pond. The estimated cost of these improvements is $54,200, including engineering and contingencies.

Land disposal of effluent by irrigation in the semi-arid South Plains region can greatly enhance the local environment, in addition to providing a dependable source of valuable irrigation water. Such practice is accepted locally and should be encouraged until local economics dictate a greater need for the treated effluent.

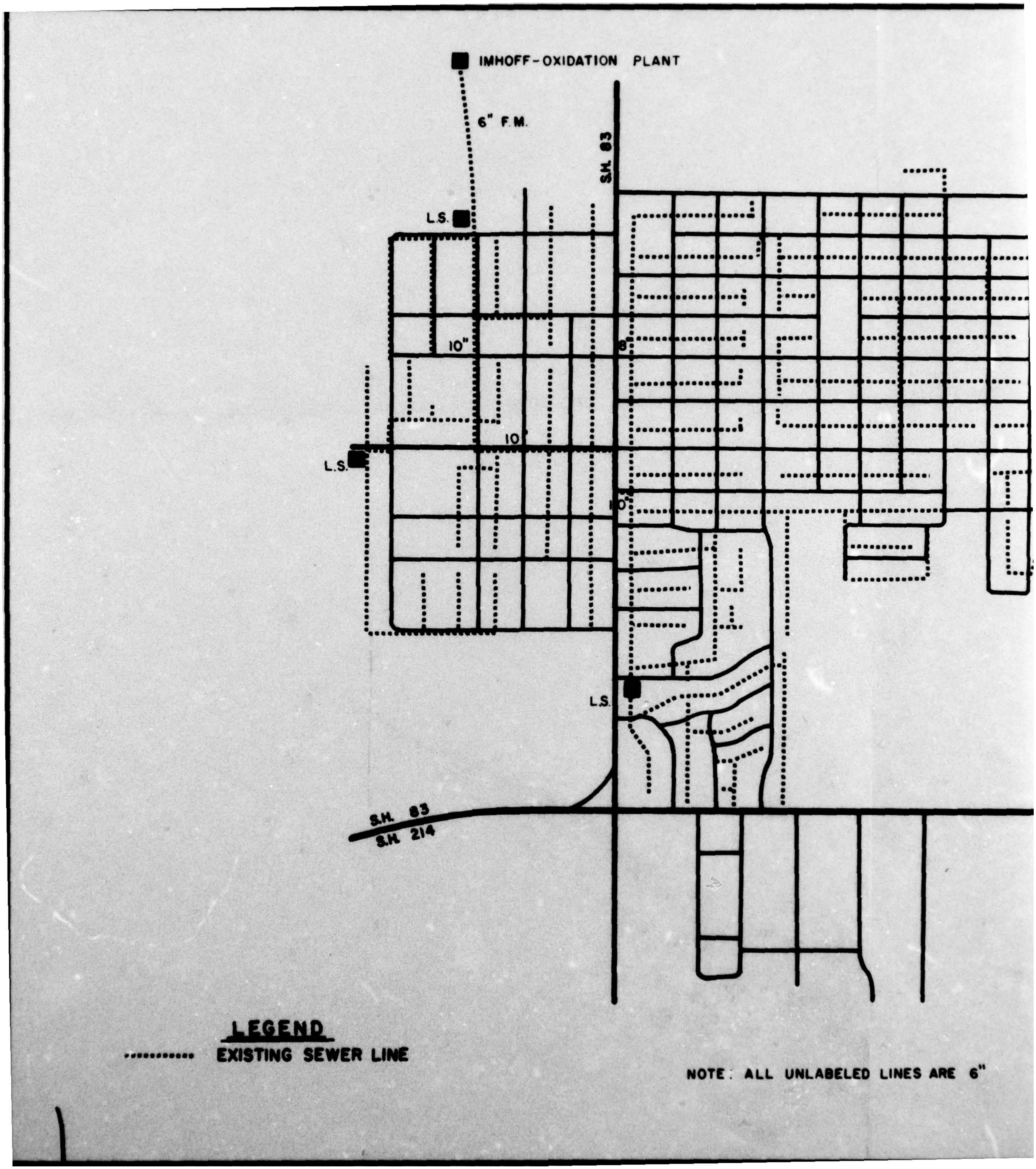
It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Denver City wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a force main from the existing lift station on the north side of town to the South Plant and a 0.4-mgd conventional secondary treatment facility of the contact-stabilization

type at an approximate capital cost of $351,000, including engineering and contingencies, with an associated annual operation and maintenance cost of $24,800.

2. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $172,000, including engineering and contingencies.

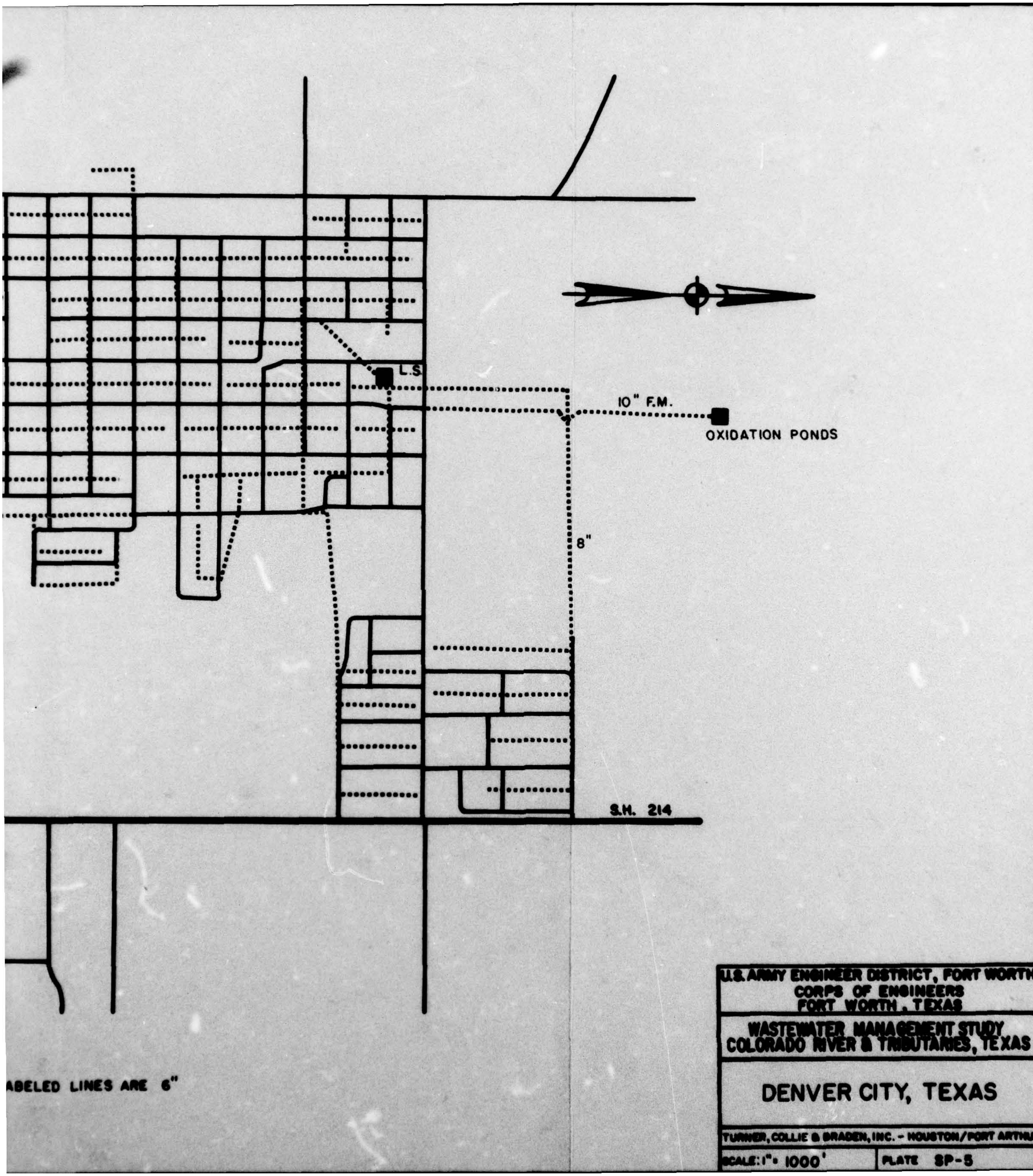
3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $137,000, including engineering and contingencies.



LEGEND

EXISTING SEWER LINE

NOTE: ALL UNLABELED LINES ARE 6"



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

DENVER CITY, TEXAS

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 1000'

PLATE SP-5

AREAWIDE PLAN
FOR
PLAINS, TEXAS

The City of Plains is an incorporated, general law municipality located in the center of Yoakum County at the intersection of U.S. 380 and U.S. 82, and approximately 80 miles southwest of Lubbock, Texas. The incorporated area of the City encompasses approximately 640 acres. Plains is the county seat of Yoakum County and is under the jurisdiction of the SPAG.

The town is divided into northern and southern portions by Sulphur Springs Draw into which both portions drain. The southern portion varies in elevation approximately 70 feet and drains predominantly to the northeast. The northern portion has less topographic relief and drains to the south. The City is underlain by the Portales-Arch and Spur-Potter soil types. The Portales-Arch soils have a friable, calcareous, fine, sandy loam to clay loam surface, 10 to 15 inches thick, over friable, granular, strongly calcareous clay loam grading into white, chalky clay loam at 20 to 36 inches beneath the surface. The Spur-Potter soils have a friable, calcareous, sandy loam to clay loam surface, 10 to 20 inches thick over a clay loam sometimes underlain by a semi-hard layer of caliche several feet thick. Permeabilities range from 0.63 to 2.0 inches per hour. There are moderate to severe limitations on septic tanks due to the underlying bedrock.

Population data developed by the TWDB for use in this study indicate a moderate decrease in population is expected for Plains over the next fifty years. The population estimates are as follows:

Population Projections

Year	1970	1980	1990	2020
Population	1,087	950	930	790

The land use for the City is generally typical of that of other small cities which are characterized by scattered residential development and a concentration of commercial and public facilities along major thoroughfares in the central areas of the City. The economic resource base is agricultural and oil oriented, with no known industrial contribution. Plains is accessible by U.S. 82 and U.S. 380 and S.H. 214. The City is served by the Yoakum County Airfield which is located to the north of Plains. No growth is anticipated due to a lack of economic activity and industrial interest.

Plains obtains its municipal water from two wells, each about 145 feet deep. Storage for the system is provided by a 0.1-mg elevated storage tank. The projected water use is a reflection of the population trend and has been projected by the TWDB to be as follows:

Water Use Projections
(in mgd)

	Year			
	1970	**1980**	**1990**	**2020**
Municipal Use	**0.16**	**0.14**	**0.14**	**0.12**
Industrial Use	**None**	**None**	**None**	**None**

Municipal wastewater return flows have been projected for the City by the TWQB to be as follows:

Waste Load Projections

	Year			
	1970	**1980**	**1990**	**2020**
Flow in mgd	**0.09**	**0.08**	**0.08**	**0.07**
BOD in lb/day	**185**	**171**	**167**	**150**
TTS in lb/day	**217**	**200**	**205**	**182**

The existing wastewater collection system for the City of Plains is shown on Plate SP-6. It appears that the system is adequate for present needs and with the minor extensions shown will meet the future needs of the declining population. The estimated cost for these extensions is $13,300, including engineering and contingencies. Currently, there are no significant areas where septic tanks are the primary means of sewage disposal.

Plains' existing sewage treatment plant is northeast of town approximately one mile east of S.H. 214 and 1.5 miles north of U.S. 380. The plant was constructed in 1955, has a design capacity of 0.135 mgd, and is maintained in relatively poor physical condition. The plant serves about 1,100 people and is of the Imhoff oxidation pond type and consists of a bar screen, an Imhoff tank, an oxidation pond, and sludge drying beds. Available sampling data published by the TSDH and TWQB are as follows:

Influent-Effluent Data (mg/l)

	TSDH (1970)	**TWQB (1970)**
Raw BOD	**210**	**210**
Raw TSS	**160**	**161**
Final BOD	**18**	**18**
Final TSS	**47**	**47**

Sludge disposal consists of hauling the material to a landfill site. Effluent from the system that has not evaporated is used to irrigate adjacent pastures. Under the requirements of PL 92-500, publicly-owned treatment works must provide secondary treatment of effluent by 1977 and the best practicable waste treatment technology by 1983. According to

the present interpretation of this law, land disposal of effluent as practiced meets all requirements when the disposal is carried out in an approved manner, and when no effluent is introduced into the surface water or ground water resource either directly, as runoff, or by direct percolation.

To meet all requirements, the City of Plains should make some minor revisions in the present treatment facilities. These revisions include:

1. Modification of existing pond or addition of another pond to provide multi-cell series operation with overflow weirs from each pond to the next in the series.

2. Organization of irrigation practices under contract to insure dependable year-round operation.

Cost estimates for these improvements (by 1977), including land, engineering and contingencies, is $17,600.

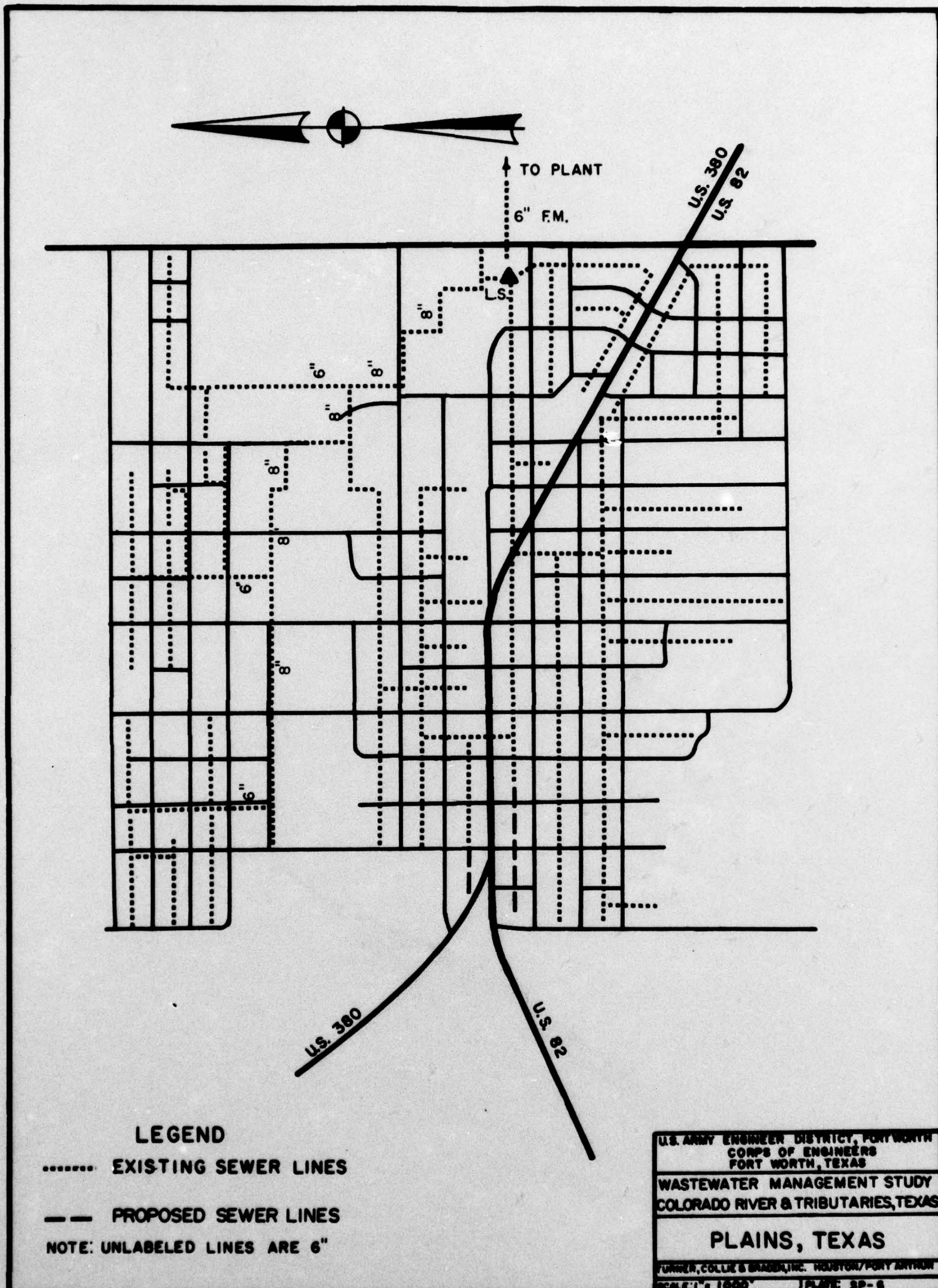
Land disposal of effluent by irrigation can provide a valuable reuse of a scarce natural resource and greatly enhance the local environment in the semi-arid South Plains region. Such irrigation practices are accepted locally and should be encouraged until a more critical need for the water develops.

It is therefore recommended that all steps necessary to implement the aforementioned no-discharge plan be undertaken. However, should the City of Plains wish to implement a discharge plan, the following items would be required:

1. By 1977, construct a 0.09-mgd conventional secondary treatment facility at an approximate capital cost of $110,000, including engineering and contingencies, with an annual operation and maintenance cost of $10,200.

2. By 1983, construct partial tertiary treatment facilities, including partial filtration and phosphorus, ammonia-nitrogen and organic nitrogen reduction facilities at an approximate capital cost of $122,000, including engineering and contingencies.

3. By 1985, construct tertiary treatment facilities including total filtration, denitrification and further phosphorus reduction facilities at an approximate capital cost of $99,500, including engineering and contingencies.



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