Section 8: Infrastructure and Utilities

8.0 Infrastructure and Utilities

8.1Goals and Objectives

Goal 8: Manage and development of infrastructure and utilities to meet the requirements for future development and growth.

Objective 8.1: Develop an equitable system of fees for water and wastewater services and facilities that reflect the cost of extending and providing those services.

Objective 8.2: Extend water and wastewater services to undeveloped areas in accordance with City Utility Plan.

Objective 8.3: Provide for a system of orderly development through regular bond programs and reasonable rates.

Objective 8.4: Identify areas where water and wastewater lines can be efficiently extended and consider incentives to encourage growth in these areas.

Objective 8.5: In equitable fashion require development that is not adjacent to existing utilities or streets to pay for the utilities and street extensions under policies set and adopted by the City Council.

Objective 8.6: Moderate the incremental increasing of local taxes and utility rates through the equitable use of development impact fees for roadways, and utilities.

Objective 8.7: Develop and maintain an infrastructure extension policy based on the phasing in of the City's capital improvement program which would not place an undue burden on City services.

Objective 8.8: Maintain energy and water conservation plans for the City of Rockdale, leveraging state and federal funding opportunities to support them.

8.2 Overview

There are three major concerns with respect to the development, financing and operation of the infrastructure for the City. These concerns revolve around the

requirement to provide an adequate level of water and wastewater service. The first of these concerns is managing growth to the extent that it is possible to adequately plan, finance and develop the infrastructure necessary to accommodate an uncertain increase in population. We must have the ability to acquire an adequate water supply and the ability to treat the water at a higher standard than is required by state agencies. A second concern is how the incremental additions to infrastructure are financed. There are several different ways to accomplish this, each with its own political considerations. A third concern is the development and implementation of management strategies for charging customers for use of the infrastructure as this will normally be one of the major revenue sources for the City. Drought conditions, conservation practices and competitiveness are all factors which must be considered.

8.3 Water System

The City of Rockdale presently owns and operates the water distribution system and treatment plants. The System includes water wells for supply, treatment units for the well water, pumping stations, ground storage tanks, and elevated storage tanks.

The distribution system is operated in two pressure planes, called the "High Plane" and the "Low Plane". The distribution system consists of approximately 271,000 linear feet of pipes ranging in diameters from one inch to twelve inches in diameter. The materials that make up the pipe include PVC, ductile iron, concrete lined, unlined cast iron and asbestos cement.

The City owns and operates two treatment plants, the Mill Street Water Treatment Plant (Mill St. WTP) and the Texas Street Water Treatment Plant (Texas Street WTP).

The Mill Street WTP treats water from two wells located at the airport (Airport Well and Runway Well) and one well located in the Praesel Addition (Praesel Well). The Mill St. WTP utilizes an aeration and filtration process along with chlorination for disinfection. The treated water is then stored in the Mill Street Ground Storage Tank (Mill St. GST). The Mill St. WTP then pumps water into the Mill Street Elevated Storage Tank (Mill St. EST) that serves to also provide storage and maintains pressure throughout the Low Plane. The Texas St. WTP treats water from two wells located at the Texas St. WTP site (New Texas Well and Tracy Well).

The Texas St. WTP utilizes mechanical aeration and chlorine for disinfection to treat the groundwater from the wells and is stored in the Texas Street Ground Storage Tank (Texas St. GST). The Texas Street WTP pumps water to the Allday Elevated Storage Tank (Allday EST) located on Allday Street. The Allday EST serves as a storage tank and also provides pressure to the High Plane.

8.3.1 Raw Water

The City currently owns and operates five groundwater wells and obtains water from these wells for its water supply. The wells are located in the Carrizo-Wilcox aquifer that provides an adequate supply of water for the city in the future. Two factors will control the need to drill new wells or find other sources of water. One factor will be the growth of the City in the future and the other being the need to replace an existing well due to malfunction and/or cost to repair the well. The City currently has an emergency tap that is connected to Southwest Milam Water Supply Corporation and is utilized only in the case of an emergency. Planning a management strategy to provide a good raw water source is critical to the water system and should be as follows:

- Maintain well logs and maintenance records of the existing wells
- Perform annual inspections of the groundwater tables (Post Oak Savannah Groundwater Conservation District)
- Test production from wells on an annual basis and perform maintenance as required.

8.3.2 Water Demand

The City's demand for water currently averages 0.9 million gallons per day and has gone as high as 2.4 million gallons per day. The City currently provides water to over 2450 service connections to customers in and outside of the incorporated limits. The system is maintained to provide adequate pressure and volume to all customers. The City shall plan to for each element that would cause the demand to increase such as new subdivisions and businesses.

8.3.3 Water Quality:

The quality of water that is produced from the existing wells has concentrations of iron and manganese that must be removed to meet the primary standards for safe drinking water. The treatment plants remove these constituents to levels below the primary standards. Secondary standards are not required by state

regulations as they are only to meet aesthetic qualities of the water. The water treatment facilities will need to be upgraded to meet the secondary standards.

8.3.4 Water System Improvements

The City contracted with KSA Engineers Inc. to perform two evaluations, a water distribution study in 2008 and a water treatment study in 2009. The studies provide a good plan on the improvements the City will need to improve the water system. The water system should be reviewed every five (5) years for improvements. The projects include:

8.3.5 Distribution Recommendations:

- Increase pump capacity at Texas St. WTP for the High Plane
- Replace the Allday EST (proposed 2011-2012 fiscal year)
- Water line replacement to improve fire flow and low pressures
- Replace Mill St. EST
- Implement a SCADA system (proposed 2011-2012 fiscal year)
- Provide emergency power to the pump stations
- Continue to upgrade mapping

8.3.6 Water Treatment Recommendations:

- Upgrade Existing Infrastructure at Mill ST. WTP and Texas ST. WTP
- Add pressure treatment at Mill St. WTP and Texas St. WTP
- Build Mill St. Central Treatment Facility

8.3.7 Water Mains

Major water mains, 12 inches in diameter and larger, should be located approximately one mile apart in each direction. 8-inch diameter water mains should be located approximately one-half mile apart in each direction and about half way between major water mains.

A minimum of 8-inch diameter water mains should be installed in all commercial and industrial areas. A minimum of 6-inch diameter water mains should be installed in all residential areas.

Figure No. 2 Water Distribution System Plan, shows the locations of proposed water mains in the City of Rockdale.

For Water System Schematic see Appendix A.

For Water System Map see Appendix B.

8.4 Wastewater System

The wastewater system is made up of the collection system and the wastewater treatment plant. The collection system consists of clay tile, PVC and cast iron piping ranging in size from 6 inch to 18 inches pipes. The wastewater treatment plant is a sequential batch reactor (SBR) that was put online in February 2007. The current capacity of the plant is 1.25 million gallons per day with a peak two hour flow of 2.5 million gallons per day. The plant is located on Beverly Drive and serves the entire City of Rockdale.

8.4.1 Collection System

The collection system provides sewage services to residential and commercial developments. The system is designed to carry the wastewater to the treatment plant located on Beverly Drive. The older pipes are the cause of Inflow/Infiltration that allows the extraneous water to flow into the sewer system. Improvements to the system are very important and several factors will need to be considered when replacing these lines such as:

- Existing flow and pipe diameter allow for expansion
- Future growth to extend system
- Construction cost

8.5 Wastewater System Plan

8.5.1 General

This Wastewater Plan has been prepared by The Hogan Corporation for the City of Rockdale. Texas, (City), in accordance with Work Order No. RD-5, that was approved by the City Council on October 8, 2001. This plan is being updated in 2011. This Plan is one of the elements of a City Plan being prepared for the City.

The purpose of this study is to prepare a City Plan of proposed wastewater facilities to serve the anticipated population within the areas generally covered by the proposed Thoroughfare Plan.

The areas of anticipated growth are within the drainage areas of Ham Branch, Little Ham Branch, and Rockdale Branch. FIGURE NO. 1 shows the different drainage areas studied, and they are designated by Letters A through K.

The acreage in each drainage area was determined, excluding those designated by school grounds, parks, the proposed Relief Route, cemeteries, and areas in the 100-year flood plain. Wastewater flows were calculated as though the drainage areas were fully developed. Then preliminary pipe sizes were determined, using grades developed from U.S.G.S. contour maps of the area, to convey the accumulated wastewater to the treatment plant.

8.5.2 Wastewater Characteristics and Flows

1. Characteristics

The City's wastewater system provides service to residential, commercial, and a minimum of industrial development. In addition to the domestic and industrial wastewater flows contributed by the various types of developments, extraneous water (infiltration/inflow) also enters the collection system through faulty materials or breaks in the collection system.

The domestic wastewater is that sewage that can be attributed to residences and commercial establishments and is quite often expressed as a certain percentage of water usage. Domestic sewage or wastewater is usually of normal strength and presents no special problems in collection or treatment.

Industrial wastewater is comprised of the discharge from establishments engaged in the various aspects of processing or producing some material or product. Many times this type of waste is of a nature that requires special processes and equipment for sufficient treatment before it can be safely discharged into a stream. If this type of wastewater is discharged into a sewerage system at full strength and in appreciable quantities, the pipe lines and pump stations can suffer damage, and the chemical-biological composition of the sewage entering the plant may necessitate changes in the treatment operations. Unlike domestic sewage, which usually has fairly constant characteristics, industrial wastes will vary according to the type of industrial process, time of day, day of the week, season of the year, volume of business, and numerous other conditions.

At the present time, there are very few industrial wastewater contributors in the City. In the future, consideration should be given to requiring industries to pre-treat their wastes through the enforcement of an industrial waste ordinance. Of course, the location, type, and capacity of the required pre-treatment facilities will be according to the specific needs at each industrial site.

Extraneous wastewater, known as infiltration/inflow, is that part of the wastewater flow that comes from stormwater run-off and groundwater. This water enters the sewage collection system by leakage through faulty pipe joints, manholes, cracked pipe, and any connections that may not be watertight. All wastewater collection systems have some infiltration/inflow because it has not been economically feasible to build and maintain a watertight sewerage system, except in areas where the sewer mains are constructed below the groundwater table.

2. Flows

In analyzing the principal sewer mains in the sanitary sewerage system, projected peak flows were routed through the system using Manning's Formula for the flow of water by gravity through pipe.

Manning's Formula is $V=(1.486/n x R^{2/3} x S^{1/2}$, in which "S" is the slope ratio and "R" is the hydraulic radius. The coefficient of roughness "n" was assumed to be 0.013, which is believed to be an average, typical of the entire system, although some of the older sewers may have a higher coefficient of roughness.

In a review of recent flow records of the City, it was determined that the wastewater flows varied from 90 gallons per capita per day (GPCD) in dry weather to 110 GPCD during wet weather conditions. 'These compare favorably with the recommended wastewater flows of the Texas Commission on Environmental Quality (TCEQ) of 100 GPCD for average dry weather flow and an infiltration flow of 20 GPCD. Therefore, the recommended flows of TCEQ were used in the preliminary designs of facilities in this Wastewater Plan.

The criteria used in establishing flow characteristics for each drainage area were based upon estimated population densities that might be expected for each type of zoning or land—use development. In this Plan, a population

equivalent of 6 people per acre was assumed for all residential, commercial, and industrial development.

In the design analysis of the system of wastewater mains, average flows do not represent the flows which the mains must be expected to handle. The wastewater mains should be designed to carry the projected peak flows which can range from 2.5 to 5.0 times the average flow, depending upon the drainage area and population served by the wastewater main. The peak flows should include all wastewater contributed from domestic, commercial, and industrial developments with allowances for peak infiltration/inflow.

For purposes of this Report, peak flows are based on the Babbitt Formula, $M=5/P^{0.2}$, where M is the ratio of maximum to average for sewage flows and p is the accumulated population in thousands. The Babbitt Formula is illustrated by FIGURE NO. 2.

FIGURE NO. 1, shows the drainage areas studied and the preliminary pipe sizes that will be required to convey the wastewater from those areas when fully developed.

The following table shows the total acreage, total contributing population equivalent, and total maximum flow rates in million gallons per day (MGD) anticipated from each drainage area studied.

Area	Total Acres	Total Population Equivalent	Maximum Flow Rate (MGD)
A	1,146	6,876	2.81
B	1,758	10,548	3.92
C	886	5,316	2.30
D	136	816	0.49
E	894	5,364	2.32
F	175	1,050	0.57
G	60	360	0.22
H	272	1,632	0.88
I	115	690	0.42
J	494	2,964	1.42
K	267	1,602	0.87

8.5.3. Existing Collection and Treatment Facilities

1. Collection System

The collection and transmission of wastewater in Rockdale is principally accomplished by a gravity flow system which consists of pipes ranging in size from 4 inches to 21 inches in diameter. The majority of the collection system, however, is comprised of 6-inch and 8-inch diameter mains.

The collection system conveys wastewater to the treatment plant from four principal areas. These are as follows:

a. The Little Ham Branch consists of two 8-inch interceptors. The first interceptor begins at the Meadow Drive/Alcoa Street intersection; then flows southward along Meadow Drive and crossing Cameron Avenue (U.S. Highway 79); then flows eastward parallel to the Union Pacific Railroad to the Little Ham Branch; then flows southward along the Little Ham Branch. The second interceptor begins east of the Childress Street/Cameron Avenue intersection; then flows southward to the Union Pacific Railroad and continuing in the Little Ham Branch parallel to the first described interceptor. Both 8-inch interceptors connect to a 10-inch interceptor that flows along the Little Ham Branch and culminates in a 12-inch interceptor before reaching the wastewater treatment plant located on the south side of the City.

b. The western portion of the City consists of 6-inch and 8-inch collection lines. The primary flows are from the Murray Street/Calhoun Boulevard intersection southward along Calhoun Boulevard to Cameron Avenue. An 8-inch interceptor flows along the north side of Cameron Avenue eastward to the above-described 8- inch interceptor located in Meadow Drive.

c. The Ham Branch area consists of 6-inch collection lines in the northern portions of the City beginning along F.M. 487 (Ackerman Street) and F.M. 908 (Main Street) and flowing southward to the Cameron Avenue/Ham Branch crossing. An 8-inch interceptor begins at Cameron Avenue and flows southward along Ham Branch and connects to a 15-inch interceptor south of the Mill Street Water Treatment Plant. The 15-inch interceptor flows southward along Ham Branch and connects to a 21-inch interceptor located along the Old Railroad right-of-way before reaching the wastewater treatment plant. This area serves the northern and central portions of the City including the downtown district.

d. The Rockdale Branch includes the eastern portion of the City's service area. The collection system consists primarily of 6-inch lines. An 12-inch interceptor begins at the Third Street/Upton Street intersection and flows westward along Third Street to MLK Drive, then southward to the Rockdale Branch, and traversing southwesterly along the Rockdale Branch to the above mentioned 21-inch interceptor.

FIGURE NO. 3 shows the layout of the existing principal wastewater mains in the collection system, 6 inches in diameter and larger,

2. Treatment Plant

The wastewater treatment plant consists of an influent lift station, bar screen, SBR, digester, drying beds, sludge dewatering boxes and ultra violet disinfection. The SBR is permitted at 1.25 MGD and as population and industry grow the plant should expand to meet any of these needs. Sludge dewatering boxes were added in 2011 to the plant to assist the sludge drying beds during rainy events.

8.5.4 Proposed Collection and Treatment Facilities

1. Criteria for Design

The overall objective in the preparation of a wastewater plan for the City of Rockdale is to present a general guide for the future development of the City`s wastewater collection system which can be integrated with the future growth of the City and its surrounding area. Due to the large amount of relatively open or undeveloped land which exists in the areas surrounding the City, recommendations for initial improvements should be confined to the existing areas of development and to those projects which justify immediate attention.

As the needs arise to construct future wastewater mains in the locations shown, a detailed study should then be made of that specific area in order to determine the pipe size, alignment, expenditure, and the type of development and wastewater flow the area is expected to have. Due to the large size of some drainage areas and small amount of development, it is highly probable that one or more intermediate steps or phases of construction may be required in the interim period prior to accomplishing the total plan for the future overall wastewater mains shown on FIGURE NO. 1. However, with an overall plan as a guide, there should be little difficulty in constructing facilities that would be compatible with future growth and expansion. Also, as required easements or

rights-of-way are acquired, they should be of sufficient width to provide for the installation of future parallel mains.

The smaller diameter mains (6-inch and smaller) providing service in the wastewater collection system need continued surveillance to identify problem areas which may re-establish the priorities for proposed improvements.

Major problems requiring large capital expenditures may need to be handled through bond issues; however, as the funds, personnel, and equipment of the City will permit, the smaller problems should be budgeted for and handled by the City as part of an ongoing annual program of sewerage system improvements.

The design for the new wastewater mains should conform to the criteria of the TCEQ, and particular attention should be given to the minimum grades that provide cleansing velocities (2.00 feet per second or greater). It is recommended that the following sizes of pipe should be designed and constructed with the minimum grades indicated.

RECOMMENDED MINIMUM SEWER MAIN GRADES

Pipe Diameter (I.D. in inches)	Minimum Grade (ft./100 Ft. of Pipe	Q* MGD.	Velocity* (Ft./Sec).
6	0.50	0.259	2.02
8	0.33	0.458	2.03
10	0.25	0.735	2.05
12	0.20	1.04	2.04
15	0.15	1.67	2.11
18	0.11	2.35	2.06
21	0.09	3.24	2.08
24	0.08	4.14	2.04
36	0.045	9.65	2.11

*Based on n = 0.013

For any sewer pipe larger than 24 inches in diameter, the grade that will maintain a minimum velocity of 2.0 feet per second and carry the anticipated flow may be determined by Manning's formula.

The manholes in a wastewater collection system provide a convenient access to the sewer pipe for inspection of flows and maintenance purposes. However, if the manhole is poorly constructed or the spacing is not properly made, the value of the manhole is lost. Again, the TCEQ recommends specific criteria for the design and construction of manholes in the wastewater system. These recommendations should be reviewed and adopted as minimum standards of the City. A recommended maximum spacing and diameter for manholes are shown in the following table according to the largest pipe entering the manhole.,

DESIGN CRITERIA FOR SANITARY SEWER MANHOLES

Pipe Diameter	Maximum Spacing	Manhole Diameter
8"	500'	4.0'
10"	500`	4.0`
12"	500'	4.0`
15"	500`	4.0'
18"	600`	4.0'
21"	600`	5.0`
24"	600'	5.0'

Where wastewater mains will not be extended beyond a given point, it is recommended that a cleanout be constructed at the end of the pipe. This will, at least, provide a means for cleaning the pipe, if it becomes necessary.

2. Collection System

a. Drainage Area A

Drainage Area A includes the western portion of the City's wastewater collection system. The system consists of 6-inch and 8-inch collection lines that flow from the northern portion of Drainage Area A southward to and

along Cameron Avenue into two 8-inch interceptors located south of the Childress Street/Cameron Avenue intersection. The two 8-inch interceptors flow along Little Ham Branch into a 10-inch interceptor which connects to a 12-inch interceptor before reaching the treatment plant.

As anticipated flows increase in Drainage Area A, it is recommended that 8-inch, 10-inch, 12-inch and 15-inch interceptors be installed in the drainage area. A 10-inch interceptor is recommended to be installed along Calhoun Boulevard flowing southward across Cameron Avenue to the Union Pacific Railroad and connecting to a 15-inch pipe traversing southward to a proposed lift station located approximately 3/4 mile south of the Union Pacific Railroad.

It is also recommended that an 8-inch interceptor be installed along the east side of the Oak Park Subdivision and flow southward, and connect to a proposed 12-inch interceptor flowing eastward along U S. Highway 79 which culminates into the previously mentioned 15 inch interceptor. A proposed lift station will pump the anticipated flows eastward via force main to a new 15-inch interceptor which culminates into a proposed 18-inch interceptor located along Little Ham Branch before reaching the treatment plant.

It is recommended that 8-inch and 10-inch interceptors be installed south of the Union Pacific Railroad in Drainage Area A and located along Little Ham Branch, and connect to the above mentioned 18-inch interceptor.

b. Drainage Area B

The existing wastewater collection system in Drainage Area B consists of 6-inch and 8-inch lines and includes an area from the treatment plant through the central portion of the City, and northward along F.M. 487 and F.M. 908 to the proposed U.S. Highway 79 Relief Route. In the western portion of Drainage Area B, it is recommended that an 8-inch and 10-inch interceptor he installed beginning along and west side of an electrical substation located along F.M. 908 and flowing southward to a proposed I2-inch interceptor north of Wilcox Street. It is also recommended that two 8-inch interceptors be installed north of the Rockdale Junior High School along Bushdale Road and flow eastward to the before mentioned 12-inch interceptor.

A 15-inch interceptor is proposed to be installed beginning north of Wilcox Street and flowing southward along Wilcox Street to the Cameron Avenue /Ham Branch intersection. An additional 10-inch interceptor is recommended to be installed east of the Junior High School beginning in Highland Street and flow eastward and connect to the proposed 15-inch interceptor at the Wilcox Street/Hillyer Street intersection.

The eastern portion of Drainage Area B is recommended to consist of three interceptor routes. One route, consisting of three 8-inch and one 12-inch interceptors, is proposed to begin along F.M. 487 traveling southward along Ham Branch to Main Street and connect to a proposed 15-inch interceptor to be installed along Ham Branch north and west of the Main Street/San Andres Street intersection.

The second route is proposed to begin with an 8-inch interceptor west of Texas Street and flow southward and connect to a proposed 10-inch interceptor beginning east of the Ferguson Street/Smith Road intersection and traverse along the east channel of Ham Branch and connect to the previously mentioned 15-inch interceptor.

The third route is recommended to begin at the Bell Street/Texas Street intersection and flow westward to San Gabriel Street, southward to an alley between Cameron Avenue and Bell Street, and then westward through the alley and connect to the above-mentioned 15-inch interceptor in Ham Branch.

The recommended route of the proposed 15-inch interceptor is along Ham Branch from north and west of the Main Street/San Andres Street intersection until crossing Cameron Avenue. This will connect to the 18 inch interceptor and flow southward along Ham Branch.

c. Drainage Areas C and J

The C Drainage Area consists primarily of the eastern portion of the City's wastewater collection area. Two interceptor routes are proposed in the drainage area. In the first route, it is recommended that an 8-inch interceptor he installed beginning east of Texas Street in the Old Railroad right-of-way and flow southward to a proposed 10-inch interceptor beginning north of the Belton Street/Pear Street intersection. An additional 8-inch interceptor is recommended to be installed beginning north of Belton

Street and flow westward to the proposed 10-inch interceptor. The 10-inch interceptor is proposed to flow along Rockdale Branch southward to Cameron Avenue. This will connect to the 12 inch line in Rockdale Branch.

The second route is recommended to consist of a 12-inch interceptor and begin approximately 1,000 feet west of the U.S. Highway 77/County Road 333 intersection and flow parallel to U.S. Highway 77 southward to U.S. Highway 79 and across the Union Pacific Railroad into Drainage Area J. The 12-inch pipe will continue flowing southward in Drainage Area J to Third Street east of the Oaklawn Cemetery. From this point, it is recommended that a 15-inch interceptor be installed flowing southward to U.S. Highway 77 into a proposed new lift station located approximately 1,000 feet east of the U.S. Highway 77/F.M. 908 intersection.

It is also recommended that an 8-inch interceptor be installed south of the Riddle Cemetery and flow eastward to the 15-inch pipe along U.S. Highway 77. A lift station and force main will then be installed to pump flows westward into a 15-inch interceptor located in Drainage Area K.

d. Drainage Area D

Anticipated flows in Drainage Area D are proposed to flow westward in an 8-inch interceptor along County Road 306 to a proposed new lift station to be located west of County Road 306 and along the proposed U.S. Highway 79 Relief Route. From this lift station, the wastewater will be pumped in a force main eastward along U.S. Highway 79 to a proposed 12-inch interceptor in Drainage Area A.

e. Drainage Area E

Studies of Drainage Area E show that wastewater should be collected in three separate 8-inch interceptors and flow in a 10-inch interceptor to a proposed new lift station to be located north of the proposed U.S. Highway 79 Relief Route. Wastewater will then be pumped southward via a force main to U.S. Highway 79 and connect with the proposed force main serving Drainage Area D.

f. Drainage Area F

Wastewater in Drainage Area F is proposed to flow northward in an 8-inch interceptor to a proposed lift station located along the proposed U.S. Highway 79 Relief Route and west of Bushdale Road. Wastewater will then be pumped through a force main along the proposed Relief Route to an 8-inch interceptor located in Drainage Area G.

g. Drainage Area G

The proposed 8-inch interceptor in Drainage Area G is recommended to flow eastward for approximately 1,000 feet along the proposed U.S. Highway 79 Relief Route to a new lift station to the located west of FM. 908. Flows will then be pumped through a force main southward to a proposed 10-inch interceptor located in Drainage Area B.

h. Drainage Areas H and I

Three 8-inch interceptors are recommended in Drainage Area H and are proposed to flow northward along the Old Railroad right-of-way to a proposed new lift station to be located along the proposed U.S. Highway 79 Relief Route. Wastewater will then be pumped via a force main to a 10-inch main to be located in Drainage Area I and flow eastward to a proposed new lift station located along U.S. Highway 77. An 8-inch interceptor is also recommended north of County Road 333 flowing northward to the lift station. Wastewater will then be pumped through a force main to the proposed 12-inch interceptor located west of U.S. Highway 77 in Drainage Area C.

i. Drainage Area K

In Drainage Area K, a 15-inch interceptor is recommended to begin approximately 1,000 feet north of the U.S. Highway 77/F.M. 908 intersection and flow westward approximately 3,000 feet to a proposed new lift station to be located east of the treatment plant along the Old Railroad right-of-way. It is also recommended that an 8-inch interceptor be installed beginning east of the Beverly Street/F.M. 908 intersection and flow southwesterly to the previously mentioned lift station. From the lift station, it is recommended that wastewater be pumped via a force main westward to the 21-inch interceptor in Drainage Area B.

8.5.5 Conclusions and Recommendations

1. The City has a wastewater collection system that flows by gravity to an existing wastewater treatment plant located approximately one mile south of the Cameron Avenue/Wilcox Street intersection.

2. The collection mains vary in size from 6-inch pipes, principally in residential areas, to 12-inch pipes which enter the treatment plant site.

3. The existing and proposed wastewater collection system was evaluated and preliminarily sized to meet the design criteria of TCEQ. In the design of future wastewater facilities, the City should continue to design its facilities to meet at least the minimum criteria of TCEQ, as included herein.

4. Large drainage areas are located in all directions around the City, and the effluent flows from future development in these areas will flow by gravity primarily along the Ham Branch, Little Ham Branch, Rockdale Branch, and then to the wastewater treatment plant.

5. It is recommended that, hereafter, the minimum size of wastewater lines are 8 inches in diameter. Only on dead-end lines, 500 feet and shorter, should 6-inch pipes be considered, and then they should terminate with a cleanout.

6. Along with additional wastewater flows occurring from development along the proposed U.S. Highway 79 Relief Route, it is recommended that the proposed interceptors in Drainage Area B be installed beginning at the wastewater treatment plant to (a) east of the Rockdale Junior High School, (b) north of the Rockdale Youth Baseball Complex along Wilcox Street, (c) north of the I.O.O.F. Cemetery along F.M. 908, (d) to the Rice Street/Ferguson Street intersection, and (e) to the Bell Street/Texas Street intersection.

8.6 Solid Waste Service

Garbage service is mandatory to property owners and provided by the City through contract. The City might consider a composting and mulching operation as a potential revenue source and environmental issue.

8.7 Water, Wastewater and Sanitation Rates

UTILITIES AND SOLID WASTE

Monthly Water Charges - inside city limits		
First 2000 Gallons	$23.18	minimum
All over 2000 Gallons	$4.53	per 1000 gallons
Monthly Water Charges - outside city limits		
First 2000 Gallons	$29.13	minimum
All over 2000 Gallons	$6.79	per 1000 gallons
Monthly Wastewater Charges - inside city limits		
First 2000 Gallons	$14.96	minimum
All over 2000 Gallons	$5.84	per 1000 gallons
Monthly Wastewater Charges - outside city limits		
First 2000 Gallons	$22.45	minimum
All over 2000 Gallons	$8.76	per 1000 gallons

UTILITY - SOLID WASTE / GARBAGE

Solid Waste collection (one time per week)		
Residential curbside pick-up (1 Cart plus 3 bags)	$13.51	per month
Commercial small hand pick up (1-5 bags)	$13.51	per month
Commercial large hand pick up (6-10 bags)	$21.64	per month
Roll-off bins/Dumpsters	Customer must contact company directly	
Additional Roll-out (cart) fee	$6.00	per month/per cart
Delivered to City Yard - Residents		
Small trash bag	$0.50	per bag
Medium trash bag	$0.75	per bag
Large trash bag	$1.00	per bag
Pick-up Truck (level)	$15.00	
Pick-up Truck (with side boards)	$30.00	
Extra-large load	as determined by Public Works Director	
Delivered to City Yard - Non-Residents		
Small trash bag	$0.75	per bag
Medium trash bag	$1.50	per bag
Large trash bag	$2.50	per bag
Pick-up Truck (level)	$20.00	
Pick-up Truck (with side boards)	$40.00	
Extra-large load	as determined by Public Works Director	

8.8 DRAINAGE PLAN

8.8.1 SECTION I - INTRODUCTION

8.8.2 Purpose

The purpose of this document is to provide the City of Rockdale, Texas with information to use as a guideline in the planning and development of a comprehensive stormwater management system. This information will be used in conjunction with the Stormwater Management Design Criteria Manual as adopted by the City of Rockdale. This document is a part of the Comprehensive City Plan prepared for the City of Rockdale.

8.8.3 Scope

This document will present recommendations to the City of Rockdale for use by the City and developers in the design of future storm drainage facilities. The recommendations will involve several aspects of the overall stormwater drainage characteristics of the City and the immediate surrounding areas including but not limited to:

- Analysis of the drainage areas in and around the City.
- Determination of drainage areas and runoff within the presently developed areas of the City.
- Preparation of a separate document that will serve as a drainage design manual.
- Preparation of a general plan for proposed major improvements to the existing storm drainage system.
- Preparation of a general plan for proposed improvements in areas that currently experience flooding and/or ponding due to the absence of an existing system.
- Recommended locations and alignments for major drainage facilities including open channels, and enclosed inlet and pipe systems.

8.8.4 Background

The City of Rockdale, Texas is located in the east-central part of the State, in the southern half of Milam County. The City lies approximately 170 miles northwest of the Gulf of Mexico in the coastal plain.

The soils in the area consist of several types including Silstid Series, Padina Series, Rader Series, Minerva Series and Edge Series. These soil types have drainage characteristics that range from well-drained loam in the Silstid, Padina and Minerva Series to very slowly permeable silts in the Rader and Edge Series. The well-drained, moderately permeable Padina soils are located in the far west and northwest part of the City. The well drained, moderately permeable Silstid soils are found in the near west and central part of the City. The very slowly permeable soils in the Rader and Edge Series are found in the eastern and southeastern part of the City.

The drainage in and around the City of Rockdale is predominantly from the northwest to the southeast. There is a drainage divide in the northwest corner of the extraterritorial jurisdiction (ETJ) that separates the major drainage basins of Brushy Creek and East Yegua Creek. The topography is such that the City is then divided into six (6) minor drainage basins that drain into tributaries of East Yegua Creek. These tributaries empty into the main channel of Yegua Creek approximately 4.5 miles south of the City.

The tributaries are named in some areas of the City. The tributaries are as follows, starting from the west and moving to the east along the roadway of U.S. Highway 79:

- A channel that begins at the intersection of San Jacinto Drive and Cameron Avenue. This channel flows to the south for approximately two (2) miles before turning east. The channel joins several other small tributaries before merging with the Ham Branch Creek about 2.5 miles south of the City. This channel is unnamed according to information available at the time of this report. This document will subsequently refer to the tributary as the "West Channel".

- A channel that begins at the intersection of Childress Drive and Cameron Avenue. This channel becomes the Little Ham Branch as it flows to the south of the City.

- A channel that joins the Ham Branch Creek on the south side of Cameron Avenue between Wilcox Street and Scarborough Street. This channel is

unnamed according to information available at the time of this report. This document will subsequently refer to the tributary as the "West Ham Branch Channel".

- The main channel of the Ham Branch Creek that crosses Cameron Avenue between Wilcox Street and Scarborough Street.
- The channel that is known as the Rockdale Branch Creek that crosses Cameron Avenue between Texas Street and Pear Street.
- A channel that crosses Cameron Avenue on the east side of the City at approximately the current City Limits. This channel is unnamed according to information available at the time of this report. This document will subsequently refer to the tributary as the "East Channel".

An aerial representation of these channels is shown in Figure I-1. These channels and creeks are overgrown with weeds, grass and small trees in many places. There is also a high degree of sedimentation along many reaches as well as accumulated debris. The result is a reduction in capacity to convey stormwater runoff from major storm events. The demand on the capacity of these channels is expected to increase significantly as the City develops. Any future improvements in the upstream reaches of these tributaries should take into account the potential downstream effects of the development. This document will provide guidelines and recommendations to successfully manage future development related drainage issues.

8.8.5 Design Criteria Overview

8.8.5.1 Determining Runoff

There are several methods available to professionals in the field of hydrology to determine the amount of rainfall runoff from a given storm event. The most commonly used and accepted is known as the Rational Method. This method involves several key factors including the size of the area under investigation, the surface characteristics of the area, the topography of the area, the intensity of the storm, and time factors such as the duration and frequency of the storm in question. The Rational Method applies the equation:

$Q = C * I * A$

Where Q represents the quantity of rainfall runoff in cubic feet per second, (cfs); C represents a coefficient that indicates the percentage of runoff from a rainfall event; I represents the intensity of rainfall in inches per hour; and A represents the size of the drainage area in acres.

8.8.5.2 Area Size

The size of the area is determined by the natural topography of the area. The area is surrounded by drainage "divides" that follow the high points in the adjacent terrain. The unit of area used in the Rational Method is an acre.

8.8.5.3 Surface Characteristics and Runoff Coefficients

The runoff coefficient is a unitless coefficient that reflects the surface conditions and the ability of the soils to absorb or retain the excess rainfall from the storm event. This coefficient can range from as low as 0.3 for pastures, parks, and cemeteries with thick grass cover to 0.90 for large commercial shopping areas where parking and street pavement cover much of the area and are considered impervious to rainfall absorption. These latter types of areas present problems for the planner in that large areas of impervious cover can cause severe flooding in downstream areas. The following Table may be used to estimate the runoff coefficient for various land uses:

Land Use	Runoff Coefficient "C"
Residential	0.6
Commercial	0.9
Industrial	0.8
Multiple Unit Dwelling	0.8
Parks	0.4
Cemeteries	0.3
Pasture	0.4
Woods	0.3
Cultivated	0.5

Shopping Centers	0.9
Paved Areas	0.9
Schools	0.7
Patio Homes	0.6

8.8.5.4 Rainfall Intensity

The intensity of the rainfall during a storm event is determined by the use of curve data developed from the National Weather Service Rainfall-Frequency Data as presented in Technical Memorandum NWS Hydro-35, dated June, 1977, and Technical Paper No. 40, dated May, 1961. The curves have been prepared for a range of storm frequencies and durations. The duration of the storm is assumed to be equal to or greater than the time of concentration. The terms frequency and time of concentration will be described very briefly in the following paragraphs. However, reference should be made to the Stormwater Management Design Criteria Manual for a complete discussion on these concepts. Figure I-a shows a typical set of Rainfall Intensity Curves for a range of storm durations.

8.8.5.5 Frequency

The design discharge resulting from storm runoff is dependent upon the required level of protection, which represents a certain "return" period, or frequency of occurrence, in years. For example, for a storm event that has a design frequency of five (5) years, the probability that a storm of equal or greater severity occurring at least once in five (5) years is 100%. Similarly, the probability that a storm of equal or greater severity occurring at least once every year is 20%. The same principle applies for the entire range of frequencies used in stormwater drainage design. A 25-year design frequency storm event has a 100% probability of occurring at least once in 25 years, and a 4% chance of occurring at least once every year. This report recommends that the City of Rockdale use the 25 -year storm as a basis for future planning.

8.8.5.6 Time of Concentration

The time of concentration (tc) used in determining the rainfall intensity is defined as the time required by a theoretical drop of water to travel from the most hydraulically remote point of the drainage area to the point of interest. This time is a combination of the overland travel time, channelized travel time, and the travel time in the drainage facilities. The overland travel time is the time required by the drop of water to travel a certain overland distance where there is no defined channel, gutter or storm drainage facility. The maximum overland travel distance allowed is 300 feet, after which the flow should be considered channelized. If there is evidence of a well-defined channel in the upper reaches of a drainage area, channelized flow should be considered even though the overland travel distance will be only a fraction of the 300-feet allowable. The inlet time of concentration is defined as the sum of the overland travel time and the channelized travel time required by a drop of water to travel from the most hydraulically remote point of the drainage area to the first inlet into the storm drainage system. The Table below may be used to estimate the minimum time of concentration for inlets used in various types of land uses.

Land Use	**Minimum Inlet Time (Minutes)**
Residential	15
Commercial	10
Industrial	10
Multiple Unit Dwelling	10
Parks	15
Cemeteries	15
Pasture	15
Woods	15
Cultivated	20
Shopping Centers	10
Paved Areas	10

Schools	15
Patio Homes	15

8.8.5.7 Channels

The three types of drainage channels that will be recommended in this report are Type I, Type II, and Type III. Figure I-b shows the typical cross sections of these three types of channels. A Type I channel is a channel that is mostly unimproved with respect to cross section or slope. The channel is intended to remain in its natural state with minor maintenance activities such as mowing and debris removal performed at appropriate intervals. This type of channel has the largest right-of-way and easement requirements.

8.8.6 Organization

This document will be organized to present findings, recommendations, proposals, and conclusions in the following manner:

- A Section that will contain a brief discussion of the major and minor drainage basins that comprise the overall stormwater drainage system of the City and immediate surrounding areas.
- A Section that will contain descriptions of the various types of stormwater drainage control structures as well as some of the benefits that accompany the use of these structures.
- A Section that will present proposals and suggestions for the locations of future drainage improvements that will include the appropriate use and placement of the various types of structures.
- A Section that will present a summary of conclusions and recommendations, based upon available information, that will serve as a guideline for the City of Rockdale in the planning of future stormwater drainage systems.

8.9 SECTION II – MAJOR AND MINOR DRAINAGE BASINS

8.9.1 DRAINAGE BASINS

The City of Rockdale is located in a topographical area which creates eighteen (18) major and minor drainage basins within an area bounded by an imaginary line drawn approximately one mile outside the present City Limit line. The three largest basins are in excess of 600 acres in area, with the largest being greater than 780 acres. There are several intermediate-sized basins ranging in size from 140 acres to 440 acres. The smaller basins range from 28 acres to 130 acres. A list of the drainage areas and their designations is as follows:

Drainage Area Name	Drainage Area Size (Acres)
W1	198
W2	341
W3	28
C1	438
C2	606
C3	785
C4	137
E1	129
E2	321
E3	301
SW1	309
SW2	65
SC1	144
SC2	399

SE1	163
SE2	396
S1	151
S2	84

Figure II-1 illustrates the drainage basins and their relative location within the City and surrounding area.

8.9.2 Drainage Areas, Basins and Runoff

This section will present the drainage areas shown in Figure II-1 with a brief discussion of the area's estimated runoff, the drainage channel that serves the area, the present surface characteristics of the area, and the potential changes that may be expected with future development.

8.9.2.1 Drainage Area – W1

This area is located on the west side of the study area. The drainage basin includes the Oak Park community. The area is approximately 25% developed at this time. The area is approximately 198 acres in size and will generate between 220 to 390 cfs, depending on the severity of the storm and the type of future development. The runoff is conveyed downstream via a natural channel which passes under U.S. Highway 79 through an improved box culvert that has been installed as part of the highway improvements by the Texas Department of Transportation (TxDOT). The channel joins with another channel at the southernmost point and continues to flow to the south.

8.9.2.2. Drainage Area - W2

This area is located in the western portion of the City and includes the Edgewood and Hogan Subdivisions and portions of the Linwood, Coffield #4, Coffield #3, Westwood, Parkview and Hillcrest 1 Subdivisions. These areas are residential in nature with some light commercial use along U.S. Highway 79. The area is approximately 50% developed at this time. The area is approximately 340 acres in size and will generate between 490 to 860 cfs, depending on the severity of the storm and the type of future development.

The runoff is conveyed downstream via overland flow, small local natural channels, streets, gutters and a small enclosed pipe system. The pipe system discharges through two (2) twenty-four inch (24") pipes into a culvert at the intersection of San Jacinto Drive and West Cameron Avenue. The culvert discharges into an improved natural channel and continues to flow south to another culvert under the railroad tracks. This culvert is undersized at this point and will not accommodate the anticipated flows from future development within this drainage basin. This situation will be discussed in further detail in Section IV.

8.9.2.3. Drainage Area - W3

This area is undeveloped and is located south of the railroad tracks adjacent to the drainage channel that serves Drainage Area - W2 described above. The natural channel continues to the south where it joins the channel that serves Drainage Area - W1. The area is relatively small in size and will contribute 25 to 48 cfs of surface runoff to the creek system.

8.9.2.4. Drainage Area - C1

This area contains land uses that range from school districts, residential tracts and medical offices to commercial properties along U.S. Highway 79. The school districts include both Rockdale Senior High School and the Junior High School. The residential tracts include the Meadowbrook, Linwood 1 & 2, Coffield 1 & 2, Town East, McGranahan and Smith Subdivisions. The area is over 95% developed at this time. The land use and level of development in this area indicates a surface runoff coefficient of 0.60. The area is approximately 440 acres in size and can generate as much as 1,230 cfs.

The runoff is conveyed downstream via overland flow, small local natural channels, streets, and gutters onto Meadow Drive and Childress Drive. The runoff then enters culvert pipes at the intersections of those streets and West Cameron Avenue. The flow on Meadow Drive and Childress Drive is intercepted on the north side of the highway right-of-way and conveyed in box culverts under the highway to discharge into a natural channel south of the Childress Drive intersection. The channel continues to the south where it enters another box culvert to pass under the railroad tracks. This box culvert is also undersized at this point and will not accommodate the anticipated flows from current

development within this drainage basin. This situation will also be discussed in further detail in Section IV.

8.9.2.5. Drainage Area - C2

This area is the second largest drainage basin in the study area. The drainage area is located in the west central part of the City and is bounded by the major drainage divide to the north of the City. The area is predominately residential in use with a portion of IOOF Cemetery, several baseball fields, and undeveloped pasture included within the boundaries. The developed portion consists primarily of established residential neighborhoods with small to medium sized lots. The undeveloped area in the north will have a high potential for development, particularly with the prospect of a Relief Route being built along the northern boundary of this drainage area. The area is approximately 40% developed at this time. The area is approximately 605 acres in size and will generate between 870 and 1,540 cfs, depending on the severity of the storm and the type of future development.

The runoff is conveyed downstream via overland flow, small local natural channels, streets, and gutters which discharge into a well-defined natural channel at various points along the channel course. The channel meanders from the northwest to the southeast for about a mile before turning to the south and roughly paralleling North Wilcox Street to a point just south of Cameron Avenue. At this point the channel joins the main channel of Ham Branch and continues south through Drainage Area – SC1.

The channel is currently severely choked with grass, weeds, and debris from past storms in several places. This blockage in the stream bed occurs mainly along the reaches in developed neighborhoods and severely limits the capacity of the channel to effectively convey the runoff. The channel is irregular in cross section which causes rapid changes in the flow velocity. This leads to scouring and erosion problems along the stream course. As the areas to the north are developed, this channel will require considerable improvement and modification to ensure sufficient capacity. These improvements may include:

- The widening of the channel in some areas.
- Reshaping the channel to a more hydraulic efficient cross section in some areas.

- Lining the channel with concrete sides and bottom.
- Cleaning debris from the stream bed.
- Regular mowing of grass-lined sections to maintain a uniform vegetal cover.
- Installing a non-erosive lining, such as concrete, in sharp bends and corners of unlined portions.
- Realignment of the channel to reduce the number of sharp bends and corners.
- Modification and/or replacement of street crossings with properly designed box culverts to improve hydraulic efficiency.

These improvements and modifications will increase the capacity of the channel to accommodate future development in the upstream reaches. The planner must also bear in mind that this increase in capacity along the upstream reaches will ultimately flow into the downstream reaches, and appropriate consideration will be required to prevent creating downstream problems while resolving the upstream drainage issues.

8.9.2.6. Drainage Area - C3

This drainage area is the largest basin within the study area. The drainage area is located in the east central part of the City and is bounded by the major drainage divide to the north of the City. The area is predominately residential in use and includes a large portion of the Original Township of Rockdale as well as a portion of IOOF Cemetery and undeveloped pasture land within the boundaries. There is currently some light industry along Farm-to-Market Roads 908 and 487. The developed portion consists primarily of established residential neighborhoods with small to medium sized lots. The undeveloped area in the north will have a high potential for development, particularly with the prospect of a Relief Route being built along the northern boundary of this drainage area. The area is approximately 35% developed at this time. The area is approximately 785 acres in size and will generate between 1,120 and 1,990 cfs, depending on the severity of the storm and type of future development.

The runoff is conveyed downstream via overland flow, small local natural channels, streets, and gutters which discharge into the main channel of Ham Branch Creek at various points along the channel course. This creek is the

largest of the drainage channels, and all but one of the remaining channels are tributaries to this creek and join at some point downstream.

The creek channel flows south through the City and becomes progressively larger in capacity as the tributaries discharge their runoff flows into the creek. There are some locations along the stream bed that are restricted by unchecked vegetal growth, driftwood and debris from previous storms, and trash articles. Because this creek is the main drainage channel for the entire Rockdale area, it is essential that a concerted effort be made by the appropriate agencies to keep the main channel clear from these types of blockage. As the undeveloped areas are developed, drainage easements such as those described in the Stormwater Management Design Criteria Manual should be acquired to allow access for maintenance personnel and equipment.

As the areas to the north are developed, the creek channel will require some degree of improvement and modification to ensure sufficient capacity. These improvements may include:

- The widening of the creek channel in some areas.
- Reshaping the creek channel to a more hydraulic efficient cross section in some areas.
- Lining the channel with concrete sides and bottom.
- Cleaning debris and trash from the stream bed.
- Regular mowing of grass-lined sections to maintain a uniform vegetal cover.
- Installing a non-erosive lining such as concrete in sharp bends and comers of unlined portions.
- Realignment of the channel to reduce the number of sharp bends and corners.
- Modification and/or replacement of street crossings with properly designed box culverts to improve hydraulic efficiency.

These improvements and modifications represent the most cost-effective means to increase the capacity of the creek channel to accommodate future development along Ham Branch as it flows through the City and its Extraterritorial Jurisdiction (ETJ). There are other options that may be considered

at such time that a particular problem area is defined and solutions are designed. As in the case of the tributaries to this creek channel, the planner must also bear in mind that this increase in capacity along the upstream reaches will ultimately flow into the downstream reaches, and appropriate consideration will be required to prevent creating downstream problems while resolving the upstream drainage issues.

8.9.2.7. Drainage Area - C4

This area is located in the northeastern part of the City and is also bounded by the major drainage divide to the north of the City. Most of the area is currently undeveloped; however, tax assessment maps indicate that approximately 40% of the land is planned for high-density residential use. The area has a fair to high potential for development in conjunction with the proposed thoroughfare plan and Relief Route construction. The area is approximately 137 acres in size and will generate between 170 and 305 cfs, depending on the severity of the storm and the type of future development.

The runoff is conveyed downstream via overland flow, small local natural channels and gutters which discharge into a poorly-defined natural channel at various points along the channel course. The channel meanders from the northeast to the southwest for about one-half mile before joining the main channel of the Rockdale Branch. The main channel of Rockdale Branch continues southwest through Drainage Area - SC2.

The channel in this area is currently overgrown with grass, weeds, and debris from past storms in places where the channel is too shallow or lacks definition. This lack of depth and definition severely limits the capacity of the channel to effectively convey the runoff, and this problem will worsen with upstream development. The channel is irregular in cross section which causes rapid changes in the flow velocity. This leads to scouring and erosion problems along the stream course.

As the areas to the north are developed, this channel will require considerable improvement and modification to ensure sufficient capacity. These improvements may include:

- The widening of the channel in some areas.

- Reshaping the channel to a more hydraulic efficient cross section in some areas.
- Lining the channel with concrete sides and bottom.
- Cleaning debris from the stream bed.
- Regular mowing of grass-lined sections to maintain a uniform vegetal cover.
- Installing a non-erosive pilot channel, such as concrete, in the unlined portions to help define the channel course.
- Realignment of the channel to reduce the number of sharp bends and comers.
- Modification and/or replacement of street crossings with properly designed box culverts to improve hydraulic efficiency.

These improvements and modifications will increase the capacity of the channel to accommodate future development in the upstream reaches. The same downstream issues mentioned above will be in effect and should be considered when planning channel improvements. As future development occurs, drainage easements should be acquired wherever possible to facilitate maintenance and construction activities.

8.9.2.8. Drainage Area - E1

This area is located next to Drainage Area - C 4 in the eastern part of the City and is also bounded by the major drainage divide to the north of the City. Most of the area is currently undeveloped; however, tax assessment maps indicate that approximately 45% of the land is planned for medium-density residential use. The area has a fair to high potential for development in conjunction with the proposed thoroughfare plan and Relief Route construction. The area is approximately 129 acres in size and will generate between 160 and 290 cfs, depending on the severity of the storm and the type of future development.

The runoff is conveyed downstream via overland flow, small local natural channels, streets, and gutters which discharge into a poorly-defined natural channel at various points along the channel course. The channel meanders from the northeast to the southwest for about one-half mile before becoming the main channel of the Rockdale Branch. Rockdale Branch continues

southwest through Drainage Area - SC2. The channel in this area is currently overgrown with grass, weeds, and debris from past storms in places where the channel is too shallow or lacks definition. This lack of depth and definition severely limits the capacity of the channel to effectively convey the runoff, and this problem will worsen with upstream development. The channel is irregular in cross section which causes rapid changes in the flow velocity. This leads to scouring and erosion problems along the stream course.

As the areas to the north are developed, this channel will require considerable improvement and modification to ensure sufficient capacity. These improvements may include:

- The widening of the channel in some areas.
- Reshaping the channel to a more hydraulic efficient cross section in some areas.
- Lining the channel with concrete sides and bottom.
- Cleaning debris from the stream bed.
- Regular mowing of grass-lined sections to maintain a uniform vegetal cover.
- Installing a non-erosive pilot channel, such as concrete, in unlined portions to help define the channel course.
- Realignment of the channel to reduce the number of sharp bends and corners.
- Modification and/or replacement of street crossings with properly designed box culverts to improve hydraulic efficiency.

These improvements and modifications will increase the capacity of the channel to accommodate future development in the upstream reaches. The downstream issues mentioned previously will be in effect and should be considered when planning channel improvements. As future development occurs, drainage easements should be acquired wherever possible to facilitate maintenance and construction activities.

8.9.2.9. Drainage Area - E2

This area is in the eastern part of the City and includes the area extending to U.S. Highway 77 at the eastern edge of the current City Limits. The area is currently sparsely developed along the roadway alignments of U.S. Highways 77 and 79. The area has a fair potential for development in conjunction with the proposed thoroughfare plan and Relief Route construction. The area is approximately 300 acres in size and will generate between 280 and 505 cfs, depending on the severity of the storm and the type of future development.

The runoff is conveyed downstream via overland flow, small local natural channels and gutters which discharge into a fairly-defined natural channel at various points along the channel course. The channel meanders in a southerly direction for about a mile before joining another channel which combine to form an unnamed creek that this document will refer to as the "East Channel". The East Channel continues south through Drainage Area - SE1. The creek continues to the south and eventually joins Reece Creek southeast of the City. The channel is similar to other channels in the City in that it is currently overgrown with grass, weeds, and debris from past storms in places where the channel is too shallow or lacks definition. This lack of depth and definition will limit the capacity of the channel to convey the runoff, and this problem will worsen with upstream development. The channel is irregular in cross section which leads to scouring and erosion problems along the stream course. The channel represents the primary drainage channel for this portion of the City.

As this area is developed, this channel will require considerable improvement and modification to ensure sufficient capacity. These improvements may include all of the types of improvements that have been presented in the previous discussions. These improvements and modifications will increase the capacity of the channel to accommodate future development in the upstream reaches. The downstream issues mentioned previously will be in effect and should be considered when planning channel improvements. As future development occurs, drainage easements should be acquired wherever possible to facilitate maintenance and construction activities.

8.9.2.10. Drainage Area - SC1

This area is located in the west half of the south-central part of the City. The land is primarily used for commercial purposes along the major thoroughfares

with light industrial, agricultural supply, and water treatment facilities interspersed throughout the area. The area is approximately 85 % developed at this time. The area is approximately 144 acres in size and will generate between 320 and 570 cfs of runoff through this reach, depending on the severity of the storm. This runoff will combine with runoff from the upstream reaches, and the combined flows will represent a significant portion of the total runoff from the central part of the City. The runoff is conveyed downstream via overland flow, small local natural channels, streets, and gutters which discharge into the main channel of Ham Branch at various points along the channel course. This creek is the largest of the drainage channels, and this reach is one of five critical reaches in the overall drainage scheme.

There are some locations along the stream bed that are restricted by unchecked vegetal growth, driftwood and debris from previous storms, and trash articles. Because this creek is the main drainage channel for the entire Rockdale area, it is essential that a concerted effort be made by the appropriate agencies to keep the main channel clear from these types of blockage. At some point in the near future, the creek channel will require some degree of improvement and modification to ensure sufficient capacity. These improvements should be made as soon as it is economically feasible. These improvements will include:

- The widening of the creek channel in some areas.
- Reshaping the creek channel to a more hydraulic efficient cross section in some areas.
- Construction or replacement of street crossings with properly designed box culverts to improve hydraulic efficiency.
- Cleaning debris and trash from the stream bed.
- Regular mowing of grass-lined sections to maintain a uniform vegetal cover.
- Installing a non-erosive lining, such as concrete, in sharp bends and comers.
- Realignment of the channel to reduce the number of sharp bends and corners.

Improvements made along this reach should be extended to the south to include the reach of streambed that passes through Drainage Area-SW2.

8.9.2.11. Drainage Area - SC2

This area is located in the east half of the south-central part of the City. The land is mixed use with commercial and light industrial development along the major thoroughfares. Single-family residential neighborhoods in the area include a large portion of the Original Township of Rockdale, Rowlett Subdivision, Milam Oaks Subdivision, as well as Sunrise, Perry, Camp, and Washington Heights Subdivisions.

The area is approximately 90% developed at this time. The area is approximately 399 acres in size and will generate between 700 and 1,230 cfs of runoff through this reach, depending on the severity of the storm. This runoff will combine with runoff from the upstream reaches, and the combined flows will represent the majority of the total runoff from the eastern part of the City. The runoff is conveyed downstream via overland flow, small local natural channels, streets, and gutters which discharge into the main channel of Rockdale Branch at various points along the channel course. This creek is the second largest of the drainage channels, and this reach is also one of five critical reaches in the overall drainage scheme.

This creek is one of the two main drainage channels for the entire Rockdale area, it is essential that efforts are made to keep the main channel clear. At some point in the near future, the creek channel will require some degree of improvement and modification to ensure sufficient capacity. These improvements should be implemented in conjunction with the necessary improvements on the Ham Branch as soon as it is economically feasible. These improvements will include:

- The widening of the creek channel in some areas.
- Reshaping the creek channel to a more hydraulic efficient cross section in some areas.
- Construction or replacement of street crossings with properly designed box culverts to improve hydraulic efficiency.
- Cleaning debris and trash from the stream bed.
- Regular mowing of grass-lined sections to maintain a uniform vegetal cover.

- Installing a non-erosive lining, such as concrete or rock, in sharp bends and corners.

- Realignment of the channel to reduce the number of sharp bends and corners.

Improvements made along this reach should include the reach of streambed downstream of the confluence of the Ham Branch and Rockdale Branch that passes through Drainage Area - SW2.

8.9.2.12. Drainage Areas — E3, SE2, SE1, S1, S2, SW2, & SW1

A wastewater treatment facility is included in this drainage area. These areas are all in the outlying sections of the City to the east and south of the current City Limits. Plans for future development will inevitably include some or all of these areas. Several of these areas include the downstream reaches for the major drainage channels that serve the City and its ETJ. This requires that these areas be considered as part of the overall drainage scheme during the planning stages of future development in the upstream regions. The present level of development is low, and this results in low runoff contributions to the relatively large runoff flows from the developed upstream reaches. However, these reaches must remain capable of passing the increased flows from future development. This will require the same type of improvements that have been suggested for the developed reaches. Similarly, the effects on downstream properties must be evaluated prior to implementation of the planned improvements. This report recommends that the City of Rockdale seek professional services with experience in hydrological and hydraulic evaluation in Stormwater Management to perform these activities at such time that development occurs.

8.10 SECTION III - FUTURE DRAINAGE IMPROVEMENTS

8.10.1 FUTURE DRAINAGE IMPROVEMENTS – OVERVIEW

The planning of future drainage improvements is a complex process of balancing the need for reducing the risk of flooding and the damage caused by flooding with the availability of funding required to implement the necessary improvements. Some of the complications arise from the difficulty in foreseeing problems that may not exist at a given planning stage but manifest themselves after that particular phase of development has been completed. Other sources of complication are the political and economic realities that exist in every community. There are inevitable conflicts that occur when improvements are made in some areas, and other areas are left for future consideration.

The proposed improvement plans contained within this report are based upon available current information such as USGS Topographic Maps, field observations of existing conditions, and past experience in drainage problems that occur in developing urban communities. The proposed improvements are ambitious in nature, but every attempt has been made to propose improvements that will be feasible in an economic sense as well. The proposed improvements will be presented in an order that is based on the Index of Sheets as shown on the next page. The Index contains an area that is considerably larger than the City of Rockdale and its surrounding ETJ.

Only the Map Sections that contain proposed improvements will be presented in this report. Those sections are outlined by a yellow line surrounding the included sections. The sections included are Map Section B-3, B-4, B-5, C-2, C-3, C-4, D-2, D-3, and D-4. This will be the order in which the proposed improvements are presented with a description of the improvements. The individual Map Section will be shown at the end of each discussion for convenient visual reference.

8.10.2. MAP SECTION B-3

This section is located in the northwest part of the City and includes the residential neighborhoods of the Linwood I, 2, and 3 Subdivisions. The proposed drainage improvements are as follows:

- An enclosed pipe system that will run along Cady Road. This system will include inlets that will collect runoff from the neighborhood to the east. The system will flow southward from Skyles Road on the north and northward from

O'Kelley Road on the south to a collection point between Sager Lane and Yokley Road. The system will discharge to the west into a natural channel. Cady Road is currently a partially paved road with no curb and gutter. The anticipated growth in this direction will undoubtedly warrant an upgrade to curb and gutter sections as additional roads are built to the west. This system will consist of standard curb inlets, reinforced concrete pipe (RCP), and an outlet structure with head and wing walls.

- An enclosed pipe and inlet system in Brazos Street from Sager Lane south to Yokley Road and in Yokley Road from Brazos Street east to the low point just west of Rockdale Road. This system will flow into a storm sewer which will flow southward from Skyles Road.

- An enclosed system of inlets and pipes that will flow southward from Skyles Road, west of and parallel to Rockdale Road, to Alcoa Street. This storm sewer will need to be installed in easements between existing houses through the low points on Skyles, Sager, Yokley, and O'Kelley Roads, and Highland Avenue and down Coffield Street to Alcoa Street.

- The upper end of an enclosed pipe and inlet system that will run along Brazos Street from O'Kelley Road on the north to Murray Avenue on the south. The system will flow to the south where it will continue into Map Section B-4. The system will consist of standard curb inlets and RCP.

- Inlets and a pipe system at the low point In Rockdale Road north of Skyles Road. This storm sewer will discharge into an existing ditch which flows eastward into West Ham Branch.

8.10.3. MAP SECTION B-4

This section is located in the western part of the City and includes the residential neighborhoods of the Coffield 2 and 4 Subdivisions, as well as the Westwood, Edgewood, and parts of several other Subdivisions. The proposed drainage improvements are as follows:

- The lower end of an enclosed pipe and inlet system that begins in Map Section B-3. This system flows south on Brazos Street to Murray Avenue and then eastward In Murray Avenue to Meadow Drive.

- The lower end of an enclosed pipe and inlet system that continues southward in Coffield Street from Highland Avenue to Alcoa Street. From there, the storm sewer will continue eastward in Alcoa Street to Meadow Drive and southward in Meadow Drive to Cameron Avenue (U.S. Highway 79).

- A system of inlets, pipe, and outlet structure at the low point on Ortega Street

north of Alcoa Avenue. From there, an improved channel section will extend to the west and south where it will discharge into an inlet/outlet structure specifically designed for this channel on Post Oak Road.

- An enclosed pipe and inlet system that begins at the inlet/outlet structure described above on Post Oak Road. The system will flow south on San Jacinto Drive to discharge into an improved drainage culvert at Cameron Avenue. This system will represent an extension and upgrade to the existing system which does not possess sufficient capacity to accommodate current runoff flows.

- A system of Inlets, pipe, and outlet structure at the low point of Allday Street; an improved drainage channel that flows eastward to Post Oak Road; and a storm sewer system that will convey the flows from the low point in Post Oak Road eastward to the proposed storm sewer In San Jacinto Street.

- An enclosed pipe and inlet system that begins at the intersection of Murray Avenue and Calhoun Boulevard and flows south in Calhoun Boulevard to the reinforced box culverts at U.S. Highway 79. The main trunk in Calhoun Boulevard will intercept storm sewers In Vogel Street from Alamo Drive westward and in Post Oak Road from Mistletoe Lane westward.

8.10.4. MAP SECTION B-5

This section is located in the southwest part of the City and is largely undeveloped at this time. There are several drainage channels in the area. These channels will serve future development in this part of the City. As this development occurs, drainage easements should be obtained where possible.

The primary identifiable source of drainage problems at this time is the culvert that passes under the railroad right-of-way and discharges to the south. This channel is a continuation of the improved channel on the north side of the railroad. The current and future runoff flows from Map Section B-4 are conveyed through this channel reach.

The proposed drainage improvements will consist of an improved channel section that begins at the railroad culvert bridge. The improved section will extend to the south for an appropriate distance to be determined by an in-depth study and final design process. This improvement should be made in conjunction with negotiations to modify the culvert bridge at the time of Improvement.

The culvert bridge under the railroad does not appear to have sufficient capacity to accommodate either presently anticipated flows from the TxDOT improvements or

expected increases in runoff from future development in the area. At some future date, negotiations will need to be accomplished with the railroad for additional capacity at the culvert to accommodate the increased flows.

8.10.5. MAP SECTION C-2

This section is located in the north part of the City and is largely undeveloped at this time. The future development in the area will be considerable due to the construction of a Relief Route in this vicinity. As this development occurs, drainage easements should be obtained where possible. This report does not recommend any specific improvements at this time; however, the upstream reaches of Ham Branch are located in this section. Improvements along this channel will be necessary as development progresses, and these improvements can be identified at such time.

8.10.6. MAP SECTION C-3

This section is located in the north-central part of the City and includes many well established residential neighborhoods as well as several parcels of undeveloped land. The Rockdale Junior High School and a baseball field complex are also in this area. This area will likely experience considerable growth associated with the construction of a new Relief Route north of the area. This development will introduce significant increases in runoff to the existing drainage channels. The principal drainage channels in the area are the west tributary and the main channel of the Ham Branch. The proposed drainage improvements are as follows:

- An improved Type III concrete-lined channel section in the west tributary that begins at the current City Limits just north and west of the baseball complex on North Wilcox Street. The improved section will extend to the east and south to where it converges with the main channel of the Ham Branch just south of Cameron Avenue in Map Section C-4. The improved section will be approximately one-half mile in length and will include several street crossings where construction and/or modification of a reinforced concrete box culvert (RCB) will be required. The specific type and size of the structures will be determined by a final design as development occurs. The street crossings that will require improvement include Copeland Street, North Wilcox Street, Hillyer Avenue, Brandon Street, Murray Avenue, Belton Avenue, West Davilla Street, West Bell Avenue, and Cameron Avenue. The improved section of the tributary will discharge into an inlet/outlet structure specifically designed for this channel at the confluence with the main channel of Ham Branch. The improved

reach of the tributary channel will consist of concrete sides and bottoms with the slope and cross section shape to be determined by a final design.

- An improved Type III concrete-lined channel section in the main channel of the Ham Branch that begins at the existing City Limits at a point adjacent to North Main Street. The improved section will extend to the south to where it converges with the channel of the west tributary just south of Cameron Avenue in Map Section C-4. The improved section will be approximately one-half mile in length and will include several street crossings where construction and/or modification of a reinforced concrete box culvert (RCB) will be required. The specific type and size of the structures will be determined by a final design as development occurs. The street crossings that will require improvement include North Main Street, Burleson Street, Murray Avenue, San Andres Avenue, West Belton Avenue, West Davilla Avenue, West Bell Street, and Cameron Avenue. The improved section of the Ham Branch main channel will intercept the west tributary channel just south of Cameron Avenue in Map Section C-4 and a minor tributary from the east at a point just north of Murray Avenue. The improved main channel will consist of concrete sides and bottoms with the slope and cross section shape to be determined by a final design.

- An improved Type III concrete-lined channel section in the minor tributary of Ham Branch that joins from the east just north of Murray Avenue. The improved reach begins at the existing City Limits at a point northeast of the Rice Street crossing in Map Section D-3. The improved section will extend to the southwest to where it converges with the main channel of Ham Branch. The improved section will be approximately one-half mile in length and will include several street crossings where construction and/or modification of a reinforced concrete box culvert (RCB) will be required. The specific type and size of the structures will be determined by a final design as development occurs. The street crossings that will require improvement include Rice Street, San Gabriel Street, Green Street, Ackerman Street, and North Main Street. The improved section of the tributary will discharge into an inlet/outlet structure specifically designed for this channel at the confluence with the main channel of Ham Branch. The improved main channel will consist of concrete sides and bottoms with the slope and cross section shape to be determined by a final design.

- A short enclosed pipe and Inlet system under Bushdale Road at Yokley Road. The system will terminate in an outlet structure and discharge into an existing ditch that flows northeasterly into West Ham Branch.

- An enclosed pipe and inlet system that begins at a low point on Dyer Street

south of Highland Street and extends eastward to Miller Street, thence northward in Miller Street to Highland Street. From there, the storm sewer will flow northeastward, across Broadnax Street to Stokes Street. This system will then discharge into an improved channel which will flow northeastward into West Ham Branch.

- A system of inlets and pipes that begins at the northern end of Jackson Street and flows northward to Williams Street. The storm water will then flow eastward in Williams Street to Shelton Street and thence northward in Shelton Street for a discharge into the Stokes Street Channel.

- An enclosed pipe and inlet system that begins at the intersection of Murray Avenue and Francine Street. The trunk line flows east on Murray Avenue to North Wilcox Street and then to the south where it joins the main trunk line flowing from the west at Belton Avenue. The combined system then continues south to discharge into the improved channel of the west tributary at a point just north of West Davilla Street. The Belton Avenue storm sewer will begin at Bowser Street and continue in Belton Avenue for its intersection with the storm sewer in Wilcox Street.

- Short storm sewer systems that flow into Ham Branch:

  1. In Murray Avenue from Scarbrough Street eastward to Ham Branch

  2. In Belton Avenue from Burleson Street westward to Ham Branch

  3. In Scarbrough Street from Belton Avenue to Ham Branch in Davilla Street.

- A storm sewer system is proposed In Green Street from San Andres Street northward to the east tributary of Ham Branch.

- Storm sewer systems are proposed in San Gabriel Street from Hamilton Street southward to the east tributary of Ham Branch and from San Andres Street northward to the east tributary of Ham Branch.

- An enclosed pipe and inlet system that begins at the intersection of Main Street and East Davilla Street and flows northward in Main Street to San Andres Street. At that point, the storm sewer joins another system in San Andres Street which starts at Ackerman Street and flows westward. The combined system then flows westward to San Andres Street to Ham Branch.

- An enclosed pipe and Inlet system that begins at the intersection of Main Street and Cameron Avenue. The system will flow to the west to Scarbrough

Street, northward in Scarbrough Street to Bell Avenue, and westward in Bell Avenue to discharge into Ham Branch.

8.10.7. MAP SECTION C-4

This section is located in the southern part of the City and includes many well-established residential neighborhoods as well as several parcels of undeveloped land. The Rockdale High School, football stadium, and baseball complex are also in this area. Fair Park is also included in this section. This section is located downstream of many of the proposed improvements and will ultimately receive the runoff from existing and future development in those areas. The principal drainage channels in the area are the Little Ham Branch and the main channel of the Ham Branch. The proposed drainage improvements are as follows:

- An enclosed pipe and Inlet system that begins at the intersection of Cameron Avenue and Travis Street. The system will flow to the east along Cameron Avenue to discharge into the main channel of Ham Branch.

- An enclosed pipe and inlet system that begins on Maple Avenue east of Spence Street. Storm water will flow westward in this system in Maple Street and southward in Spence Street to Bell Avenue. From there, it will flow westward in Bell Avenue, southward in Charles Street, and under Cameron Avenue for discharge into an improved channel to the railroad.

- An enclosed pipe and inlet system that begins at the intersection of Main Street and Cameron Avenue, flows westward in Cameron Avenue to Scarbrough Street, north to Belton Avenue, and westward in Bell Avenue for a discharge into Ham Branch.

- The lower end of a main trunk line collects flows at the intersection of Murray Avenue and Meadow Drive. The trunk then flows south on Meadow Drive where it will discharge into the box culvert system at U.S. Highway 79. This system, when connected to the system in Childress Street, will comprise the largest storm sewer system in the City.

- The lower end of a main trunk line that begins at the intersection of Hunter and Alcoa Streets in Map Section C-3. The system will provide crucial relief of local flooding problems in the area. This relief is crucial to the proposed major thoroughfare alignment in this area. The trunk line will continue southward around the current high school baseball practice facilities to a point just north of the cul-de-sac at the north end of Bounds Avenue. The line will then turn south along Bounds Avenue to Zana Lane, west to Childress Street, and south to the box culvert stub-out at U.S. Highway 79.

The entire system will consist of standard curb inlets, reinforced concrete pipe (RCP), and reinforced concrete box (RCB).

- An improved Type III concrete-lined channel section in the main channel of Ham Branch that begins at the confluence of the northern main channel and the west tributary just south of Cameron Avenue. The improved concrete section will extend to the south to West Roberts Street where a transition to a Type II natural grass-lined channel occurs. The channel continues to the south where it converges with the main channel of Little Ham Branch in Map Section C-5. The improved sections will be approximately three-fourths (3/4) mile in length and will include street crossings where construction and/or modification of a reinforced concrete box culverts (RCB) will be required. The specific type and size of the structures will be determined by a final design as development occurs. The street crossings that will require improvement are Mill Street and West Offield Street. Consideration must be given to ensure that the railroad culvert bridge will have sufficient capacity to carry the anticipated increase in runoff flows from upstream development. The cross sections of the improved concrete portion of the main channel and the improved grass-lined portion of the channel with a concrete pilot channel will need to be determined by a final design.

- An improved Type II natural channel section in the main channel of Little Ham Branch that begins at the end station of the improved channel at U.S. Highway 79 at Childress Street. The improved section will pass under the railroad right-of-way and extend to the south and east where it converges with the main channel of Ham Branch in Map Section C-4. The improved section will be approximately one mile in length across topography that is currently undeveloped land. The improved section of the tributary will discharge into the improved main channel of Ham Branch. Consideration must be given to ensure that the railroad culvert bridge will have sufficient capacity to carry the anticipated increase in runoff flows from upstream development.

8.10.8. MAP SECTION D-2

This section is located in the northeastern part of the City. The land in this area is currently undeveloped. The potential for future development is high due to the proximity of the proposed Relief Route in this area. The headwaters of the main channels of Rockdale Branch and the "East Channel" are in this area. As development occurs, drainage easements should be obtained where possible. This report does not recommend any specific improvements at this time. Improvements along these channels will be necessary as development

progresses, and these improvements can be identified at such time.

8.10.9. MAP SECTION D-3

This section is located in the eastern part of the City and includes some residential neighborhoods as well as large areas of undeveloped land. The potential for future development is high due to the proximity of the proposed Relief Route in this area. The principal drainage channels in the area are the main channel of Rockdale Branch and the main channel of the "East Channel". The proposed drainage improvements are as follows:

- An enclosed pipe and inlet system that begins at a point just east of the intersection of Cameron Avenue and Sanford Street. The system flows to the east along Cameron Avenue to discharge into the "East Channel". The system will prevent excessive street flows resulting from future development.

- An enclosed pipe, inlet, and channel system that begins at a low point on Yoakum Street between Cameron Avenue and Belton Avenue. The system then flows northwesterly in a channel to Belton Avenue. The channel will be intercepted by a storm sewer system that starts at the intersection of Douthit Street and Belton Avenue and then flows westward in Belton Avenue to discharge into Rockdale Branch.

- An enclosed pipe and inlet system that begins at the Intersection of Cameron Avenue and Green Street. The system flows to the east along Cameron Avenue with 1-block extensions joining from the north at San Gabriel Street and Rice Street. The system will discharge into Rockdale Branch.

- An enclosed pipe and inlet system that begins at the low point on Douthit Street south of Isaac Avenue and flows southwesterly across Houston Street in Rockdale Branch.

- A storm sewer at the intersection of Riley Street and Peach Street which will discharge westerly into Rockdale Branch.

- An improved Type III concrete-lined channel section in the main channel of the Rockdale Branch that begins at Houston Street and extends southwesterly to Roberts Avenue.

- A storm sewer system beginning at the intersection of Third Street and Pear Street which flows southward into an improved channel. From there the flow will be westerly, crossing under Baxter Street to discharge into Rockdale Branch.

8.10.11. MAP SECTION D-4

This section is located in the southeastern part of the City and includes some residential neighborhoods as well as large areas of undeveloped land. The potential for future development is fair to high due to the proximity of open land and utilities. The principal drainage channels in the area are the main channel of Rockdale Branch and the main channel of the "East Channel". The proposed drainage improvements are as follows:

- An enclosed pipe and inlet system that begins at the intersection of First Street and Pecan Street and flows southward to Rockdale Branch.

- An improved Type III concrete-lined channel section in the main channel of Rockdale Branch that continues from the north in Map Section D-3. The improved concrete section will extend to the south to Roberts Street where a transition to a Type II natural grass-lined channel occurs. The channel continues southward to merge with the main channel of Ham Branch in Map Section C-4. The improved sections will be approximately one mile in length and will include street crossings where construction and/or modification of reinforced concrete box culverts (RCB) will be required.

- Short sections of storm sewer should be installed at MLK Drive from Fifth Street to Rockdale Branch; from the low point on Fourth Street to Rockdale Branch; and from the low point on White Street to Rockdale Branch.

- A storm sewer will be required at the intersection of Seventh Street and MLK Drive and an improved channel from that point northwesterly to Rockdale Branch.

8.11 SECTION IV - CONCLUSIONS AND RECOMMENDATIONS

8.11.1. GENERAL

The scope of the improvements that have been discussed in Section III of this report is quite broad and is intended to serve as a guideline for planning future stormwater management methods and means. The proposed improvement plans contained within this report are based upon available current information such as USGS Topographic Maps, field observations of existing conditions, and past experience in drainage problems that occur in developing urban communities. The proposed improvements are ambitious in nature, but every

attempt has been made to propose improvements that will be feasible in an economic sense as well.

The improvements by TxDOT as part of the widening of U.S. Highway 79 will aid the City in the efforts to control stormwater runoff. The addition of the proposed improvements by the City will enhance those of TxDOT and provide an efficient stormwater drainage system that should serve the City of Rockdale in an exemplary manner for many years into the future.

These improvements are intended as suggestions to manage flooding problems associated with urban development over an extended period of time. Significant changes to the type, quantity, size, and locations of actual drainage improvements should be expected. The proposed improvements discussed in this report are based on the available information at the time of the report. The overall concept contains sufficient flexibility to accommodate these types of changes.

The areas that have been identified in Section II and Section III are within the City of Rockdale and its Extraterritorial Jurisdiction (ETJ). They are consistent with the Zoning Plan, the proposed alignment of a Relief Route, and the proposed Thoroughfare Plan. The proposed improvements are general in nature to afford the City maximum flexibility. The proposals are intended for use as a guideline and a forecasting tool to assist in planning future stormwater drainage improvements in areas of the City that are likely to be developed in the near future. An emphasis is placed on the acquiring of drainage easements wherever possible along the natural channels to allow access for future modification, improvement, and maintenance. As development occurs, studies should be conducted at appropriate intervals to determine final design parameters for individual areas. These studies will determine the most cost-effective means of providing the optimum level of stormwater drainage.

8.11.2. PRIORITY AREAS

At the time of this report there are five (5) specific areas that have been identified as areas that have chronic severe drainage problems. These areas are characterized by flooding that overtops the curbs during minor rainfall events, ponding of runoff water for extended periods of time following the rainfall events, and damage to existing roadway surfaces, appurtenances, and

surrounding structures caused by standing water or erosion. These areas are listed below in the recommended order of priority for improvement:

- The enclosed pipe system on Calhoun Street from the intersection at U.S. Highway 79 north to Murray Avenue. This system will connect to the improvements by TxDOT and relieve the flooding in this area during storm events, Refer to Map Section B-4.

- The enclosed pipe system along San Jacinto Drive from the intersection at U.S. Highway 79 to north of Post Oak Road. This system will connect to the improvements by TxDOT and, combined with the system on Calhoun Boulevard, should eliminate the flooding problems in the area. Refer to Map Section B-4.

- The combined enclosed pipe system on Meadow Drive from the intersection at U.S. Highway 79 north to Alcoa Street, west on Alcoa Street to Coffield Street, and north on Coffield Street to Highland Avenue. This system will connect to the improvements by the TxDOT and should relieve the flooding in this area during storm events. Refer to Map Sections B-4, C-3, and C-4.

- The combined enclosed pipe system on Childress Street from the intersection at U.S. Highway 79 north to Zana Lane, east to Bounds Avenue, and north to the southern edge of the High School Athletic Fields.

- The combined enclosed pipe system along Alcoa Street from the intersection of Hunter Street eastward to east of Hogan Street.

- The combined enclosed pipe system on Charles Street from the intersection at U.S. Highway 79 north to Bell Street, east to Spence Street, north on Spence Street, and east to the west end of Maple Avenue.

- Improving the existing channels through the City either by widening the existing earth channels or constructing concrete lining.

- Storm sewers in Murray Avenue from Meadow Drive to Brazos Street and in Brazos Street from Murray Avenue to O'Kelley Road.

- The two storm sewer systems along and near Williams Street from Dyer Street to Francine Street.

- A storm sewer system in Green Street from San Andres Street to the east channel of Ham Branch.
- Storm sewers and improved channels between Mill Street and White Street from Hickory Street westward to Ham Branch.

8.11.3. SUMMARY

In summary, this report recommends that the City of Rockdale, through the appropriate agencies, direct the efforts in stormwater management in the following manner:

- Seek public input to assist in identifying drainage problems throughout the community.
- Seek professional assistance in developing cost-effective solutions to the problem areas as they become identified.
- Coordinate the improvements proposed in this document with any current or future plans for TxDOT improvements.
- Develop a maintenance program for the future enclosed drainage systems. The purpose of this will be to remove built-up sediment that will accumulate over time. This sediment will adversely affect the hydraulic functions of these systems.
- Develop a maintenance program for the existing and improved natural drainage channels. The purpose of this will be to remove built-up sediment, grass, weeds, and trash that has accumulated. These types of obstructions will also cause adverse effects on the hydraulic functions of these channels.
- Where possible, acquire drainage easements along the channels in order to facilitate maintenance, modification, and future improvement.
- Require developers to provide on-site detention facilities that limit post-development runoff volumes to pre-development levels. The developer should be responsible for the maintenance of the facility.
- Require new developments to dedicate drainage easements for all stormwater drainage facilities and systems.

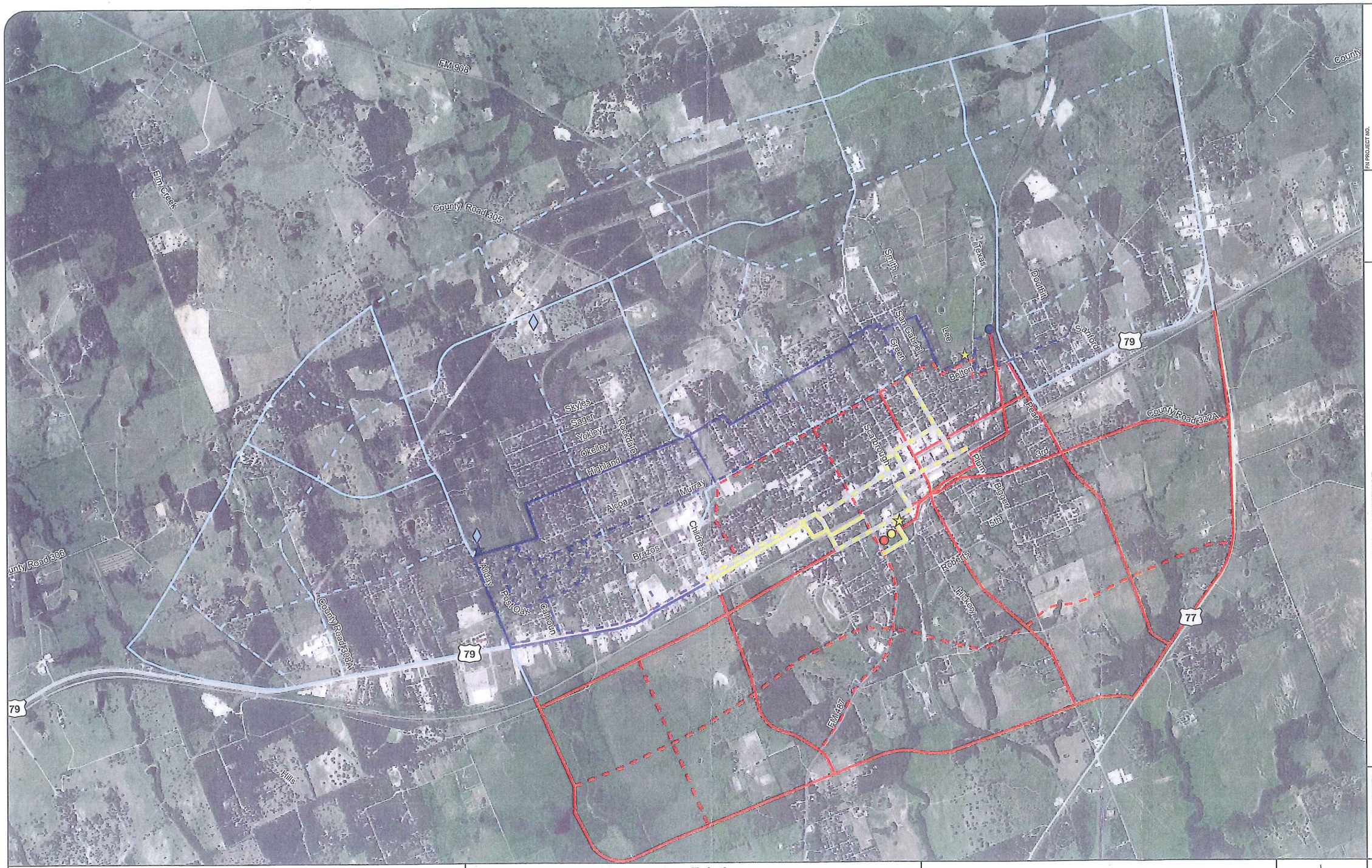
- Adopt a Stormwater Management Policy that includes minimum requirements for new development as well as standards for rehabilitation and repair of existing systems. The Stormwater Management Design Criteria Manual should serve as the blueprint for such a policy.

- Limit or restrict development within the flood plains. Identification of the flood plain limits has not been included in the scope of this report. A study should be performed to identify any 100-year flood plain areas within the City and its ETJ. The federal agencies responsible for determining the limits of flood plains issue periodical revisions of this information. The City should consult with professionals in this field to stay apprised of such revisions.

- Require developers to install enclosed inlet and pipe systems as needed in new subdivisions and when streets and thoroughfares are improved or upgraded. These systems should discharge into downstream channels through structures designed to minimize adverse effects on the downstream properties.

- Maintain constant communication with the TxDOT in order to stay fully informed of the proposed improvements, construction schedule, and changes made to the plans.

- Identify any problem areas, not mentioned previously in this document, which may he eliminated by incorporation into these proposed improvements.



CITY OF ROCKDALE

Water Distribution System Plan (September 2010)

High and Low Plane Service Areas

FN PROJECT NO.	RKD10316
DATE CREATED	August 2010
DATUM & COORDINATE SYSTEM	NAD83 State Plane (feet) Texas Central
FILE NAME	WaterPlan.mxd
PREPARED BY	JM

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HIGH PLANE SERVICE AREA

Proposed
- 8 Inch
- 12 Inch or Larger
- Elevated Storage Tank
- Ground Storage Tank

Existing
- 8 Inch
- 12 Inch or Larger
- Elevated Storage Tank
- Ground Storage Tank

LOW PLANE SERVICE AREA

Proposed
- 8 Inch
- 12 Inch or Larger
- Elevated Storage Tank
- Ground Storage Tank

Existing
- 8 Inch
- 12 Inch or Larger
- Elevated Storage Tank
- Ground Storage Tank

0 2,000 4,000 Feet

FIGURE No. 2

Updated: Monday, August 30, 2010 Updated By: jm File: H:\TRANSPORTATION\FINAL_EXHIBITS\WaterPlan.mxd