JOPLIN, MISSOURI

STORMWATER MANAGEMENT MASTER PLAN

City of Joplin

100% EMPLOYEE-OWNED
Burns & McDonnell
ENGINEERS · ARCHITECTS · CONSULTANTS

JUNE 1998

CITY OF JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN

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PART I

EXECUTIVE SUMMARY

PART I

EXECUTIVE SUMMARY

A. GENERAL INFORMATION

This Executive Summary presents a condensed discussion of the Joplin Stormwater Management Master Plan authorized by the City of Joplin on January 17, 1994. The following sections of this report, together with accompanying watershed maps, computer models, and exhibits, present the detailed report and supporting information resulting from the study of the City's major drainage system which is the focus of this project. The major system is considered to begin at the point where approximately 40 acres become tributary to the system.

Services performed by Burns & McDonnell Engineers of Kansas City, Missouri to complete the study included:

- Field investigation of the City's major drainage system.
- Preparation of a set of watershed maps covering the study area.
- Evaluation of the existing system's performance capability.
- Development of a recommended capital improvements plan for the City to correct existing major system deficiencies.
- Preparation of capital cost estimates for the proposed improvements to the major system.
- Recommendation of implementation priorities for improvements.
- Evaluation of potential mechanisms for funding the proposed improvements.

In addition, a draft "Stormwater Management Criteria" manual, which outlines specific technical standards and criteria for storm drainage system design, was prepared as a part of this study and submitted to the City as a separate document for the City's review.

The 16 principal watersheds included in this study cover over 50 square miles tributary to three major waterways: Turkey Creek, Joplin Creek, and Shoal Creek. Figure I-1, following this page, indicates the study area and the general extent of the 16 primary watersheds.

Average annual precipitation is 40.8 inches. Rainfall events that create peak demands on the system occur as convective thunderstorms an average of 55 times each year. Land slopes vary from nearly flat to greater than 20 percent toward the south.

Land use within the corporate limits is substantially developed with single family residential development comprising approximately 50 percent of the area. Office and business parks, institutional land use, and retail commercial areas cover approximately 15 percent, with industrial areas accounting for 10 to 15 percent and parks and recreation areas covering approximately 5 percent. Recent growth areas are limited to the south edge of the City along I-44, southwest near the medical centers, and east of the City. Future development will be mostly residential and industrial areas expanding to the east and south.

Data for modeling the existing system's performance were acquired from field investigations and a comprehensive review of City records and related studies. Two computer models developed by the Corps of Engineers were the primary tools used for the analyses. In addition, two programs developed by Burns & McDonnell were utilized for various aspects of the project. Specific models are:

- HEC-1 - Flood Hydrograph Package: Corps of Engineers hydrology program for generating runoff or streamflow hydrographs for peak flows.
- HEC-2 - Water Surface Profiles: Corps of Engineers program for determining flood elevations and evaluating open channels, bridges and culverts.
- SYCOST - B&McD program for estimating drainage system capital and annual maintenance costs.
- PRIOR - B&McD program for ranking improvement priorities on basis of benefit, cost and performance.

Operating copies of the models, users manuals, and data files are being furnished to the City for their use in continuing management of the stormwater system.

B. EXISTING SYSTEM PERFORMANCE

The existing major drainage system within the study area consists of both conveyance elements (enclosed pipe storm sewers, improved and natural open channels, and cross-road culverts) and storage elements (planned and, in some instances, as at highway culverts under high fill, unplanned). The entire existing major system was defined in individual sections, or reaches, for analysis. Peak rates of discharge for each reach were computed for events having return periods from 2 to 100 years. The hydraulic capacity of the various reaches of the major system was then evaluated in terms of the return period for which they provide adequate capacity (e.g., the level of service afforded by the various reaches was determined).

Proposed design criteria for new construction (embodied in the draft "Stormwater Management Criteria") requires that the system be designed for a 10-year return period in all areas with provisions for overflow channels to handle the 100-year peak flow when combined with the conveyance element capacity. By these proposed standards, the bulk of the existing improved system is hydraulically deficient.

However, identifying an existing system element as failing to meet either current or proposed criteria, according to the model, does not indicate deficiencies in design or construction at the time the element was originally constructed. The principal determinants of hydraulic demand on the drainage system are land use and rainfall, neither of which has remained static during the period of time over which Joplin's system has developed. Additionally, the development of more sophisticated computer modeling techniques and other analytical methods, which permit a much more refined analysis of the systems' performance than was previously practical, has had a major impact on the results of studies and design calculations.

The mere absence of "criteria" capacity also is not necessarily indicative of a problem requiring corrective action. Corrective action is warranted only when the deficiency results in damage from flooding, an unacceptable level of nuisance or a public safety issue. Conversely, adequate hydraulic capacity does not mean that a system component is performing satisfactorily. Significant erosion, difficult maintenance, and structural deterioration are examples of problems that may warrant the replacement of a storm drainage system component having adequate total hydraulic capacity.

For the purposes of identifying and developing recommended improvement projects for this study, only those system elements where the existing deficiency results in one or more of the recurring adverse effects listed below were considered.

- Building flooding at 25-year or more frequent intervals.
- Erosion on private property due to the direct discharge from public drainage facilities that, if permitted to continue, will eventually either endanger buildings or adversely affect the use of the property.
- Overflow of public streets by the 2-year storm for a time duration greater than 15 minutes.
- Recurring nuisance and the lack of maintenance control created by the uncontrolled discharge of water collected in public right-of-way onto adjacent private property.

Although this study focuses on the major drainage system, the criteria for replacement can also be applied to the improved minor system.

C. DRAINAGE POLICY

The draft "Stormwater Management Criteria" includes specific recommendations concerning all aspects of drainage policy and design. Its review and eventual adoption by the City is recommended. The following is a brief summary of criteria contained in the manual which relate to drainage policy issues.

1. STORMWATER DETENTION

A drainage system responds to rainfall in an interdependent and complex manner. Stormwater detention may either reduce or increase the peak rate of discharge to other drainage elements depending on the specific location of the basin within the system; therefore, requiring detention for all new development may not always accomplish the desired goal.

We recommend that the City establish a policy of requiring stormwater detention in connection with new development only when such detention is recommended by the Stormwater Management Master Plan in areas where it provides a clear benefit to the drainage system, or where the results of specific engineering analysis of any proposed development indicate a significant impact on the level of service afforded by downstream elements of the system.

2. GENERAL DESIGN CRITERIA

The detailed design criteria contained in the draft "Stormwater Management Criteria" provides that:

a. All enclosed and improved open channel drainage system components shall be designed for the 10-year return period peak flow or the capacity of the existing upstream improved system, whichever is greater.

b. Surface overflow channels shall be required in all areas in addition to, and above, the 10-year conveyance element. The overflow channel, when combined with the conveyance element, must provide sufficient capacity to convey the 100-year peak flow. Overflow channels will be provided in drainage easements, with restrictions on land use within the easement required to prevent obstruction of flow.

c. Enclosed pipe-inlet systems will be required under the following conditions:

   1) Within the right-of-way of improved streets in new developments.

   2) In all areas where the bank line of an open channel, either

natural or improved, would be within 30 feet of any existing or proposed habitable structure, regardless of system design capacity.

3) In new development areas where the permanent drainage easement of an open channel, either natural or improved, would encroach upon any existing or proposed structure.

d. Existing natural channels may be retained in the drainage system of a developed area provided that flow velocities do not exceed recommended maximums based on soils present in the channel bed and bank.

e. Dedication of easements for all improved system components to be maintained by the City shall be required, as well as maintenance access connections to street right-of-way. Easements will also be required along natural, unimproved channels and around detention facilities (other than parking lots, roof-top detention, or similar situations). Restrictions on land use within some easements are outlined in order to ensure proper function of the overflow system.

D. RECOMMENDED MAJOR SYSTEM IMPROVEMENTS

System capital improvement project recommendations were developed after consideration of the benefits, performance and cost of a broad range of options including:

- Land Use/Zoning Changes
- Flowage Easements
- Removal of Damageable Improvements
- Detention
- Open Channels
- Enclosed Pipe/Box Culvert Storm Drains

The resulting recommended improvement projects are generally structural improvements to the system. Detention, both regulatory and municipally constructed, is also proposed for limited areas and specific situations.

1. RECOMMENDED CAPITAL IMPROVEMENTS

The recommended improvements to the City's existing major drainage

system are consolidated into 49 defined projects. A detailed description of each project, together with the estimated capital cost of the project, is presented in Part VI of this report. The total estimated capital cost of the 49 improvement projects is $20.8 million, including estimated costs for construction, construction contingencies, engineering, and land acquisition.

2. PROJECT PRIORITIES

The recommended prioritization for the 49 improvement projects, as well as their geographic location, is presented on Exhibit 1. Table I-1 lists the 10 projects having the highest recommended priority. Recommendations are as developed by the PRIOR computer program. The priorities are established objectively to optimize the mitigation of property damage, benefit to the system, and cost.

Table I-1

RECOMMENDED IMPROVEMENT PROJECTS PRIORITY RANKING

Prior. No.	Proj. No.	Project Description	Estimated Cost($)
1	4-2	6th St. Relief Sewers, Virginia to Byers	2,470,000
2	4-7	Culvert Replacement, 7th East of Kentucky	165,000
3	4-8	Kentucky Relief Storm Sewers, 7th to 10th	648,000
4	10-1	Canterbury Ditch, 3rd to 7th	583,000
5	6-7	16th and Texas Storm Sewers	774,000
6	6-1	Culvert Replacement, 4th St. East of Murphy	1,001,000
7	6-2	Culvert Replacement, 5th & Division	951,000
8	4-4	Connor Ave. Relief Sewers, 9th to 10th	509,000
9	6-8	Davis Blvd. Detention Basin	502,000
10	1-1	Brownell Ave. Paved Ditch, 34th to I-44	606,000

A specific recommended prioritization for each of the 49 projects is presented on Exhibit 1; the structure of the software used in the prioritization permits no ties.

Of course, responsibility and authority for final establishment of project priorities rest with the Joplin City Council. The recommendations made herein do not and cannot consider the influence of other City programs and efforts on the desired timing and relative weight to be placed on completion of individual projects.

E. MINOR SYSTEM IMPROVEMENTS

The capital improvement projects recommended in this report are intended for the correction of existing deficiencies in the City's major drainage system. Analysis of the City's "minor" system was beyond the scope of Burns & McDonnell's contract with the City; as a result, no specific recommendations are made herein for the nature, location, and extent of necessary improvements to the minor system.

The designation of the smaller components of the City's overall storm drainage system as "minor" does not mean to imply that they are of little importance in the real (and perceived) overall performance of the system. To the contrary, the performance of the minor system directly affects the public perception of the adequacy of the City's system; deficient capacities in the minor system directly inconvenience both the public at large and individual properties, and do result in traffic interruptions and occasional damage to real property.

A regular program of improvement to the minor system is an integral element in any comprehensive plan of improvement to the storm drainage system, and in obtaining public acceptance of the need for the continued devotion of resources and effort to correction of the major system deficiencies. Definition of the level of spending necessary for improvement of the minor system, in the absence of a specific and comprehensive analysis of that system, is of necessity subjective in nature. For a minor system of the scale and age of that in the City of Joplin, we suggest that an appropriate level of spending would average roughly $500,000 per year.

F. SYSTEM MAINTENANCE

Past maintenance of the City's storm drainage system has been done on a complaint/emergency response basis. As a result, "normal" maintenance needs for many of the drainage facilities exist. Major system high-priority maintenance to open obstructed facilities and to repair structural deficiencies exist a numerous locations within the municipal boundaries.

It is recommended that a planned program of regular inspection and maintenance of the storm drainage system, with a corresponding budget, be established. We estimate that a total maintenance budget of approximately $250,000 annually is required for proper maintenance of the City of Joplin's system.

G. FUNDING

At present, the City funds maintenance and improvement of the storm drainage system from the City's general fund in an amount of roughly $500,000 per year. As indicated above, we consider that level of spending to be appropriate for the proper regular maintenance of the system, and for improvements to the minor system. An increase in the current level of funding for storm drainage is essential to construct the recommended capital improvements to correct present major drainage problems. An analysis of alternative funding mechanisms and revenue sources necessary to implement the improvements program was prepared, and is discussed in detail in Part VIII of the report.

The two basic alternatives for financing the recommended improvement projects are cash-basis and debt financing. It should be noted that general obligation bonds are not recommended for the capital improvements program, as the recent issuance of such bonds for improvements at the wastewater treatment plant have largely occupied the City's statutory debt limit.

Potential revenue sources, either for cash-basis or debt financing, include: the establishment of a stormwater utility; additional ad-valorem (property taxes); and a capital improvements sales tax.

It was determined that a one-quarter of one-percent sales tax can provide sufficient funds to construct the 49 recommended major system improvement projects on a cash basis over a 10 year period. Should the City elect to proceed with funding the major system improvements with that mechanism, we would recommend the concurrent continuation of an annual level of spending of $500,000 from the general fund for the proper operation and maintenance

of the system, and for construction of regular improvements to the minor system.

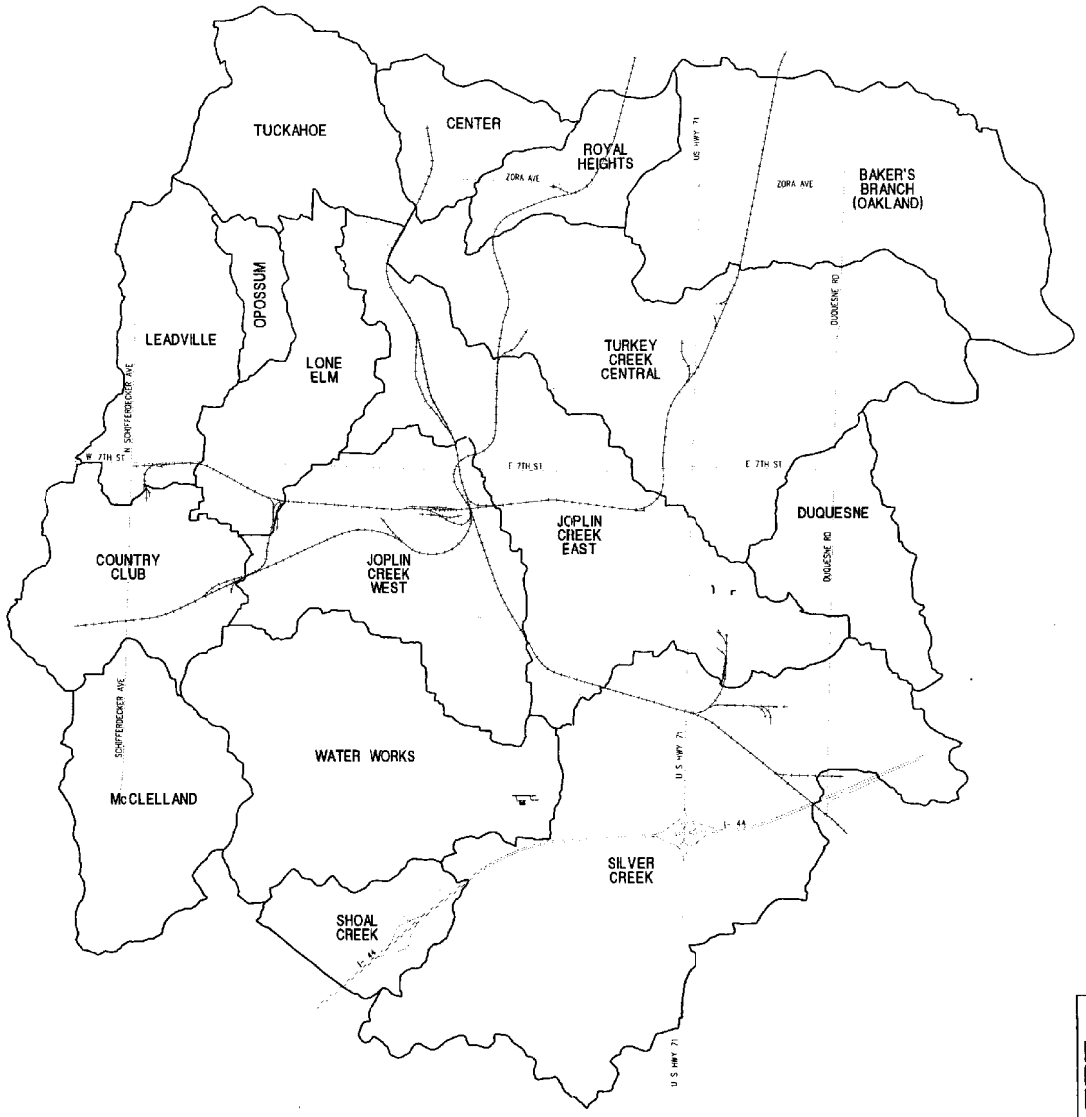
Should the City desire to consider the formation of a stormwater utility, proceeds from such a utility would be applied to all stormwater-related activities and expenditures in the City of Joplin. Revenues from such a utility could be utilized to retire revenue bonds issued for construction of the major system improvements, as well as for construction of minor system improvements and operation and maintenance of the overall storm drainage.

It is anticipated that the creation of such a utility, having an annual rate base of between $2.68 and $2.8 million per year, could adequately fund the needs of Joplin's storm drainage system without continuation of the current annual general fund investment in the system, either on a cash basis (completion of the recommended major system improvements over 10 years) or debt financed basis (issuance of 20-year revenue bonds, permitting completion of the recommended major system improvements over a 5 year period).

The determination of rate classifications and amounts for such a utility requires the conduct of extensive analyses well beyond the scope of this contract. However, on the assumption that the basic structure of the utility billings would be similar to that in other, established Missouri and Kansas stormwater utilities, we would anticipate that an annual utility income of $2.7 million would require the equivalent of monthly billings on the order of $4.00 per month for a typical single-family residence.

While the funding analysis in Part VIII presents options, the actual choice of funding mechanisms, spending levels and revenue sources is the prerogative of the City Council. It is the City's responsibility to balance the community's needs with available revenues which are acceptable to the community.

* * * * *



NORTH

NOT TO SCALE

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CITY OF
JOPLIN, MISSOURI

FIGURE I-1
STUDY AREA

PART II

GENERAL INFORMATION

PART II

GENERAL INFORMATION

A. AUTHORIZATION AND SCOPE

This stormwater management master plan and report for the City of Joplin, Missouri were authorized by an agreement between the City and Burns & McDonnell Engineers of Kansas City, Missouri dated January 17, 1994. Specific services authorized included:

- Assembling, reviewing and organizing pertinent existing maps, records, reports, ordinances, criteria and floodplain studies available from the City and other agencies and sources.

- Planning and conducting public meetings early in the study process to gather information concerning existing drainage problems throughout the City and the public's perception and opinions regarding overall drainage service.

- A field investigation of the City's existing major drainage structures and open channel system, and of the hydrologic land use parameters throughout the drainage basins to measure and record data for use in computer modeling of the system.

- Preparing drainage system maps identifying:
  - Watershed and subwatershed boundaries.
  - Future land use and zoning coordinated with the City's Comprehensive Development Plan.
  - Existing major drainage system components.
  - Known drainage problem locations.
  - Composite soils map based on county soils reports and maps.

- Proposed system capital improvements plan.

- Evaluating the performance capability and deficiencies of the existing major drainage system through development of computer models utilizing the Corps of Engineers' HEC-1 and HEC-2 programs for return periods from one year to 100 years.

- Developing an optimized capital improvements plan incorporating structural components, public and private regulatory detention facilities, and improved and natural open channels considering hydraulic performance, capital costs, annual operation and maintenance costs, and water quality impacts.

- Defining recommended project priorities and an overall schedule for implementing the capital improvements plan.

- Performing a financial study to identify potential sources and estimates of revenue, and to balance selected revenue source(s) with the capital improvements plan and schedule.

- Preparing a Stormwater Design Criteria document coordinating technical design issues with recommended drainage policy issues for continuing management of the municipal drainage system.

- Conducting a stormwater criteria workshop for area developers and professionals when the draft criteria document is complete and a public information meeting/workshop when the draft final report has been approved by the City.

B. DEFINITION OF TERMS

Various technical terms are used throughout this report. They are defined as follows:

Detention Facility - Any structure, device or combination thereof that functions to accept inflow from surface runoff and discharge it at a controlled rate less than the peak inflow rate.

Developer - Any person or corporation engaged in the process of changing, modifying or altering the use of land.

Development - Any activity that alters the surface of the land that generally creates additional impervious surfaces including, but not limited to, pavement, buildings and structures.

Enclosed Drainage System - A drainage system consisting of essentially continuous pipes and/or box culverts below the ground surface.

Erosion - The removal of soil particles by the action of flowing water.

Freeboard - The vertical difference in elevation between the hydraulic gradient and a referenced point. Examples are the difference between the maximum water surface level behind a dam and the top of a dam, or the difference in elevation between the water surface at a culvert beneath the roadway and the surface of the roadway.

Hydraulic Gradient - The elevation of the surface of the water in the drainage system at any point.

Impervious Surface - Any surface that does not readily permit water to enter. Examples are roofs and concrete or asphalt-paved surfaces.

Improved Channel - Any channel whose characteristics are changed by either grading or construction of lining materials.

Level of Service - The return period for which a drainage system, or an individual element of that system, has adequate hydraulic capacity.

Natural Channel - An existing channel that has not been appreciably altered by grading, lining or changing its course.

Open System - A drainage system consisting of open channels, either natural or improved, with only comparatively short lengths enclosed by pipes or culverts.

Pervious Surfaces - Surfaces that absorb water such as yards and other unpaved areas.

Reach - A specific length of the storm drainage system between two points. For example, a reach may consist of a single culvert or may consist of several connected pipes or channel sections. The term "line" may also be used synonymously within the report.

Return Period - A statistical term for the average frequency that a given event may be expected to occur although it does not imply that the event will occur regularly at even intervals. It can also be defined as the reciprocal of the probability of an event. For example, a storm having a 10-year return period statistically can be expected to occur once in a period of 10 years, a probability of occurrence of 0.10, or 10%. However, the event may happen at any time and two such events may actually occur on successive days.

Sediment - Soil particles eroded by flowing water either in suspension in that water or as deposited.

Storm Drainage System - All of the natural and constructed facilities and appurtenances, such as ditches, natural channels, pipes, culverts, bridges, improved channels, street gutters, inlets and detention facilities, that serve to collect and convey surface drainage within the City.

Watershed - All land draining to the storm drainage system at any given point. This term is used synonymously with the terms tributary area, drainage area, drainage basin and catchment area.

C. STORM DRAINAGE SYSTEMS

There are two storm drainage systems in the City, the "major system" and the "minor system." The major system serves to carry relatively large volumes of water through the City while the minor system collects runoff from individual lots and smaller areas and carries it to the major system. Each must perform its function adequately to provide an acceptable level of drainage service; however, the consequences of poor performance by each system differ greatly.

Substandard performance by the major system is usually associated with significant consequences. When it fails to perform, the comparatively large volumes of water from that system overflow streets and property and may cause real damage by both erosion and flooding of buildings. The failure of the minor system to perform is characterized by lower volume, shorter duration overflows that may, on occasion, be a nuisance to traffic or cause objectionable quantities of water to flow across property although real damage is seldom experienced.

There is no clear line of demarcation between the major and minor systems. In general, the major system is considered to begin at the point at which approximately 40 acres become tributary to the system. This study and report are directed to the major system although some minor system elements have been included for continuity of the analysis.

D. AREA INFORMATION

The City of Joplin is located in the southwestern corner of Missouri, primarily in southwestern Jasper County although the southern edge lies in northwestern Newton County. It is surrounded by, or surrounds, a number of smaller cities and villages including Webb City, Airport Drive, Leawood, Shoal Creek Drive, Silver Creek and Duquesne. Major highways through the area include Interstate 44, US Highways 66 and 71, and State Highways 43, 96 and 171. Major waterways include Center Creek, along the north edge of the city; Shoal Creek, along the south edge; and Turkey Creek, which runs approximately through the middle. Missouri Southern College is located in the northeast quadrant of the City and the municipal

airport is at the north edge. Two large municipal parks, McClelland and Schifferdecker, and a golf course are located on the west edge.

For this study the city and adjacent areas tributary to the municipal drainage system are divided into 16 main watersheds. Each area is generally associated with one of the three main streams or their tributaries. These tributaries include Joplin Creek, Baker's Branch, Silver Creek, County Line Creek, and Tin Cup Creek.

Soils in the area generally are fine-grained with moderately pervious surface soils and less pervious subsoils. They are classified according to the Unified Classification system primarily as silt loams and silty-clay loams with some sandy loams in the floodplain areas. They typically are classified as hydrologic group B or C soils according to the Soil Conservation Service (SCS) system. Surface slopes across the area range from less than one percent, generally in the northern portions of the City, to greater than 20 percent toward the south.

Average annual precipitation in the area is 40.8 inches. Heaviest rainfall is expected during the spring and summer months with 75 percent of the total precipitation falling in the period from April to September. The driest period occurs from November to March. Rainfall events that place the most frequent demands on the drainage system occur as thunderstorms having intense, short duration rainfall which, on average, occur on approximately 55 days per year. Precipitation of 0.01 inch or more is recorded 108 days per year.

* * * * *

PART III

TECHNICAL METHODS

AND CRITERIA

PART III

TECHNICAL METHODS AND CRITERIA

A. FIELD INVESTIGATION

A field reconnaissance survey was conducted by Burns & McDonnell staff to observe and confirm physical features of the existing drainage system throughout the City. Specific data regarding reach size, configuration, and hydraulic conditions were measured and recorded for over 500 individual reaches included in the system model. In addition to measured data, notes were taken concerning the apparent physical condition and state of maintenance of a number of the storm drainage structures, both City-owned and private. Additional information was obtained from the City's drainage system base map and records.

Field information was recorded concerning pertinent hydraulic and hydrologic data for each reach of the system surveyed. In addition to verifying sizes and materials of existing enclosed system and culvert elements, the following information was obtained where applicable:

- Channel/culvert depth to overflow or structural damage: Measurements were made of the available headwater (freeboard) at a number of principal culverts before overflow of the roadway or downstream property begins. These data were later used in office studies to evaluate allowable flow depths in the system reaches.

- Open channel conveyance capacity: Cross sections were measured for important open-channel reaches on the major system.

- Hydraulic roughness coefficients: Roughness coefficients (Manning's "n") values were estimated and recorded for system reaches in their existing condition. Table III-1 indicates the standards applied for estimating existing roughness coefficients.

TABLE III-1

FIELD EVALUATION STANDARDS FOR ROUGHNESS COEFFICIENTS

Conveyance Structure	Manning's "n"
Closed Conduits	
Reinforced Concrete Pipe	.013
Corrugated Metal Pipe	.023
Reinforced Concrete Box Culverts:	
a. Single Barrel	.013
b. Multiple Barrel, Effective	.0155
Stone or Brick Masonry	.022
Improved Open Channels	
Full Concrete Lining - Good Condition	.015
Full Concrete Lining - Minor Joint Problems	.017
Full Concrete Lining - Advanced Deterioration	.020
Full Asphalt Lining - Good Condition	.017
Full Asphalt Lining - Poor Condition	.020
Grouted Masonry - Good Condition	.023
Grouted Masonry - Poor Condition	.030
Riprap	.035
Concrete Invert - Maintained Turf Sides	.020
Concrete Invert - Moderate Brush/Shrub Sides	.030
Concrete Invert - Tree and/or Improvement Obstruction	.035
Concrete Invert - Appreciable Fences	.045
Turfed - Clean, Few Obstructions	.030
Turfed - Moderate Obstructions	.035
Turfed - Severe Obstructions	.045
RR Tie - One Bank	.023
RR Tie - Both Banks	.020
Concrete Block Sides - Concrete Bottom	.019
Concrete Block Sides - Earth or Turf Bottom	.023
Natural Ditches or Channels	
Straight to Moderately Sinuous	
Clean Earth Banks, Earth Bottom or Smooth Rock	.030
Clean Earth Banks, Rough Rock Bottom	.035
Brushy Banks - Few Obstructions	.040
Brushy Banks - Significant Obstructions	.050
Debris and/or Weed Choked	.070

Overbank Floodways

Street R/W Perpendicular to Flow	.035
Yards - Open Grass	.030
Yards - Grass - Some Bushes and Trees	.040
Yards - Significant Trees and Bushes	.050
Unimproved - Weedy - Moderate Brush	.050
Unimproved - Heavy Brush and Trees	.060
Unimproved - Dense	.100
Unimproved - Open	.040

B. SYSTEM MAPPING

The primary source of information for mapping was the existing drainage system map provided by the City. Information concerning the location of existing drainage structures was obtained by reference to these maps supplemented by information obtained during the field investigation phase of the work.

During the office study phase, the system maps were expanded to include definition of subwatershed boundaries and drainage areas tributary to each modeled reach of the drainage system. Orthotopographic maps at a scale of 1"= 200' were the primary source of information for defining the major watershed boundaries and subareas.

After defining the system and individual drainage areas, the maps were keyed and coded to correspond to the computer models used for performance evaluation and confirmation of system hydraulic capacity. The completed full-size maps have been separately furnished to city staff.

C. COMPUTER MODELING

1. GENERAL

Office studies were conducted to accomplish the following objectives.

- Define the performance level of the present drainage system under conditions of current land use and development.

- Define the hydraulic demand on the drainage system under conditions of future land use as defined by the City's comprehensive land use plan.

- Confirm the performance capacity of the system as improved according to recommendations contained in other sections of this report.

- Evaluate alternative system improvement possibilities and evaluate the effect of various sequences and priorities of recommended improvements.

2. COMPUTER MODELS

Two computer models developed by the Corps of Engineers Hydrologic Engineering Center for storm drainage analysis, were the primary tools used to model the existing and proposed drainage systems. The HEC-1 "Flood Hydrograph Package" was used for the hydrologic analysis and the HEC-2 "Water Surface Profiles" program was used for the hydraulic analysis of the open channel system. Enclosed system components were analyzed using the HYDRA Storm and Sanitary Sewer Analysis Software by Pizer, Inc, since neither HEC-1 nor HEC-2 accurately analyzes enclosed facilities. In addition, two programs developed by Burns & McDonnell were used to estimate costs and to prioritize recommended improvements. Each program has a number of options to tailor the model to the specific system components and conditions.

a. HEC-1 and HEC-2

The HEC-1 hydrology package generates streamflow or runoff hydrographs at desired locations for specific storm events over a watershed. The model simulates surface runoff within an area and the subsequent routing through various drainage system components, including pipes, channels and reservoirs, by representing the watershed as an interconnected system, or network, of hydrologic and hydraulic components. The runoff and routing simulation is based on the specific input parameters for each component of the process including the subwatershed.

For this study, the HEC-1 model was used to generate hydrographs to determine the peak flows at each of the drainage system components

for return periods of 1, 2, 5, 10, 25, 50 and 100 years. Options used in modeling the runoff to the system include the hypothetical storm generated from rainfall frequency data for precipitation, the SCS curve number for the loss rate, and the SCS dimensionless unit hydrograph.

The Muskingum-Cunge method was used for relatively short runs of channel and pipe routing. Typical input included is curve number and lag time for the drainage area; diameter or width, slope, roughness coefficient and length for pipes and box culverts; and a typical cross section, length, slope and roughness coefficients for open channels.

The HEC-2 program is used to calculate water surface profiles for steady, gradually varied flow in natural or improved open channels and to evaluate the effects of various obstructions such as bridges, culverts, weirs and structures within the floodplain of the particular stream. The procedure used for computations in the program is generally known as the standard step method and is based on solution of the one-dimensional energy equation with energy loss due to friction determined by Manning's equation.

The HEC-2 program was used in this study where appropriate to determine rating curves for channel reaches, as mentioned previously, and to evaluate the capacities of the open channels, bridges and cross-road culverts in the drainage system. Water surface profiles generated by the program for peak flows for the various return period storms were used to determine and/or verify the 100-year floodplain for the major open channels in the system and to determine the impact, if any, on adjacent existing or proposed development. Portions of the input data for the major channels were obtained from copies of the original HEC-2 model used to develop the flood profiles for the FEMA Flood Insurance Study (FIS) published in 1983.

b. SYCOST Program

The SYCOST program is used primarily for estimating the budget grade costs of storm drainage systems for study and planning purposes. The program performs conceptual grade design of component system facilities then estimates their capital and annual cost using current unit prices for key items. It accommodates pipe systems with pipe sizes up to 96 inches diameter, single and multi-span box culverts, lined or natural open channels, and site specific detention facilities. Output data for each reach includes structure type and size, and cost estimates for construction, land acquisition, design fees and contingencies, total capital cost, and annual maintenance cost.

This program was used in this study to determine the value of and annual maintenance costs for the existing drainage system; to evaluate alternative facility designs; and to develop cost estimates for the most feasible proposed improvements.

c. PRIOR Program

The PRIOR program is a model for developing rational and logical priorities among discrete "projects" included in a large scale program or proposal for stormwater system improvements. The model design is biased to assign the highest priorities to those projects that relieve deficiencies benefitting the greatest number of people at the lowest capital cost per benefitted system "user." Operation of the model sequentially determines a "score" for each project on an internally weighted scale then differentiates between equal "score" projects by secondary level comparison of component factors to establish an absolute priority ranking of all projects within the model. The evaluation scale used to determine project scores is presented in Part VI of this report.

Parameters analyzed for each project are frequency of damage from overflow of the existing system; number of damaged properties; type of damage such as structure and/or contents damage, erosion only, or

nuisance only with no direct economic damage; frequency of existing system overflow; effect of inadequate system on future land development; structural condition of an existing facility, if present; magnitude of the absolute hydraulic deficiency; and capital cost of the project.

Output data from this program for each project includes priority number, priority points (or raw score), capital cost, and priority control which was the model's justification for assigning that project's priority.

For this study, the PRIOR program was utilized with the recommended improvement plan to rank the series of projects made up of the reaches proposed for improvement.

D. RAINFALL AND STORM DURATION

The design storm used in the analyses of the drainage system is defined as the pattern of rainfall over a specific period of time, or duration, for a given return period. The duration that tends to put the greatest demand on the system is termed the "critical storm duration" and is roughly equal to the time of concentration of the watershed. The time of concentration, T_c, is defined as the time at which all parts of the drainage area begin to contribute runoff or the time of flow from the farthest point in the watershed to the outlet.

The regional conditions that are expected to produce the greatest demands on the system are those associated with short-duration, high-intensity thunderstorms occurring as part of longer duration rainfall. Within the HEC-1 program the "hypothetical storm" option most closely those conditions. Storm duration was selected based more or less on the critical storm concept described previously. Although the times of concentration for the various watersheds included in this study vary, a storm duration of six hours was selected for all modeling. This duration is long enough to insure that the model reflects the peak flow when all areas of the watershed are

contributing and that the effects of any detention within the system are accounted for without overstating the actual demand on the system.

Rainfall data for the Joplin area were obtained from the Cherokee County table from the Kansas Department of Transportation (KDOT) "Rainfall Intensity Tables for Counties in Kansas," 1991 edition which provides more detailed information than the intensity-duration-frequency curves available from current City design information. (Cherokee County is located approximately six miles west of Joplin, just across the state line.) From this information, total 6-hour rainfall depths for return periods of 1, 2, 5, 10, 25, 50 and 100 years were determined as indicated in Table III-2.

TABLE III-2

DESIGN RAINFALL EVENTS

Return Period (Years)	6-hour Rainfall (Inches)
1	2.28
2	2.82
5	3.60
10	4.14
25	4.98
50	5.58
100	6.18

E. LAND USE

Land use parameters influencing runoff were evaluated on the basis of the City's 1986 orthotopographic maps supplemented by data from the City's Comprehensive Development Plan and field observation to develop existing system performance models. The Comprehensive Development Plan was also used to develop model data for future fully-developed conditions.

According to information in the development plan, recent growth areas in Joplin are limited to the south edge of the City along I-44, southwest near the medical centers, and east of the City. Large tracts of land remain undeveloped throughout the area. Residential development is the largest single land use accounting for approximately 50 percent of the developed area within the city. Office and business parks, institutional land use,

and retail commercial areas cover approximately 15 percent of the City. Industrial areas account for another 10 to 15 percent, and parks and recreation areas cover approximately 5 percent. Future development, for the most part, will be residential and industrial areas expanding to the east and south according to the City's Comprehensive Development Plan.

Runoff parameters with respect to land use are as set forth in Table III-3. The land use categories indicated are those used in preparing data for the system models. They vary somewhat from the categories contained in the Comprehensive Development Plan or the Stormwater Management Criteria manual.

TABLE III-3

LAND USE RUNOFF PARAMETERS

Land Use	SCS Curve Number
Residential	83
Commercial	97
Industrial	90
Open/Agricultural	75
Developed Park	77
Abandoned Mines	78
Mine Tailings Areas	70

F. COMPARISON TO PREVIOUS STUDIES

The current FEMA Flood Insurance Study (FIS) was completed almost 15 years ago. In that period of time, the extent and type of development within Joplin has obviously changed to some degree. Less obvious are the many changes in the technical methods and the increased information available for analyzing the storm drainage system and simulating its performance. Therefore, it is somewhat difficult to directly compare the results of this report with previous studies. It should not be concluded, however, that any of the reports are incorrect simply because different results have been obtained.

As an example, substantial differences may be noted between the FIS peak flows and those determined in this study for several of the watersheds. This is due primarily to the different technical methods used to determine

those flows in each case. The current FIS study relied on peak flows for several basins generated in previous studies which were completed prior to 1976. Although specific information was not available, it appears that those flows were developed using a statistical method which, in certain cases, can provide fairly accurate data. However, the accuracy of this method when applied to small, developed urban watersheds is much less than in larger watersheds of primarily open land, for which the method was developed. Therefore, variations in the peak flows determined by the two studies can be considerable since the watersheds identified for this study are considered small, urbanized areas in this context.

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PART IV

EXISTING SYSTEM PERFORMANCE

PART IV
EXISTING SYSTEM PERFORMANCE

A. GENERAL

This section presents the results of the hydrologic and hydraulic analysis of Joplin's major drainage system using the computer models and techniques described in Part III of this report. The analysis was based on the storm drainage system and land use as they existed in the summer of 1996. The performance of the existing system was reviewed based on both the current municipal drainage design criteria and the proposed "Stormwater Management Criteria" document which has been supplied separately to City staff.

The City's current drainage standards are based primarily on subdivision and floodplain ordinances, and review and approval of drainage plans for new development by the Director of Public Works. Generally, drainage system components are designed for a 10-year return period storm. The detention policy and design criteria have essentially been "borrowed" from the City of Springfield and never formally adopted by ordinance by Joplin. The proposed criteria, presented in the separate Stormwater Design Criteria document, outlines specific requirements for storm drainage systems including capacity and performance criteria for enclosed systems, open channels and detention facilities; design storms and precipitation data; design methods and techniques; easements; and plan submittal and review.

It is important to remember, however, that identifying an existing system element as failing to meet either current or proposed criteria, according to the model, does not indicate deficiencies in design or construction at the time the element was originally constructed. The principal determinants of hydraulic demand on the drainage system are land use and rainfall. Neither has remained static during the period of time over which Joplin's drainage system has developed. Major impacts on the capacity rating of the system include updated information on the predicted intensity of rainfall based on ongoing Weather Bureau statistical analysis of precipitation records; changes in land use not anticipated at the time

of the original design and construction; and development of computer modeling techniques and other analytical methods that permit a more refined analysis of system performance than was previously practical.

B. BASIN MODEL DEVELOPMENT

Computer models were developed for 16 principal watersheds including the City of Joplin and immediately adjacent areas. Each of the watersheds has its own unique drainage system tributary to one of the main waterways in the area. System maps indicating watershed limits and individual model reaches have been separately furnished to City staff.

The HEC-1 model was used to determine the demand discharge, or peak flow, to the drainage system (See Part III). The existing drainage system and structures were analyzed using the HEC-2 computer program, where appropriate. In addition to HEC-2, culverts were analyzed using inlet and outlet control and Manning's equation to determine capacities.

Although the models' calculations are precise with respect to the rainfall, land use, and system data, they are predicting system performance that is naturally variable. Infinitely changing rainfall rates, seasonal and other changes in day-to-day conditions of the land surface and vegetation, and the changing maintenance condition of the system itself will all influence the actual performance of the system at any given time.

Due to these natural variations, it is not realistic to conclude that a system element is not capable of supplying a given level of hydraulic service (i.e. 5-year, 10-year, etc.) simply because the model indicates a small capacity deficiency during the modeled storm. Therefore, deficiencies were not interpreted as being significant if the magnitude of the deficiency was relatively small or if it was determined that the deficiency was of a short duration (10 to 15 minutes or less).

C. EXISTING SYSTEM PERFORMANCE

Information on known drainage problems was gathered from City records and the residents of Joplin. The City provided a list of 29 known drainage problems with estimated costs for system improvements at those locations and a list of those projects that had been funded for the then current fiscal year. Information was obtained from residents through a questionnaire distributed to participants at two public meetings held in June, 1994. Of the 17 questionnaires that were completed, most pertained to problems that were already included on the City's list of problem areas.

The following pages contain descriptions of each watershed's major drainage system and summaries of the performance of the individual components.

1. SILVER CREEK WATERSHED

The Silver Creek watershed covers 6.25 square miles in the southeast corner of the city. It extends from approximately 1,000 feet south of West 20th Street east of Duquesne Road sloping southwest to its outlet at Shoal Creek. The upper watershed slopes north of Interstate Highway 44 are fairly flat, ranging from 1 to 4 percent. South of I-44 the slopes increase to around 8 percent and continue to increase towards the outlet where the slopes exceed 10 percent. The watershed drains to Shoal Creek at one main outlet 2,100 feet upstream of the I-44 crossing.

a. Land Use

This watershed is approximately half undeveloped. Residential land use comprises around 15 percent of the land use scattered throughout the watershed. The majority of the housing lies north of Interstate Highway 44. There is a fairly high concentration in the northwest corner of the watershed and the extreme northeast corner of the watershed just east of Duquesne Road. There are also residential developments located in the Leawood community just south of I-44. Industry makes up just over 5 percent of the land use. Most of the industrial development is along I-44 and

South Range Line Road. Commercial land use located along South Range Line Road also comprises around 5 percent. Maintained open areas, mostly located adjacent to the industrial and commercial areas, total approximately one quarter of the land use. Interstate Highway 44 runs from the northeast corner of the watershed to the west-central region with a cloverleaf interchange at the intersection with South Range Line Road.

b. Existing Drainage System

The existing major drainage system in this watershed consists of an open channel system fed by six tributaries consisting of natural and lined channels.

c. System Performance

Three major drainage problems have been reported in the Silver Creek watershed and are included in the City's current list of planned drainage improvements. The problem areas are: (1) intersection of East 25th Street and Ozark Avenue where street flooding is reported; (2) the area bounded by East 34th and East 35th Streets, Park Avenue and Highland Avenue where unimproved drainageways create flooding problems; and (3) the area from East 32nd Street to I-44, east of South Brownell Avenue, where another unimproved channel also creates flooding problems. The City's current plan calls for construction of new storm sewers and street inlets at the first location and paved channels or drainageways in the other two areas. The drainage facilities in the first two locations are not part of the major system and therefore, are not included in the system technical analysis. A summary of the rated capacity and level of source affected by the major drainage system in the silver Creek watershed is presented in Table IV-1.

2. SHOAL CREEK WATERSHED

The Shoal Creek watershed covers 0.84 square mile in the southwest corner of the Joplin city limits. It extends from as far north as East 41st Street near Pennsylvania Avenue south to its outlet at Shoal Creek about 500 feet east of Interstate Highway 44. Land slopes are fairly steep throughout most of the watershed, ranging from 5 to 12 percent. The majority of the watershed slopes at approximately 10 percent. The area drains to Shoal Creek at the main outlet east of the interstate with two smaller sub-watersheds of 117.8 acres and 90.85 acres draining to Shoal Creek west of the interstate.

a. Land Use

This watershed is approximately one-quarter residential with the majority of the housing concentrated in the northern half of the watershed. There is a small amount of industrial development, mostly along Interstate Highway 44 south of 44th Street. The rest of the watershed remains primarily undeveloped with some houses scattered throughout. Open land amounts to around 40 percent of the watershed. Undeveloped land with tree cover makes up almost one third of the land use. Interstate Highway 44 extends from the northeast corner to the southwest corner of the watershed.

b. Existing Drainage System

The existing major drainage system in this watershed is primarily an open channel system consisting of natural channels discharging into Shoal Creek.

c. System Performance

One major drainage problem has been reported in the Shoal Creek watershed, located near East 43rd Street between Virginia and Pennsylvania Avenues. The problem has been reported as inadequate drainage capacity of a natural channel. The City's current improvement plans call for increasing the capacity of this channel. A summary of the rated capacity and land of source afforded by the major drainage system in the Shoal Creek watershed is presented in Table IV-2.

3. WATERWORKS WATERSHED

The Waterworks watershed covers 3.43 square miles located in the southwest corner of the city. It extends from East 4th Street east of Main Street to its confluence at Shoal Creek just west of Maiden Lane. The watershed extends as far east as St. Louis Avenue and nearly to Schifferdecker Avenue to the west. The land slopes in the northern and eastern regions of the watershed are fairly flat, generally ranging from 3 to 6 percent. The land slopes in the southern regions increase greatly ranging from 10 to 20 percent in some areas near the confluence at Shoal Creek. The area drains to Shoal Creek at one outlet located about 900 feet west of Maiden Lane extended.

The main drainage channel in this watershed is Tin Cup Creek, which was included in the 1983 Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) for the City. Tin Cup Creek branches off into County Line Creek, which was also included in the FIS, just south of the Jasper-Newton County Line.

a. Land Use

This watershed is approximately 50 percent residential and 25 percent undeveloped. Industrial and commercial developments each make up around 5 percent of the watershed. Developed open areas, including parks, contribute just over 15 percent. The residential developments are located primarily in the northeast region of the watershed. The undeveloped land is located in the southern and southwestern regions of the watershed. The industrial and commercial developments are generally located along West 32nd Street and in an area south of West 26th Street and west of Picher Avenue. Park areas are located throughout the residential areas and near the major industrial facilities. Some areas of mine tailings are located in the extreme northwest corner of the watershed.

b. Existing Drainage System

The existing major drainage system in this watershed is primarily an open channel system with some culverts and enclosed elements

conveying street runoff collected through curb inlets, and is divided into three main tributaries that converge near Shoal Creek.

c. System Performance

Six major drainage problems have been reported in the Waterworks watershed as follows:

(1) Mohaska Ave. ditch, Jackson Ave, to West 30th Street - Insufficient channel size and insufficient culvert capacity.

(2) West 35th Street and Pearl Ave. - Insufficient culvert capacity.

(3) West 34th Street and Grand Ave. - Insufficient ditch size.

(4) West 30th Street and Massachusetts Ave. - Street flooding due to lack of inlets.

(5) East 32nd street to East 33 rd Street west of Connecticut Ave.

(6) East 35th and Ferguson Rd. to East 36th Street West of Wisconsin Ave. - Drainage problems due to unproved channel.

The City's improvement plans call for increasing channel and culvert capacities at the first, second and third locations; constructing new storm sewers at the fourth location; and paving the channels at the other two locations. A summary of the rated capacity and level of source afforded by the major drainage system in the waterworks watershed is presented in Table IV-3.

4. JOPLIN CREEK WEST WATERSHED

The Joplin Creek West watershed covers 2.68 square miles in the center of the City of Joplin. It extends north from East 32nd Street to West 3rd Street, near Virginia Avenue; to the west just past Maiden Lane, and to New Hampshire Avenue on the east. The land is fairly flat throughout most of the watershed, with slopes rarely exceeding three (3) percent. The area drains to Joplin Creek at one outlet near the intersection of West 4th Street and Murphy Boulevard. The main channel in this watershed is identified as the Iowa Avenue Branch in the 1983 FEMA flood insurance study.

a. Land Use

Land use in this watershed is approximately 70 percent residential, 10 percent industrial, and 15 percent commercial. The residential developments are primarily in the southern and western regions of the watershed. The industrial and commercial developments are mixed in the northern and northeastern regions. Developed park areas make up about 5 percent of the watershed, with undeveloped areas totaling less than 5 percent.

b. Existing Drainage System

The existing drainage system in this watershed is a combination of an open channel system and an enclosed system collecting street runoff through curb inlets.

c. System Performance

Only one major drainage problem has been reported in the Joplin Creek West watershed. The area involved is a reach from the intersection of West 10th Street and Chestnut Avenue to West 6th Street and Virginia Avenue. Excessive flooding of the downtown area is reported due to insufficient drainage capacity in the enclosed components of the system. A summary of the rated capacity and level of service afforded by the major drainage system in the Joplin Creek West watershed is presented in Table IV-4.

5. McCLELLAND WATERSHED

The McClelland watershed covers 1.94 square miles along the southwest corner of Joplin's city limits. It extends from West 23rd Street and Schifferdecker Avenue south to its outlet at Shoal Creek. The watershed slopes are fairly steep. Upper watershed slopes range from 6 to 12 percent with the higher slopes mostly east of Schifferdecker Avenue. The middle of the watershed tends to be steeper with slopes ranging from 10 to 13 percent and some areas exceeding 20 percent. The lower regions of the watershed have land slopes ranging from 10 to 13 percent on the west side and 6 to 10 percent on the east side. There is one main outlet to Shoal Creek east of Schifferdecker Avenue.

a. Land Use

This watershed is approximately two-thirds undeveloped. Residential land use comprises nearly 25 percent of the watershed. Most of the residential areas are concentrated north of 32nd Street and east of Schifferdecker Avenue as well as just west of Schifferdecker Avenue. Other single-family residential areas are scattered throughout the watershed. Industrial land use totals less than 5 percent, located primarily south of 32nd Street.

b. System Performance

No major drainage problems have been reported in the McClelland watershed. For detailed existing system performance see Table IV-5.

6. JOPLIN CREEK EAST WATERSHED

The Joplin Creek East watershed covers square miles, exclusive of the 2.68 square unless in the Joplin Creek West watershed, which is tributary to Joplin Creek East 14 th and Murphy, extending from Duquesne Road in the southeast to the confluence of Joplin Creek and Turkey Creek, approximately 1,200 feet east of Lone Elm Road, in the northwest corner of the city. Watershed slopes are fairly flat ranging from 3 to 5 percent throughout most of the watershed. The slopes steepen near the confluence with Turkey Creek to over 10

percent. The area drains to Joplin Creek which is the only outlet to Turkey Creek for this watershed.

a. Land Use

This watershed is approximately one half residential, 10 percent industrial, 10 percent commercial, and 15 percent undeveloped. The residential development is located primarily in the southwest corner and along the northeast boundary of the watershed. The commercial and industrial development is mostly in the northwest corner in the downtown business district. The undeveloped land is located in the very southeast corner of the watershed.

b. Existing Drainage System

The major drainage system in this watershed is a combination of an open channel system and an enclosed system that collects street runoff through curb inlets.

c. System Performance

A summary of the rated capacity and level of service afforded by the major drainage system in the Joplin Creek East watershed is presented in table IV-6.

7. LONE ELM WATERSHED

The Lone Elm watershed covers 1.62 square miles near the northwest corner of the city limits. It extends from Junge Boulevard near the intersection with Maiden Lane, north to the intersection of Lone Elm Road and Zora Street where it outlets to Turkey Creek about 1,200 feet west of Lone Elm Road. It extends east to North Pearl Avenue and as far west as Roosevelt Avenue. Upper watershed slopes range generally from 3 to 5 percent in the southern regions and less than 3 percent in the southwestern regions. Land slopes increase to near 13 percent in the lower watershed regions with a few areas greater than 18 percent near the confluence. The area drains to Turkey Creek at one main outlet near Lone Elm Road, with the exception of 98.2 acres east of Lone Elm Road that drains separately to Turkey Creek.

a. Land Use

This watershed is approximately half residential located mostly east of Lone Elm Road. Industrial land use makes up around 10 percent of the watershed and is located primarily along North Maiden Lane and West 7th Street. Commercial development comprises nearly 10 percent and is also located along North Maiden Lane and West 7th Street. Undeveloped areas make up nearly 30 percent of the watershed and are primarily north of West C Street. Developed parks contribute around 5 percent to the watershed and there are some mine tailings that total less than 3 percent.

b. Existing Drainage System

The existing drainage system is a combination of enclosed systems and open channels.

c. System Performance

Two major drainage problems have been reported in the Lone Elm watershed. One, in the area from West 6th Street and Maiden Lane to West 5th Street and Porter Avenue, reports an undersized culvert at West 6th Street and an undersized channel between West 5th Street and West 6th Street. The second location, in the area between West A Street and West C Street and North Porter Avenue and North Picher Avenue, reports undersized culverts at West A Street and West B Street causing flooding problems. For detailed existing system performance data see Table IV-7.

8. COUNTRY CLUB WATERSHED

The Country Club watershed covers 1.80 square miles along the west-central Joplin city limits. The watershed slopes generally to the west. It is bounded to the south by West 27th Street, to the east by Maiden Lane, and to the north by West 7th Street, and outlets to the west approximately one-half mile west of the city limits. The upper watershed slopes are fairly flat at less than 3 percent. The land slopes increase to around 10 percent in the lower reaches. The main drainage channel through the watershed is Short Creek which continues

past the Joplin City limits. The Country Club watershed is the extreme upper sub-watershed draining to Short Creek.

a. Land Use

This watershed is approximately 40 percent undeveloped. Nearly one third of the watershed is covered by residential development. There is a high concentration of housing in the eastern region of the watershed and less dense residential development in the north and south central regions, mostly single-family units. Industrial development comprises around 15 percent of the watershed. Most of the industry is located along Schifferdecker Avenue and West 20th Street east of Schifferdecker. There is also some industry in the northwest corner of the watershed. Park areas make up around 10 percent and are located adjacent to the industrial developments. Mine tailings total less than 5 percent and are located mostly along the St. Louis - San Francisco Railroad east of Schifferdecker Avenue.

b. Existing Drainage System

The existing major drainage system in this watershed is primarily an open channel system composed of natural channel with some lined channel.

c. System Performance

Three drainage problems have been reported in the Country Club watershed, each citing insufficient drainage capacity. One is located at West 16th Street and Willard Avenue, where a channel runs between houses to the main channel. Another reported problem, located at West 17th Street and Mina Avenue, is a minor system component and not part of the system analysis. The third reported problem, located at West 22nd Street and Willard Avenue, is a natural channel that flows northwest to the main channel. This is also a minor system component and not included in the analysis. Existing system performance data is summarized in Table IV-8.

9. LEADVILLE WATERSHED

The Leadville watershed covers 1.54 square miles along the western city limits. It extends from just south of West 9th Street near Schifferdecker Avenue north to its outlet to Turkey Creek southeast of the intersection of Zora Street and Schifferdecker Avenue. The extreme upper regions of the watershed contain fairly flat land slopes of 1 to 5 percent. Land slopes in the middle regions are around 3 to 6 percent, while the lower regions increase to between 10 and 20 percent with some areas in excess of 20 percent. The area drains to Turkey Creek at one main outlet near Zora Street and Schifferdecker Avenue.

a. Land Use

This watershed is approximately half covered by abandoned mines. They are mostly located north of Perkins Street. Nearby tailings make up a little less than 5 percent of the watershed. Approximately one-third of the watershed is residential with most single-family housing between Perkins Street and West 7th Street. Undeveloped areas make up around 7 percent of the land use with developed park areas covering about 8 percent. Industrial areas south of West 7th Street consume less than 5 percent of the watershed. Commercial land use totals only 1 percent.

b. Existing Drainage System

The existing major drainage system in this watershed is primarily an open channel system composed primarily of natural channel.

c. System Performance

No major drainage problems have been reported in the Leadville watershed. For an analysis of existing system performance, see Table IV-9.

10. TURKEY CREEK CENTRAL WATERSHED

The Turkey Creek Central watershed covers 6.72 square miles and lies generally between the northern edge of Joplin and the southern edge of the Royal Heights community. It extends from the community of Duquesne

in the southeast corner to the community of Tuckahoe in the northwest corner. The section of Turkey Creek under analysis runs from the eastern city limits to the western city limits, however the creek actually begins about 9 miles upstream from the eastern city limit and outlets to Spring River about 5.8 miles downstream of the western city limit, just west of the Kansas-Missouri border. Land slopes vary across the watershed, ranging from 5 percent or less in the upper regions to 10 to 15 percent in the lower regions. Some of the more extreme slopes are located south of Turkey Creek between Main Street and Range Line Road. The area drains to Turkey Creek through various outlets.

a. Land Use

This watershed is approximately half undeveloped. The undeveloped areas are located mostly in the northeastern and northwestern regions of the watershed. Residential development comprises nearly one quarter of the land use. The concentrated residential areas are located in the northeast corner of Joplin and the southern half of the Royal Heights community. Other housing units are scattered throughout the watershed. Industrial development makes up just under 10 percent of the watershed and is located primarily along Newman Road and Range Line Road. Commercial development is intermixed with the industrial development and contributes just under 10 percent as well. A wastewater treatment plant is located on the south side of Turkey Creek just downstream of its confluence with Joplin Creek. The Missouri Southern State College campus is located at the southwest corner of the intersection of Duquesne Road and Newman Road. College housing is located north of Newman Road and athletic facilities are east of Duquesne Road. A major shopping mall is located east of Range Line Road between Turkey Creek Road and East 4th Street.

b. Existing Drainage System

The existing major drainage system in this watershed is primarily an open channel system with an enclosed system present near the shopping mall.

c. System Performance

There are six reported flooding problems in the Turkey Creek Central watershed as follows:

(1) Florida Ave. between Newman Rd. and Princeton St - Insufficient drainage way.

(2) East, seventh street to west tank street west of Waggoner Insufficient drainage way.

(3) North end of Canterbury Lane - Street Flooding.

(4) East Seventh Street and Turk Ave. to Hodgdon Rd. and Range line road. Insufficient drainage way.

(5) College View Dr. and Butterfadd Ln. - Undersized ditch.

(6) Goetz Blvd between Willow Ln. and Ridge Dr. - Undersized ditch.

Locations 1, 5 and 6 are not a part of the major drainage system and, therefore, were not a part of the system analysis. The City has recently completed an improvement project at Location 4. A summary of the rated capacity and level of service afforded by the major drainage system in the Turkey Creek Central watershed is presented in Table IV-10.

11. CENTER WATERSHED

The Center watershed covers 0.84 square mile along the city's north side. It extends from Fountain Road at the northern most point to south of Zora Street where it drains to Turkey Creek at one outlet. The outlet is located between North Main Street and the Kansas City Southern Railroad. Land slopes vary from slightly over 5 percent in the upper watershed to around 10 percent in the downstream regions.

a. Land Use

This watershed is mostly undeveloped, with open acres comprising 72 percent of the land use. Industrial areas are located along the railroad. A lightly populated area of residential housing mixed with some small industrial structures is located east of the railroad and north of Zora Street, comprising approximately 15 percent of the land use.

b. Existing Drainage System

The existing major drainage system in this watershed is an open channel system comprised primarily of natural channel.

c. System Performance

For detailed existing system performance data see Table IV-11.

12. ROYAL HEIGHTS WATERSHED

The Royal Heights watershed covers 0.90 square mile along the city's north side and includes the northwest corner of the community of Oakland Park. It extends from Mount Hope Road, west of U.S Highway 71, and slopes generally to the southwest. Upper watershed land slopes are fairly flat, less than 2 percent, increasing to slightly greater than 5 percent downstream. The area drains to Turkey Creek at one main outlet west of the St. Louis-San Francisco Railroad.

a. Land Use

This watershed is approximately 80 percent undeveloped. Single-family dwelling units comprise 13 percent of the land use, mostly contained within Oakland Park in the eastern part of the watershed. Some isolated industrial areas are located in the southwest and south-central sections along the St. Louis-San Francisco Railroad. Royal Heights Park is located in the southeastern part of the watershed northwest of Oakland Park.

b. Existing Drainage System

The existing major drainage system in this watershed is primarily natural open channel system.

c. System Performance

No major drainage problems have been reported in the Royal Heights watershed. For detailed system performance data see Table IV-12.

13. BAKER'S BRANCH WATERSHED

The Baker's Branch watershed is also referred to as the Oakland watershed in this study and report although the 1983 FIS also refers to it as Baker's Branch to correspond to the main channel through the area. The watershed covers 3.78 square miles in the extreme northeast corner of the city. It extends from east of Travis Acres Road near Newman Road to just north of Cardinal Drive south of Webb City and outlets to Turkey Creek north of Newman Road southeast of the Royal Heights community. Upper watershed slopes are fairly flat ranging mostly from 2 to 4 percent. The land slopes increase towards the lower end of the watershed ranging from 10 to 15 percent and some areas near the confluence approach 20 percent. There is one main outlet to Turkey Creek located southeast of Royal Heights.

a. Land Use

This watershed is over 75 percent undeveloped. Residential development comprises 15 percent of the watershed and is located primarily west of Range Line Road and south of Zora Avenue in the Royal Heights community. Industrial development makes up less than 5 percent of the watershed and is located mostly along Zora Avenue. Mine tailings, located in the northeast region of the watershed, cover around 3 percent of the watershed. Abandoned mines and quarries are located in the southeast region of the watershed and make up less than 3 percent of the land use.

b. Existing Drainage System

The existing major drainage system in this watershed is primarily a natural open channel system.

c. System Performance

Three major drainage problems have been reported in the Baker's Branch watershed. The first is located between Lincoln Avenue and

North Ozark Avenue south of Xenia Street where local flooding is reportedly caused by an undersized drainage ditch. The second location is south of Zora Street between North Turk Avenue and North Highview Avenue. The reported problem is flooding due to insufficient street drainage and an unimproved drainage ditch. The third reported problem, flooding due to insufficient drainage ditch capacity, is located along Goetz Boulevard between Castle Rock Drive and Hackberry Lane. All three locations are not a part of the major drainage system and therefore, are not included in the system analysis in these areas. For detailed information on the performance of the existing major system in this watershed, see Table IV-13.

14. DUQUESNE WATERSHED

The Duquesne watershed covers 1.26 square miles just outside the eastern Joplin City limits, north of Interstate 44. The upper limits of the watershed begin approximately 2,300 feet north of 32nd Street, east of Duquesne Road. The watershed slopes to the north and outlets at Turkey Creek 1,000 feet east of Duquesne Road. The land slopes vary from between 2 and 4 percent in the upper watershed to around 6 percent in the lower watershed. The land slopes decrease greatly near the confluence of Turkey Creek to just over 1 percent.

a. Land Use

This watershed is approximately one third residential land use, mostly single-family dwelling units. The residential areas are spread fairly evenly throughout the watershed, with the exceptions of the northern end near the confluence and the southwestern corner where there is no housing. Half of the watershed remains undeveloped. There is some industry in the southwest corner, totalling less than 5 percent of the land use. Parks and maintained open areas account for slightly over 10 percent of the watershed.

b. Existing Drainage System

The existing major drainage system in the Duquesne watershed is natural open channel system.

c. System Performance

No major drainage problems have been reported in the Duquesne watershed. For detailed information on the performance of the major drainage system, see Table IV-14.

15. OPOSSUM WATERSHED

The Opossum watershed covers 240 acres (0.38 square mile) in the northwest corner of the city. It extends from B Street just west of McCoy Avenue, north to its outlet to Turkey Creek near the intersection of the St. Louis-San Francisco and Missouri-Kansas-Texas Railroads. The extreme upper watershed land slopes are fairly flat ranging from 2 to 5 percent. The remainder of the watershed contains land slopes around 10 to 12 percent.

a. Land Use

This watershed is around 70 percent undeveloped. Mine tailings make up about 15 percent of the land use, located mostly in the southwest region of the watershed. There is an area of residential development in the southern part of the watershed with other single-family dwelling units scattered throughout, comprising nearly 6 percent. Industrial land use makes up approximately 7 percent of the watershed and is located in the southeast corner.

b. Existing Drainage System

The existing major drainage system is exclusively an open channel system.

c. System Performance

No major drainage problems have been identified in the Opossum watershed.

16. TUCKAHOE WATERSHED

The Tuckahoe watershed is located in the Northwest corner of the city limits and covers 1.8 square miles. It extends from Turkey Creek on the south to just north of Zora street on the north. The ranges from the eastern boundary of just west of the Kansas City Southern Railroad line to Schifferdecker Avenue on the west. The slopes vary from zero to ten percent.

a. Land Use

The watershed is approximately 15 percent residential, located primarily in the southern areas and along Lone Elm Road. Light Industrial accounts for approximately five percent of the watershed. Ten percent of the watershed is open fields and the remaining 70 percent is lightly forested.

b. Existing Drainage System

The existing major drainage system is open channel flow; the majority of the channels are natural channels while a few have rip rap or stone lined walls while maintaining natural flowlines.

c. System Performance

For detailed information on the existing major system performance see Table IV-16.

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EXISTING SYSTEM

CAPACITY ANALYSIS

TABLE IV- 1

SILVER CREEK

EXISTING SYSTEM CAPACITY ANALYSIS

I.D. NO.		DESCRIPTION	CAP (cfs)		2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
1000		3 - 8' X 2' RCA	N.A.		1,420	1,990	2,380	3,014	3,550	4,080	Low Water Crossing; Poor Condition
1002		Concrete Dam	N.A.		1,420	1,990	2,380	3,010	3,550	4,080	Privately Owned; Structure Repair Needed
1003		20' X 12' RCA	3,000		1,410	1,980	2,370	**3,000**	3,530	4,060	MHTD; MO Rte. 86
1016		Dam and Pond	N.A.		1,400	1,950	2,320	2,930	3,440	3,960	Privately Owned
1027		5.5' X 4.7' RCB, 2 - 42" RCP	400		150	250	320	**420**	510	590	50th E/O Indiana
1033		3' X 2.5' RCB	**38**		120	200	260	350	420	490	Private Entrance
1037		4' X 2.5' RCB	**60**		120	200	250	340	410	470	Private Entrance
1043		5' X 4.3' RCB	165		90	140	**180**	240	280	320	44th E/O Indiana
1077		18' X 5' RCB	**460**		1,260	1,760	2,080	2,580	2,990	3,480	Private Roadway
1123		3 - 9' X 7' Bridge	1,300		**1,190**	1,670	2,000	2,470	2,840	3,340	44th E/O Oaklawn

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
1127	2 - 8' X 4' RCB	560	170	250	300	380	**550**	820	
1133	8' X 6' RCB	540	170	250	290	370	**540**	810	Range Line Road
1137	6' X 6' RCB	330	140	220	250	**320**	470	730	Range Line Outer Rd; Analyzed as Detention Basin Outlet Due to Extended Low-lying U.S. Area
1142	2 - 24" RCP; 1 - 30" RCP; 1 - 24" CMP	**94**	200	300	380	500	590	680	Marjorie Lane
1150	2 - 18" CMP	**25**	90	140	180	240	290	340	Lilian Road
1158	3 - 10' X 5' RCB	1,350	540	770	980	**1,270**	1,420	1,860	
1163	12' X 6.5' RCB	1,260	530	750	960	**1,230**	1,380	1,810	I-44; Analyzed as Detention Basin Outlet Due to Extended Low-lying U.S. Area
1167	8' X 3' RCB	220	50	70	84	105	120	**140**	
1172	8' X 3' RCB	220	45	63	76	94	110	**120**	Private (Sam's Club)
1173	2 - 9' X 4' RCB	950	540	**860**	1,080	1,420	1,700	1,920	Entrance to Holiday Inn
1183	5 - 72" X 44" CMPA	800	510	**790**	1,020	1,350	1,620	1,840	Railroad
1197	2 - 30" RCP	72	46	64	**76**	94	108	120	32nd Street
1202	4 - 42" RCP	370	200	320	**400**	520	610	700	32nd Street

I.D. NO.		DESCRIPTION	CAP (cfs)		2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
1203		2 - 30" RCP	80		40	60	**75**	100	110	130	32nd Street
1207		4 - 60" CMP	620		160	240	300	400	470	**540**	Railroad (Abandoned)
1223		4 - 72" CMP	920		220	360	450	630	760	**870**	Railroad
1224		53" X 34" RCHEP	82		20	30	35	45	55	**65**	32nd Street
1226		49" X 32" RCHEP	70		17	27	34	46	54	**63**	32nd Street
1227		3 - 60" RCP	570		190	330	410	**540**	660	760	Duquesne S/O 32nd
1232		3 - 42" RCP	280		100	180	220	**300**	360	410	32nd E/O Duquesne
1237		65" X 40" CMPA	90		**90**	150	190	250	300	340	Private Entrance
1238		65" X 40" CMPA	100		**90**	140	180	240	290	330	Private Entrance
1242		36" RCP	84		**74**	140	170	230	270	310	Detention Basin Outlet
1244		60" RCP; 350'L	200		100	150	**180**	220	260	290	
1245		60" RCP; 560'L	200		100	140	160	**200**	240	270	
1252		65" X 40" CMPA	90		**90**	140	180	240	290	330	Private Entrance
1253		58" X 36" CMPA	74		**80**	130	170	220	270	320	Field Entrance
1283		2 - 30" RCP; 2 - 24" RCP	114		**80**	140	170	230	280	320	Connecticutt S/O 48th
1285		3 - 24" RCP	70		40	**70**	90	120	150	170	Connecticutt S/O 46th
1286		36" RCP	42		**40**	70	90	120	150	170	46th E/O Connecticutt

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
1287	36" RCP	42	**40**	60	80	110	140	160	45th E/O Connecticutt
1288	4' X 5' RCB	170	34	55	70	100	120	**140**	44th E/O Connecticutt
1302	7' X 7' RCB	640	400	540	610	**660**	710	740	I-44; Analyzed as Detention Basion Outlet Due to Extended Low-lying U.S. Area
1308	2 - 7' X 6' RCB	700	510	**760**	930	1,190	1,400	1,590	37th E/O Brownell
1313	60" RCP; 100'L	250	90	130	150	200	230	**260**	32nd; Enclosed System Outlet
1314	72" RCP; 430'L	260	90	130	150	200	230	**260**	
1317	48" RCP; 100'L	144	70	100	120	**150**	170	190	30th @ McConnell; Enclosed System Outlet
1320	36" RCP; 150'L	67	29	43	52	**65**	76	86	On 30th W/O McConnell
1326	2 - 6' X 4' RCB	280	**300**	430	520	680	800	910	Private (Office Building)
1327	2 - 7' X 4' RCB	480	300	430	**520**	680	800	910	32nd Street
1328	58" X 36" CMPA; 50'L	130	50	70	90	110	**130**	145	Arizona N/O 32nd
1329	48" RCP; 160'L	130	50	70	90	110	**130**	145	On 32nd E/O Arizona
1333	2 - 6' X 3.5" RCB	300	180	270	**330**	420	490	550	28th & Arizona
1337	4' X 5' SMA	135	**150**	220	270	340	390	440	Railroad
1338	72" X 44" CMPA	130	100	**140**	170	210	240	270	Private (Lumber Co.)

TABLE IV-2

SHOAL CREEK

EXISTING SYSTEM CAPACITY ANALYSIS

I.D. NO.		DESCRIPTION	CAP (cfs)		2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
2025		6' X 4' RCB	>320		140	200	220	270	300	**320**	MHTD, Rt. 86; analyzed as outlet from unplanned detention.
2032		60" RCP	>240		80	110	140	180	210	**240**	MHTD; entrance ramp
2033		48" RCP; 400' L	200		70	100	126	161	**190**	210	MHTD; I-44/M-86
2034		42" RCP; 370' L	110		55	80	**100**	130	150	170	MHTD; I-44/M-86
2035		5' X 4' RCB	200		80	120	140	180	**210**	240	Virginia N/O 50th
2045		48" CMP	102		60	80	**100**	120	140	150	Outlet end needs repair
2055		48" RCP	>150		60	80	100	120	135	**150**	MHTD, I-44; Analyzed as outlet from unplanned detention.

TABLE IV-3

WATERWORKS

EXISTING SYSTEM CAPACITY ANALYSIS

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
3005	2 - 10' x 6' RCB	1500	**1490**	2250	2800	3700	4400	5080	Glendale Road
3022	2 - 48" RCP	400	33	52	65	86	100	**120**	Oakmont & Rustic Ridge
3050	12' X 6' RCB	**400**	490	740	950	1250	1510	1730	Jackson Avenue
3052	8' X 4' RCB	280	22	36	45	60	72	**84**	Jackson Avenue @ 42nd
3065	48" RCP	120	33	49	59	75	88	**100**	Moffet & 36th
3095	8' X 8' RCB	960	430	670	800	**1020**	1260	1450	Main N/O 39th
3110	6' X 4' RCB	130	66	99	**120**	160	180	210	36th E/O Main
3117	6' X 4' RCB	260	59	87	100	130	160	**180**	34th E/O Main
3120	9' X 4' SMB	**200**	350	550	660	840	1000	1150	Virginia E/O Main
3135	6' X 2.5' RCB; 6' X 2.8' RCB	300	**290**	420	520	670	790	900	Indiana S/O 36th
3145	3 - 60" RCP	540	240	360	450	**570**	670	770	36th E/O Indiana

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
3160	8' X 4' RCB	210	150	**220**	270	340	400	450	35th & Ferguson
3162	42" RCP, 500' L	45	**43**	65	79	100	120	140	
3170	8' X 3' RCB	150	69	98	120	**150**	170	190	33rd W/O Norman
3180	6' X 3' RCB	80	47	68	**83**	100	120	140	Capacity Control @ US Parking Lot
3200	2 - 128" X 83" CMPA	1000	580	840	**1050**	1370	1620	1860	McIntosh Circle Drive
3210	4 - 72" CMP	1200	550	810	1000	**1310**	1550	1780	
3219	60" RCP	300	57	86	110	140	160	**180**	McIntosh Circle Drive
3230	2 - 12' CMP	2700	500	720	900	1170	1380	**1580**	32nd W/O Jackson
3238	2 - 48" RCP	170	110	**160**	200	260	300	340	28th W/O Bird
3240	42" RCP, 620'L	134	91	**130**	160	210	240	280	
3250	12' X 6' RCB	670	380	560	**690**	890	1040	1180	Jackson S/O Mohaska
3260	8' X 2' RCB	**81**	90	130	160	200	230	260	Mohaska at Sergeant
3270	11' - 10" X 5' RCB	470	240	350	**430**	550	650	740	30th & Moffet
3280	8' X 5' RCB	440	230	340	**420**	530	620	700	Pearl N/O 27th
3290	8' X 5' RCB, 235'L	520	210	300	370	470	**540**	620	Wall N/O 27th
3300	8' X 5' RCB	240	170	**260**	310	400	460	520	Alley E/O Wall, N/O 27th

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
3320.1	8' X 5' RCB, 185'L	600	160	240	290	370	440	**500**	Outlet W/O Joplin, N/O 27th
3320.2	5' - 9" X 4' - 8" RCB, 65'L	360	160	240	290	**370**	440	500	
3320.3	6' X 4.5' RCB, 120' L	360	150	220	260	**330**	390	450	
3320.4	6' X 5.5' RCB, 55'L	470	150	220	260	330	390	**450**	
3320.5	6' X 5' - 2" RCA, 45' L	380	130	190	230	290	340	**390**	
3320.6	4' X 5' - 2" SMB, 125'L	190	130	**190**	230	300	350	400	
3320.7	6' X 5' - 2" RCB, 25'L	430	130	190	230	300	350	**400**	Inlet E/O Main, S/O 27th
3330	48" RCP, 210'L	115	**120**	180	220	280	330	380	28th W/O Pennsylvania
3340	2 - 10' CMP	1500	400	580	710	900	1050	**1190**	32nd W/O McIntosh Circle Dr.
3350	12' X 5' RCB	400	**390**	560	690	870	1010	1150	
3371.1	48" RCP, 500'L	200	69	**97**	120	140	170	**190**	
3371.2	48" RCP, 300'L	270	69	97	120	140	170	**190**	
3372	42" RCP, 600'L	130	34	50	60	76	**88**	**100**	
3373	4' X 3.5' RCA, 470'L	160	28	40	48	61	**71**	**81**	
3374	42" RCP, 160'L	160	20	29	36	46	54	**62**	
3375	60" RCP, 580'L	330	**280**	410	500	640	750	860	
3376	72" X 64" RCA, 340'L	330	220	**320**	400	510	600	690	

I.D. NO.		DESCRIPTION	CAP (cfs)		2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
3377		81" X 59" CMPA, 400'L	220		**210**	310	380	490	580	660	
3391		81" X 59" CMPA, 480'L	320		160	230	**280**	360	420	480	
3392		2 - 72" RCP, 60'L	850		150	220	260	330	390	**400**	
3393		60" RCP, 200'L	370		72	110	130	170	200	**220**	
3394		72" RCP, 490'L	280		71	100	120	160	180	**210**	
3395		60" RCP, 300'L	240		59	86	100	130	160	**180**	
3410		48" CMP	83		35	53	66	**85**	100	120	McCoy @ 25th

TABLE IV-4

JOPLIN CREEK WEST

EXISTING SYSTEM CAPACITY ANALYSIS

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
4005	3-8' X 6' RCB	**1000**	1640	2280	2740	3410	3970	4510	TW Ctl. @ 6085; Poor Struct. Cond.
4007	5 - Span Timber Bridge	2100	1160	1600	**1910**	2390	2800	3170	Private; Tot. Span = 74'
4009	4 - Span Timber Bridge	2000	930	1330	1570	**1940**	2220	2520	RR; Tot. Span = 53'
4012	3.8' X 4.3' RCB;4.8' X 5' RCB	510	250	350	420	**520**	610	680	RR
4015	13' X 7' RCB	1180	480	680	820	1030	**1200**	1350	RR
4020	2-7' X 6' RCB	740	480	**680**	820	1030	1200	1350	Private
4030	13' X 7' RCB	1000	480	680	820	1030	**1200**	**1350**	Kentucky
4045.1	12' X 4' RCB, 110'L	620	**520**	740	880	1100	1270	1440	
4045.2	12' X 4' RCB, 450'L	460	**450**	640	770	980	1130	1280	U.S. End @ Alley w/o Main
4045.3	12' X 4' RCB, 760'L	460	**410**	580	710	900	1040	1180	U.S. End @ 6th St.

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
4045.4	12' X 4' RCB, 360'L	330	**380**	560	680	860	1000	1140	U.S. End @ Wall
4045.5	12' X 4' RCB, 390'L	330	**360**	530	640	820	960	1090	U.S. End @ Pearl
4050	8' X 5' RCB, 530'L	**280**	360	520	630	810	950	1080	U.S. End @ Byers
4055	1-8' X 4'; 1-4' X 4' RCB; 600'L	420	**350**	510	620	780	920	1040	U.S. End @ West Side Moffett
4060.1	7' X 5' RCB; 340'L	400	**340**	490	600	760	890	1010	U.S. End @ West Side Sergeant
4060.2	7' X 5' RCB; 500'L	400	310	**460**	560	710	830	940	U.S. End @ 8th St.
4067	9' X 5' RCB; 500'L	600	290	420	**520**	660	780	880	U.S. End @ 9th St.
4070.1	8' X 3' RCB; 400'L	250	**270**	400	480	620	730	830	U.S. End @ Conner
4070.2	8' X 3' RCB; 330'L	250	**230**	340	420	540	630	720	U.S. End @ Chestnut
4073	8' X 3' RCB; 220'L	250	**220**	330	400	510	600	680	U.S. End @ 10th
4076	8' X 4' Timber Bridge	320	220	**330**	400	510	600	680	RR
4077	9' X 3.6' RCB	200	**200**	300	360	470	550	620	Murphy
4080	9' X 3.8' RCB	200	**200**	300	360	470	550	620	11th St.
4090	8' X 3.5' RCB	270	180	**270**	330	430	500	570	12th St.
4100	8' X 3.9' RCB	260	150	220	**270**	350	410	470	Junge Blvd.

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
4106	48" CSP	130	**100**	160	190	250	290	330	RR
4115	5' X 3' RCB	80	40	**60**	70	95	110	125	17th St.
4140	4' X 3' RCB	22	**25**	35	45	60	70	80	19th St.
4150	13.2' X 5' RCB	510	250	350	420	**520**	610	680	Private
4155	2 - Span Bridge	---	230	330	390	500	570	**650**	Private; Tot. Span = 22'
4156	5' X 3' RCB, 180'L	**150**	230	330	390	500	570	650	U.S. End @ Alley s/o 7th
4160.1	6' X 5' RCB, 410'L	330	220	**320**	380	480	560	630	U.S. End @ 8th
4160.2	6' X 5' RCB, 460'L	330	210	**300**	360	460	530	600	U.S. End @ 9th
4160.3	6' X 5' RCB, 380'L	330	200	280	**340**	430	500	570	U.S. End @ 10th
4165	72" RCP, 1090'L	300	200	**280**	340	430	500	570	
4166	6' X 4.5' SMA, 60'L	250	200	**280**	340	430	490	560	Poor Struct. Cond.
4175	5' X 6.5' SMA, 100'L	310	200	**280**	340	430	490	560	
4176	6' X 8' Bridge	359	200	280	**340**	430	490	560	RR
4177	6' X 4' RCB, 250'L	179	**180**	260	310	390	460	520	U.S. End @ Joplin
4178	8' X 4' RCB, 560'L	250	180	**260**	310	390	460	520	U.S. End @ 11th
4179	6' X 4' RCB, 390'L	197	25	35	40	50	60	**70**	

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
4180	6' X 4' RCB	157	25	35	40	50	60	**70**	RR Culvert
4181	6' X 4' RCB, 330'L	157	25	35	40	50	60	**70**	Poor Struct. Cond.
4183	8' X 4' RCB, 360'L	234	150	**220**	270	340	400	450	
4185	8' X 4' RCB	234	150	**220**	270	340	400	450	RR
4186	8' X 5' RCB	300	130	190	230	**290**	340	380	Private
4190	10' X 3.3' RCB	300	110	160	190	240	**290**	320	Byers
4195	6' X 4' RCB	162	90	130	**160**	200	230	260	RR (Abandoned)
4200	7' X 2.3' RCB, 140'L	110	80	**110**	140	170	200	230	
4207	7.5' X 2.5' RCB, 270'L	90	40	60	**80**	100	110	**130**	
4208	3' X 2.3' RCB, 800'L	44	30	**40**	50	60	70	80	
4210	2-12' X 6' RCB	2200	930	1330	1570	1940	**2220**	2520	RR (Beneath 7th)
4220	2-11' X 4' RCB	1300	930	**1330**	1570	1940	2220	2520	9th St.
4226	9 - Span Timber Bridge, 60° Skew	870	**930**	1330	1570	1940	2220	2520	RR; 122' Tot. Span; East 4 Spans Ineffective
4227	4 - Span Timber Bridge	1010	800	**1140**	1340	1650	1880	2130	RR; 48' Total Span

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
4230	3-8' X 7' RCB	1050	800	**1140**	1340	1650	1880	2130	12th St.
4235	48" RCP; 330'L	87	**80**	110	130	160	180	200	
4236	36" RCP; 330'L	107	50	70	80	100	**110**	125	
4250	4-8' X 4' RCB	**400**	740	1060	1250	1540	1750	2000	RR (Abandoned)
4260	10' X 7' RCB; 10' X 4' RCB	1050	730	**1050**	1220	1530	1790	2120	15th St.
4270	2-6' X 3.2' RCB; 1-72" RCP	460	**490**	700	850	1090	1300	1480	17th St.
4280	4-60" RCP	570	460	**660**	800	1030	1190	1340	18th St.
4286	60" RCP, 650'L	176	**190**	270	330	420	490	550	
4287	54" RCP, 220'L	**133**	190	270	330	420	490	550	
4288	1-48" RCP, 1-36" RCP, 50'L	**143**	190	270	330	420	490	550	
4289	48" RCP, 890'L	**137**	170	240	300	380	440	500	
4290	2-6' X 4' RCB	440	220	310	380	**480**	560	630	20th St.
4292	36" RCP; 250'L	67	---	---	---	---	---	---	Rated with 4298
4296.1	58" X 36" CMPA, 950'L	**53**	160	230	280	360	420	480	

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
4296.2	58" X 36" CMPA, 900'L	**53**	120	180	210	270	320	360	
4298	58" X 36" CMPA	**138**	180	260	320	410	480	550	Includes 4292
4318	65" x 40" CMPA, 250'L	**90**	140	210	250	320	380	420	
4321	58" X 36" CMPA	106	**110**	160	190	240	280	320	24th St.
4326	50" X 31" CMPA	87	**80**	120	140	180	210	240	26th St.
4342.1	72" RCP, 400'L	424	230	340	**410**	520	600	680	
4342.2	72" RCP, 1000'L	519	200	290	350	440	**520**	590	
4342.3	72" RCP, 950'L	424	160	240	290	370	**430**	500	
4343.1	48" RCP, 1000'L	100	**120**	180	210	270	320	360	
4343.2	48" RCP, 1300'L	100	**80**	120	140	180	210	240	
4346	36" RCP, 350'L	47	**40**	60	70	90	100	120	
4350	48" RCP, 450'L	123	40	60	80	95	110	**125**	

TABLE IV- 5

McCLELLAND

EXISTING SYSTEM CAPACITY ANALYSIS

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
5010	5 - 5' X 3' 8" RCB	750	410	**650**	840	1170	1440	1670	McClelland, outside corporate limits
5012	2 - 30" RCP	70	7	11	14	19	22	**26**	
5057	2 - 24" RCP	**40**	380	610	780	1090	1370	1620	Privately owned. Culvert tailwater causes problem for upstream structure 5018.
5018	2 - 9' 6" X 3' 6" RCB	580	340	**550**	720	1010	1260	1500	Outside corporate limits
5020	4' X 2' 6" RCB	**50**	250	390	490	640	770	890	McClelland Park
5025	2 - 8' X 3' 2" RCPA	240	**230**	350	440	580	690	790	McClelland Park
5047	43" X 27" CMPA	**40**	110	170	220	300	390	410	Outside corporate limits
5055	3 - 54" RCP	570	280	440	**580**	880	1110	1310	Shifferdecker Ave., outside corporate limits
5065	2 - 24" RCP	50	**40**	65	80	110	130	150	
5070	7' 5" X 3' 2" RCB	190	**150**	230	280	360	430	490	

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
5085	4 - 27" VCP	140	**64**	190	290	460	580	670	
5093	48" RCP Length = 350 ft	130	70	100	**130**	170	200	230	Enclosed system
5094	42" RCP Length = 315 ft	90	60	**85**	110	140	170	190	Enclosed system
5095	36" RCP Length = 170 ft	70	47	**73**	91	120	140	160	Enclosed system
5105	2 - 24" RCP	56	**50**	160	230	380	460	510	Upstream Detention generally ineffective for greater than 2-year return period.

TABLE IV-6

JOPLIN CREEK EAST

EXISTING SYSTEM CAPACITY ANALYSIS

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
6030	2-66" RCP, 700'L	510	150	200	240	300	350	**390**	Lt Bank Trib @ Main & B St
6031	4' X 2.5' SMA, 730'L	100	30	45	55	70	80	**100**	
6033	5' X 6' RCB, 810'L	530	100	140	170	210	240	**270**	
6034	4' X 3.8' RCA, 350'L	110	75	**110**	130	160	190	210	
6039	48" RCP, 330'L	110	60	80	**100**	130	150	170	
6035	6' X 4' RCB	330	110	170	210	270	**320**	370	Rt Bank Trib @ Murphy & Pool
6045	72" CMP	280	100	150	190	250	**290**	330	Lined Invert
6055	5.7' RCP	230	90	140	170	**220**	260	300	10' X 4' RCB DS; 42" RCP US
6057	42" RCP	100	**90**	140	170	220	260	300	Inlet to 6055
6065	8' X 3' RCB	190	75	115	145	**190**	220	290	

I.D. NO.		DESCRIPTION	CAP (cfs)		2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
6079		3-14' X 8' RC	2900		**3120**	4430	5300	6690	7790	8830	Main Stem, Murphy
6085		3-10' X 7' RCB	2900		**3120**	4430	5300	6690	7790	8830	4th St; Poor Struct. Cond.
6095		2-6.5' X 6' RCB, 220'L	**1200**		1460	2100	2530	3180	3710	4220	Poor Cond/ Under Building
6097		3-11.8' X 6' RCB	**1200**		1550	2200	2640	3310	3850	4350	TW Ctl by 6095; RR Culvert
6103		48" RCP	130		**100**	150	175	220	260	290	Rt Bank Trib @ 5th & Division
6104		42" RCP, 100'L	100		**90**	130	160	200	230	260	4th St. Crossing
6105		42" RCP, 350'L	100		75	**110**	130	165	190	220	
6106		42" RCP, 330'L	100		65	90	**110**	145	170	190	
6127		5.5' X 4.5' RCB, 250'L	390		120	170	210	260	310	**350**	Rt Bank Trib @ 7th & School
6128		66" SP, 440'L	350		110	160	200	250	290	**330**	Poor Struct. Cond.
6129		4' X 3' RCB, 300'L	160		105	**150**	180	230	270	300	
6135		48" RCP	110		**100**	145	175	220	260	290	Rt Bank Trib @ 5th & Club
6145		48" RCP	120		**100**	140	170	210	250	280	

I.D. NO.		DESCRIPTION	CAP (cfs)		2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
6153		48" RCP, 370'L	210		90	130	160	**200**	235	265	
6165		2-12' X 9' RCB	3300		1250	1800	2170	2730	**3190**	3620	7th St
6175		3-12.5' X 5' RCB	**1000**		1240	1780	2150	2700	3150	3580	East Cell Ineffective; Private
6185		2-9' X 6' RCB	1650		1200	**1720**	2080	2610	3050	3470	RR Culv; HW Ctl @ Campbell
6194		2-9' X 6' RCB	--		---	---	---	---	---	---	RR Culv; Rated with 6185
6200		85" X 54" CMPA	150		**155**	220	260	330	380	430	Rt Bank Trib @ High & Campbell
6210		85" X 54" CMPA	150		**150**	210	250	310	360	400	
6220		6' X 4' RCB	94		**100**	140	160	200	230	250	RR Culv; HW Ctl @ 9th US
6222		3-30" RCP	94		**100**	140	160	200	230	250	Poor Struct. Cond.
6230		72" X 44" CMPA, 880'L	**46**		80	105	125	150	175	200	
6245		112" X 75" CMPA	1400		1010	**1460**	1770	2220	2600	2960	
6265		6' X 6' RCB	450		270	380	**460**	570	650	730	Lt Bank Trib @ Massachusetts
6275		2-60" RCP	440		260	370	**440**	540	620	690	

I.D. NO.		DESCRIPTION	CAP (cfs)		2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
6285		2-5.7' X 4' RCB	450		205	280	330	400	**450**	500	
6295		2-8.5' X 3' RCB	390		160	215	250	300	330	**370**	
6296		42" RCP, 570'L	84		40	60	75	**90**	105	120	
6305		4' X 3' RCB	140		**140**	180	200	240	265	290	Old Road Bed
6312		3' X 3' RCB	120		100	115	**120**	125	130	140	RR Culv; HW Ctl @ Connecticut
6315		2-24" RCP	**43**		80	110	125	150	170	200	In HW Pool for 6312
6320		3-54" CMP	**600**		720	1080	1300	1660	1950	2210	
6330		2-66" RCP	600		**630**	930	1140	1460	1720	1950	
6355		42" RCP, 300'L	**82**		160	220	270	340	400	450	Under Residential Structure
6351		42" RCP	45		---	---	---	---	---	---	Rated with 6363
6359		2-24" RCP	36		---	---	---	---	---	---	Rated with 6365
6363		54" RCP, 20'L	130		**140**	200	240	310	360	410	Analysis includes 6351
6365		48" RCP, 170'L	**100**		140	200	240	310	360	410	Analysis includes 6359
6366		60" X 38" RCHEP, 80'L	**62**		140	190	230	290	340	380	

I.D. NO.		DESCRIPTION	CAP (cfs)		2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
6367		50" X 31" CMPA	**57**		73	100	120	160	180	210	
6368		4' X 2.5' RCB	100		37	50	59	73	83	**93**	
6373		10' - 3" x 6' - 9" CMPA	450		320	**490**	610	790	930	1070	HW limited by US System; Q=500 at 20th Street overtop.
6377		65" X 40" CMPA, 800'L	72		**80**	110	130	160	180	200	
6378		65" X 40" CMPA, 560'L	72		**75**	100	120	140	160	180	
6379		5' X 3' RCB	140		63	85	100	120	**140**	150	
6380		117" X 79" CMPA	350		**300**	460	520	740	920	1000	
6390		2-8' X 3.5' RCB	**240**		280	430	530	680	810	930	
6400		2-6' X 4' RCB	350		**280**	430	530	680	810	930	
6415		2-8' X 3.2' RCB	530		270	410	**500**	650	770	890	
6417		3 - 65" X 40" CMPA	**210**		260	400	500	640	760	880	
6435		87" X 63" CMPA	200		110	**180**	230	310	370	430	

TABLE IV - 7

LONE ELM

EXISTING CAPACITY ANALYSIS

I.D. NO.		DESCRIPTION	CAP (cfs)		2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
7010		2 - 112" x 75" CSPA	900		**950**	1400	1700	2180	2530	2880	
7020		2 - 10' x 4' RCB	1100		**920**	1340	1640	2100	2430	2760	
7030		6' x 2' RCB	80		52	**77**	95	123	145	165	
7040		6' x 5' RCPA Length = 700 ft	260		120	170	210	**260**	310	350	Enclosed system.
7042		6' x 5' RCPA Length = 850 ft	260		75	110	130	170	200	**220**	Enclosed system.
7043		48" RCP Length = 550 ft	80		40	55	**70**	105	125	140	Enclosed system.
7045		6' x 5' RCPA Length = 550 ft	300		140	210	260	**320**	380	430	Enclosed system.
7055		2 - 48" RCP	190		**170**	290	310	390	460	520	Located under private, unused road.
7065		3 - 6' x 3'6" RCB	**460**		648	940	1142	1449	1692	1914	

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
7075	3 - 6' x 3'6" RCB	460	**439**	637	772	979	1146	1295	Structure in poor condition. Questionable for vehicle loads.
7076	2 - 36" RCP; 450' L	**150**	200	280	350	440	520	580	
7080.1	72" X 44" CMPA	**105**	180	265	325	400	480	540	Harlem @ B St.
7080.2	49" X 32" RCHEP	**105**	180	265	325	400	480	540	
7081	2 - 48" RCP	220	170	**250**	300	370	440	500	Maiden Lane N/O A St.
7082	48" RCP	**95**	140	210	250	320	370	420	McCoy S/O A St.
7083	6' X 4' RCB	230	120	170	**210**	260	300	340	2nd W/O McCoy
7090	3 - 6'6" X 3'6" RCB	621	415	**603**	730	926	1084	1224	Structure is deteriorating and is in poor condition.
7100	10' x 5' Precast RCB	364	**390**	566	687	867	1014	1143	Located under service road for Joplin Public Works Maintenance Area.
7110	7' x 7' RCB	850	388	561	676	**856**	1001	1127	
7120	6' x 6' RCB	400	311	**453**	550	701	821	926	Under private road.
7130	6' x 4'6" RCPA	39	23	34	**41**	52	61	69	
7135	106" x 72" CMPA	345	215	**319**	388	499	587	668	Enclosed system.
7140	60" RCP	152	95	**140**	171	220	258	294	
7160	5' X 5' RCB	193	120	**179**	217	279	329	374	

I.D. NO.		DESCRIPTION	CAP (cfs)		2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
7170		5' x 4' RCB	**150**		208	308	378	486	570	648	
7180		2 - 60" RCP	460		159	240	298	386	**454**	521	Enclosed system.
7182		80" x 48" CMPA	**140**		159	240	298	386	454	521	Enclosed system.
7184		8' x 4' RCB Length = 80 ft	400		136	209	261	342	**407**	468	Enclosed system.
7186		12' x 3' RCB Length = 80 ft	410		136	209	261	342	**407**	468	Enclosed system.
7188		12' x 3' RCB Length = 110 ft	410		125	191	239	313	**372**	429	Enclosed system.
7190		2-54" RCP Length = 190 ft	320		125	191	239	**313**	372	429	Enclosed system, car wash parking lot.
7192		2-36" RCP Length = 30	112		**125**	191	239	313	372	429	Enclosed system in private alley.
7200		30" CMP & 36" CMP	126		36	56	70	93	111	**127**	Under railroad tracks.
7205		2 - 30" RCP	134		47	73	92	**121**	145	168	
7210		60" x 30" Steel Pipe Arch	137		47	73	92	121	**145**	168	Located under private road.

TABLE IV - 8

COUNTRY CLUB

EXISTING CAPACITY ANALYSIS

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
8015	10' X 7' Bridge	500	220	330	420	540	640	**730**	Outside corporate limits; abutment undercutting
8020	2 - 10' X 7' Timber Bridge	1100	170	250	310	390	460	**530**	Railroad
8022	6' X 2'6" RCB	120	90	**130**	170	220	260	300	Iron Gates; outside corporate limits
8024	6'8" X 1'6" RCB	43	**45**	70	85	110	130	150	Meadow; outside corporate limits
8045	2 - 8' X 4' RCB	650	400	**640**	750	970	1140	1300	
8057	2 - 43" X 27" CMPA	**70**	100	150	180	220	260	300	
8059	2 - 43" X 27" CMPA	100	**100**	150	180	220	260	300	Culvert is damaged.
8080	2 - 24" RCP	**44**	55	70	75	85	90	100	Culvert is damaged.
8090	36" CMP & 24" CMP	90	55	70	75	85	**90**	100	Culverts under railroad tracks; analyzed as outlet from unplanned detention.
8100	2 - 36" RCP	130	**130**	190	240	310	360	410	Roosevelt S/O 16th

I.D. NO.		DESCRIPTION	CAP (cfs)		2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
8105		2 - 36" RCP	130		**150**	220	270	350	410	470	Alley W/O Roosevelt

TABLE IV- 9

LEADVILLE

EXISTING SYSTEM CAPACITY ANALYSIS

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
9030	2 - 120" CMP	600	440	**590**	670	780	860	930	Abandoned Mining Rd. Road bed overtops 4' below crown
9045	9' X 8' RCB	**N.A.**	380	510	620	730	800	870	Abandoned Mine Road; Poor structural condition
9046.1	96" RCP (Outlet)	500	380	**510**	620	730	800	870	Perkins W/O Monroe; structural damage
9046.2	90" RCP (Inlet)	500	380	**510**	620	730	800	870	
9055	3 - 36" RCP	**110**	350	480	590	680	750	820	B Street (Extended) W/O Monroe; Low water crossing
9070.1	6' X 5' - 6" RCA (Outlet)	380	**320**	460	550	630	700	790	Abandoned Railroad; 4 houses flood @ 25-year frequency due to backwater.
9070.2	8' X 8' - 6" RCA (Inlet)	380	**320**	460	550	630	700	790	Capacity control @ 2nd St. upstream

I.D. NO.		DESCRIPTION	CAP (cfs)		2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
9080		6' X 6' RCB	**270**		310	450	550	670	730	820	2nd St. W/O Walnut needs structural correction
9100		8' X 6' RCB	600		250	360	430	**550**	640	720	4th St. W/O Walnut
9110		48" RCP	110		85	**120**	150	190	220	250	

TABLE IV- 10

TURKEY CREEK CENTRAL

EXISTING SYSTEM CAPACITY ANALYSIS

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
10050	7' X 4' RCB	360	130	200	240	320	**380**	440	G St. W/O St. Louis
10060	7' X 4' RCB	240	110	180	**220**	290	350	400	Entrance Culvert; TW Influence from 10050
10067	48" RCP; 200' L	150	70	110	**130**	180	210	240	St. Louis
10095	48" RCP	72	22	33	40	52	61	**70**	Euclid E/O St. Louis
10165	3 - 48" CMP	330	**320**	460	560	720	840	960	Commercial Entrance
10175	3 - 48" CMP	**190**	310	450	550	710	830	950	Commercial Entrance; TW Influence from 10165
10185	10' X 4' RCB	440	310	**450**	540	700	820	940	Commercial Entrance
10195.1	3 - 60" X 38" RCHEP	470	280	410	**510**	660	760	880	
10195.2	3 - 60" CMP	470	280	410	**510**	660	760	880	Railroad
10205	10' X 5' RCB	460	270	390	**470**	600	700	800	Hodgdon Road

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
10211	8' X 4' RCB	380	270	**390**	470	600	700	800	Central E/O Turk
10220	42" RCP; 650' L	105	70	**100**	120	160	180	210	Central W/O Turk
10230	8' X 4' RCB	430	170	240	300	370	**430**	490	Turk N/O 3rd
10240	3' X 3' - 7" RCB	300	160	220	**270**	340	400	450	3rd St. W/O Turk
10250	6' X 3' RCB	126	**130**	190	230	290	340	380	4th St. @ Turk
10257.1	36" RCP; 180' L	110	24	33	40	47	54	**61**	
10257.2	42" RCP; 40' L	110	24	33	40	47	54	**61**	Railroad
10265	8' X 6' RCB	540	40	60	73	92	110	**120**	7th E/O Ozark
10266	42" CMP	92	20	30	35	45	50	**60**	7th W/O Highview
10275	2 - 36" CMP	95	22	32	40	50	60	**65**	Railroad S/O 7th
10290	2 - 60" RCP; 420' L	230	40	65	80	105	125	**140**	Newman E/O Range Line
10292	48" RCP	70	40	60	**70**	90	110	125	Industrial Entrance
10293	48" RCP	110	40	60	70	90	**110**	125	Industrial Entrance
10325	14' X 3' - 2" RCB	440	260	380	**460**	600	710	810	College Drive
10335	14' X 3' RCB	420	260	380	**460**	600	710	810	College Drive
10336	6' X 3' - 9" RCB	435	255	375	**460**	595	700	800	College Drive
10345	7' X 3' - 7" RCB	435	250	370	**460**	590	690	790	College Drive

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
10350	2 - 48" CMP; 490' L	180	**170**	250	320	410	480	560	College Parking lot
10355	5' X 4' RCB	165	80	115	**140**	180	210	240	Newman E/O Goetz
10376	2 - 42" RCP	120	**140**	220	270	360	420	490	Pedestrian Walkway
10377	2 - 42" RCP	156	**135**	210	260	345	400	470	Pedestrian Walkway
10378	2 - 42" RCP	130	**130**	200	250	330	390	450	College Parking Lot
10380	7' X 4' RCB	200	100	160	**210**	270	330	380	Newman W/O Duquesne
10387	2 - 53" X 34" RCHEP	200	80	130	160	**220**	270	310	
10390	73" X 45" RCPA	170	70	120	**150**	200	240	280	Duquesne N/O Newman
10415	54" RCP; 940' L	170	80	100	120	150	**170**	200	
10416	48" RCP	124	58	80	95	**120**	135	150	3rd W/O Northpark
10427	42" RCP; 225' L	110	43	58	67	82	94	**104**	3rd E/O Range Line
10435	2 - 103" X 71" CMPA	820	300	440	530	660	**770**	870	
10445	2 - 87" X 63" CMPA	460	290	**420**	510	640	740	830	3rd E/O Northpark
10450.1	48" RCP; 180' L	100	32	48	59	77	90	**103**	
10450.2	2 - 43" X 27" CMPA	100	32	48	59	77	90	**103**	
10455	2 - 81" X 59" CMPA	400	150	230	280	**360**	420	480	Northpark S/O 3rd

I.D. NO.		DESCRIPTION	CAP (cfs)		2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
10465		2 - 36" CMP	140		70	100	110	130	140	**160**	7th E/O Rex; Analyzed as Detention Basin Outlet
10485		8' X 5' RCB	500		140	210	250	330	380	**440**	7th E/O Peters
10505		3 - 24" RCP	75		**80**	120	150	190	220	250	10th @ Peters
10525		2 - 8' X 4' RCB	540		220	360	**460**	620	750	880	Duquesne S/O Newman
10527		54" RCP	110		70	**110**	140	180	210	250	School Drive
10530		54" RCP	120		70	**110**	140	180	210	250	School Drive
10540		54" RCP	110		70	**110**	140	180	210	250	School Drive
10543		54" RCP; 640' L	206		61	96	120	160	**190**	220	School System
10545		48" RCP; 100' L	150		61	96	120	**160**	190	220	School System
10546		24" RCP; 250' L	**30**		53	84	106	140	168	194	School System
10555		73" X 45" RCPA	140		70	110	**140**	190	230	270	Newman E/O Sycamore

TABLE IV- 11

CENTER

EXISTING SYSTEM CAPACITY ANALYSIS

I.D. NO.		DESCRIPTION	CAP (cfs)		2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
11012		2 - 48" RCP	300		170	260	**330**	440	520	600	Railroad structure.
11014		54" x 42" CMPA	100		**110**	170	210	280	330	380	23rd W/O Main; Poor structure condition.
11025		6' x 4' Box Culvert	250		170	**260**	330	430	520	600	Main N/O Zora
11055		5' x 3' RCB	110		60	90	**110**	150	180	210	Main @ 23rd
11057		58" x 36" CMPA	80		53	**83**	104	137	164	188	Entrance Culvert
11060		58" x 36" CMPA	80		53	**83**	104	137	164	188	24th E/O Main
11062		58" x 36" CMPA	80		43	67	**83**	112	134	154	Entrance Culvert
11064		58" x 36" CMPA	80		33	52	66	**87**	104	120	Entrance Culvert

TABLE IV- 12

ROYAL HEIGHTS

EXISTING SYSTEM CAPACITY ANALYSIS

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
12015	2 - 60" RCP	440	220	350	**450**	600	720	840	N. St. Louis S/O Zora
12020	3 - 48" RCP	390	180	280	**360**	480	590	690	Railroad
12035	6' X 6' - 2" RCA	330	160	270	**350**	460	560	650	Zora E/O Park; Structure in poor condition
12044	2 - 2.5' X 2.5' SMB	160	80	130	**160**	220	260	300	Under abandoned railroad, (now bike trail)
12065	2.5' X 2.5' SMB	75	30	90	60	**80**	90	110	Under abandoned railroad, (now bike trail)

TABLE IV- 13

OAKLAND
(Baker's Branch)

EXISTING SYSTEM CAPACITY ANALYSIS

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
13020	60" x 38" RCHEP; 800' L	120	45	70	80	100	**120**	140	Turk S/O Zora
13030	2 - 10' x 8.5' RCB	1820	920	1440	**1830**	2450	3000	3530	Range Line Rd. S/O Zora; HW Control S. of Structure.
13055	6' x 6'4" RCPA	350	230	**370**	470	650	790	930	Zora E/O Mytle
13061	2 - 36" CMP	80	30	45	60	**80**	90	110	
13063	2 - 36" CMP	**78**	30	45	60	**80**	90	110	Under railroad
13070	2 - 60" RCP	340	120	210	260	**350**	410	470	
13077	42" RCP	60	**50**	80	100	140	160	190	Entrance culvert
13079	4' x 2'6" RCB	93	50	80	**100**	140	160	190	U.S. 71 S/O Enterprise
13080	2 - 42" RCP	140	50	70	90	120	**140**	160	
13109	Timber Bridge	>2800	710	1130	1470	1960	2370	**2820**	Railroad bridge; 480 S.F. Waterway

I.D. NO.	DESCRIPTION	CAP (cfs)	2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
13017	3 - 24" RCP	**>70**	80	130	170	230	280	330	Chelsea W/O Wellington
13120	2 - 6' x 6'4" RCPA	>290	80	130	170	230	**280**	330	
13155	6' x 6'4" RCPA	366	120	200	260	**360**	430	500	Zora W/O Duquesne
13164	2 - 48" RCB	220	90	160	**200**	270	320	370	Duquesne N/O Zora
13185	2 - 10' x 5' RCB	950	500	800	**1010**	1370	1680	1980	Duquesne S/O Zora
13224	2 - 42" RCP	160	**120**	190	250	330	400	460	Zora E/O Duquesne; Outside Corporate Limits

TABLE IV- 14

DUQUESNE

EXISTING SYSTEM CAPACITY ANALYSIS

I.D. NO.		DESCRIPTION	CAP (cfs)		2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
14002		2 - 13' X 4' RCB	1040		440	700	870	**1150**	1380	1590	7th E/O Duquesne
14005		3 - 27" RCP 1 - 18" RCP	**110**		240	360	450	600	700	800	Duquesne S/O 7th
14012		58" X 36" CMPA	**110**		190	290	360	460	550	630	10th E/O Katherine
14020		2 - 5' X 4' RCB	320		160	240	**300**	400	470	540	Markwardt W/O Duquesne
14045		2 - 43" X 27" CMPA	70		20	30	35	45	55	**60**	Markwardt E/O Duquesne
14060		6' X 2.5' RCB	**150**		190	290	360	470	560	640	Markwardt W/O Murphy Lane
14065		48" RCP	**100**		160	240	310	400	470	540	Murphy Lane S/O Markwardt; Moble Home at unprotectable elevation

TABLE IV- 15

OPOSSUM

EXISTING SYSTEM CAPACITY ANALYSIS

I.D. NO.		DESCRIPTION	CAP (cfs)		2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
* * * NO STRUCTURES * * *											

TABLE IV- 16

TUCKAHOE

EXISTING SYSTEM CAPACITY ANALYSIS

I.D. NO.		DESCRIPTION	CAP (cfs)		2 Yr. (cfs)	5 Yr. (cfs)	10 Yr. (cfs)	25 Yr. (cfs)	50 Yr. (cfs)	100 Yr. (cfs)	REMARKS
16015		6' X 6' RCA	**260**		320	540	690	920	1110	1280	Zora W/O Lone Elm
16025		2 - 4' X 2' RCB	**100**		160	240	330	440	540	620	
16035		2 - 4' X 2' 6" Box	**100**		120	180	220	280	330	370	Lone Elm Road
16050		2 - 27" RCP	**60**		70	110	130	170	210	240	Zora W/O Lone Elm
16052		3' 6" X 3' SMB	105		30	40	50	60	75	**85**	Lone Elm Road
16063		60" RCP	300		90	140	170	230	**280**	320	Zora E/O Lone Elm

PART V

DRAINAGE POLICY

PART V

DRAINAGE POLICY

A. GENERAL

This section discusses the principal public policy issues that are integral to implementing a drainage management plan. Specific policy recommendations in this section were used to develop the capital improvement project list and maintenance program recommendations presented in other sections of this report, as well as the "Stormwater Design Criteria" manual, furnished separately.

Because typical urban land ownerships are small, and approximately 15 percent of the land area is typically owned by the municipality itself in the form of street right-of-way, it's not practical for each landowner to individually provide and maintain a private drainage system. Therefore, municipalities have by necessity and tradition assumed responsibility for establishing specific drainage systems within their boundaries and have become the "owners" of most structural drainage systems. In so doing the municipality also accepts the corresponding duty to maintain those improved facilities. For the City to reasonably manage drainage in its boundaries it must:

- Specifically define a common level of service to be established.
- Provide for the construction of physical components of the drainage system.
- Control the use of land to avoid the obstruction of drainage.
- Provide for physical maintenance of drainage system improvements to ensure their function is not impaired.

B. GENERAL POLICY OBJECTIVES

Equitable division of responsibility for management of drainage between the City and private property owners is a fundamental consideration in establishing policies for providing drainage service. Pure equity must be tempered with practical constraints. The ultimate objective is to provide

an equal and acceptable level of drainage service to all citizens and to fairly apportion the cost of that service.

C. NEW CONSTRUCTION AND DEVELOPMENT

It is recommended that the City adopt the "Stormwater Management Criteria" manual, which has been furnished separately to City staff. This manual defines what is generally accepted as a reasonable level of service for storm drainage systems and outlines current standards of practice and technology for design of those systems. Included in the specific policy recommendations contained within the manual are the following:

1. All enclosed and improved open channel drainage system components shall be designed for the 10-year return period peak flow or the capacity of the existing upstream improved system, whichever is greater.

2. Enclosed pipe-inlet systems will be required under the following conditions:

   a. Within the right-of-way of improved streets regardless of system design capacity.

   b. In all areas other than residential where the bank line of an open channel, either natural or improved, would be within 30 feet of any habitable structure.

   c. In residential areas where the bank line of an open channel, either natural or improved, would be within 60 feet of any existing or proposed residential structure.

Although higher in initial cost than open channels, enclosed systems have less maintenance requirements and a longer life cycle. Because they are enclosed there is less potential hazard to the public, and they generally meet with greater public acceptance. However, surface

overflow space must still be provided to assure the passage of discharges that exceed the design capacity of the enclosed system.

3. Improved open channels may be used in all areas except those where an enclosed system is specifically required. Channel lining is required in developed areas where the 10-year peak flow is equal to or greater than 200 cfs and less than or equal to 500 cfs.

4. Existing natural channels may be retained in the drainage system of a developed area where the 10-year peak flow is greater than 500 cfs and flow velocities do not exceed recommended maximums based on soils present in the channel bed and bank.

5. Overflow channels will be required in all areas in addition to, and above, the conveyance elements, whether open or enclosed. Overflow channels shall have sufficient capacity, when combined with the capacity of the conveyance element, to convey the 100-year peak discharge without damage to land or buildings. Restrictions on land use within the overflow areas will be required to prevent obstruction of flow.

6. Detention facilities shall be provided in connection with land development under the following conditions:

   a. Where recommended by the City's current Stormwater Management Master Plan.

   b. Where homes, buildings, or other structures downstream from a proposed development are currently flooded in a 100-year or more frequent flood.

   c. Where flood damage problem areas have been identified, or an engineering study indicates the proposed development would cause or increase such flooding.

Public and private detention facilities may be either wet or dry. Joint uses, such as parking and recreation, not interfering with detention functions, are permitted for dry facilities. Rooftop and parking lot detention are acceptable for private facilities only. Performance requirements shall be based on maximum release rates outlined in the City's "Stormwater Management Criteria" manual.

In addition, it is recommended that detention basins serving more than one property owner be dedicated to the City for operation and maintenance. Operation and maintenance of private detention facilities such as residential subdivision ponds owned by homeowners associations, parking lot impoundments, roof-top basins, and other similar facilities, should be the responsibility of the owner.

7. Dedication of easements for all improved system components to be maintained by the City shall be required as well as maintenance access connections to street right-of-way. Easements will also be required, although not for City maintenance purposes, along natural, or unimproved, channels and around private detention facilities other than parking lots, rooftop detention or similar situations.

In addition to these specific criteria, it is recommended that the City adopt regulations requiring erosion control plans for all new construction projects to prevent siltation on streets and in the existing downstream drainage system.

D. EXISTING SYSTEM CAPITAL IMPROVEMENTS

When an existing drainage system component is replaced, the replacement unit should be designed and constructed to meet current City criteria and standards. The mere failure of any existing element of the drainage system to meet those current standards for hydraulic capacity should, however, not be cause for automatically planning and budgeting for its replacement. Sound and maintainable facilities should only be replaced when their lack of capacity results in, or will result in, economic consequences

commensurate with the cost of replacement, or when there is an overriding public safety or property damage issue involved.

The following recommendations apply to the upgrading of existing drainage system elements that have been previously provided by developers and accepted by the City; those which cross or are located in public right-of-way or other City-owned property; or those that are major system elements not subject to developer improvement in connection with the development of open land. It is recommended that the City replace facilities where:

1. Structural failure has occurred or is impending.

2. Building flooding occurs at 25-year or more frequent intervals due to inadequacies in the public drainage system.

3. Overflow of public streets by the 2-year storm lasts for a time duration greater than 10 to 15 minutes.

4. Erosion on private property due to direct discharge from public drainage facilities will eventually either endanger buildings or otherwise adversely affect the use of the property.

5. Uncontrolled discharge of water from public right-of-way onto adjacent private property creates a recurring nuisance and the lack of maintenance control for the property owner.

E. MINOR SYSTEM IMPROVEMENTS IN DEVELOPED AREAS

For a number of years, the City has required developers to install culverts, storm sewers, lined channels and other improvements to adequately handle storm water in their developments and dedicate them to the City for operation and maintenance. The capital cost of these "minor system" improvements was, in effect, paid for by individual property owners through special assessment to their property. However, some areas within the corporate limits, primarily those annexed after development, have no such improved facilities. Their "minor system" consists of small

roadside ditches and driveway culverts. Property owners in these areas have not made an individual investment commensurate with that of other property owners.

Because of the different levels of individual investment, it is not equitable for the City to upgrade the unimproved minor drainage system simply to relieve the adjoining property owners of what may be perceived as a nuisance. The City as a whole, however, derives specific and general benefits from unimpeded traffic flow and free access by emergency and public service vehicles so it is necessary that the City maintain the unimproved minor system to assure its continued function. In addition, since the runoff from the street right-of-way is a part of the total system demand, and the culverts and ditches on the right-of-way act to concentrate and channelize flow at its point of release to private property, the City has the common duty to control its release to avoid damage to such property. Therefore, it is recommended that the City:

1. Construct new or upgraded minor system drainage facilities only when water discharged from a public street or other City property is causing damage in the form of erosion or structure flooding to the downstream property.

2. Require individual property owners to install, repair, and maintain driveway culverts on streets not having curb and gutter with enclosed drainage systems.

3. Replace cross-road culverts if their structural condition is not serviceable, or when hydraulic capacity is less than 2-year return period demand and the deficiency causes structure flooding upstream from the culvert.

4. Replace or extend enclosed pipe-inlet systems only when structural failure has occurred, or is impending, or when the hydraulic capacity is less than a 5-year storm demand and structure flooding has occurred or is predicted to occur by competent professional advice.

* * * * *

PROJECT

DESCRIPTIONS

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Brownell Ave. Paved Ditch, 34th to I-44

Project Identification Number: 1-1

Pertinent Data Summary

Watershed:	Silver Creek
Priority No.:	10
Design Capacity:	1,000 cfs (10-year)
Estimated Cost:	$606,421
Model ID No.:	1307, 1308, 1309
Map Reference Numbers:	
Master Plan Mapping:	8
Topographic (Section):	24-27-33

Existing Problem Description

Throughout this reach, the capacity of the existing system is limited by the capacity of the existing 7'x7' RCB (1302) beneath I-44. The system as it exists results in substantial storage upstream of I-44, with the result that low-lying properties along the main drainage channel are subject to inundation due to backwater at intervals of less than 5 years. That basic cause of flooding is further worsened by the limited capacity of the existing open system.

Recommended Improvements

Replace open channel 1309 with a concrete lined trapezoidal channel having a bottom width of 10 ft, a lined depth of 3 ft, and side slopes of 2:1. In this reach, the estimated flow depth will range from 6 to 5 ft; the channel slope will be slightly less than 0.2%. Retain structure 1308 (dbl. 7'x6' RCB) in place, with properly designed transitions to the improved upstream and downstream channels. Between 1308 and 1302, construct a gabion-lined open channel having a similar cross section to that in reach 1309, at an approximate invert slope of 1%. Proper performance of the system will require that the existing detention storage remain available; it is therefor further recommended that a flowage easement to elevation 1007 be obtained between I-44 and 37th; along reach 1309, it is recommended that a flowage easement be obtained along the left descending bank to elevation 1009. Completion of the recommended improvements will result in roughly a 20-to-25-year level of protection for existing residential structures along the project; a further increase in the level of protection provided will not be possible without major investment in downstream improvements.

Downstream Controls: None.

Potential Alternatives: Consider the potential for acquisition of flood-prone properties along this reach.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Texas Ave. Paved Ditch, 32nd to 34th

Project Identification Number: 1-2

Pertinent Data Summary

Watershed:	Silver Creek
Priority No.: 29	
Design Capacity:	Varies, 640-520 cfs (10-year)
Estimated Cost:	$317,987
Model ID No.:	1325, 1326
Map Reference Numbers:	
Master Plan Mapping:	8
Topographic (Section):	24-27-33

Existing Problem Description

Through this reach, the existing unimproved open channel system provides an in-system capacity equal to roughly a 2-year event. It is estimated that one commercial property and one residential property experience flooding at roughly 5 year intervals.

Recommended Improvements

Replace the existing unimproved open channel throughout this reach with a concrete-lined trapezoidal channel having a bottom width of 8 feet, side slopes of 2:1, and a lined depth of 4 feet. Retain existing structure 1326 in place, with properly designed transitions to the upstream and downstream improved channels.

Downstream Controls: Project No. 1-1 should be completed in advance of this project.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Structure Replacement, 44th E/O Oaklawn

Project Identification Number: 1-3

Pertinent Data Summary

Watershed:	Silver Creek
Priority No.:	21
Design Capacity:	2,000 cfs (10-year)
Estimated Cost:	$278,374
Model ID No.:	1123
Map Reference Numbers:	
Master Plan Mapping:	11
Topographic (Section):	24-27-33

Existing Problem Description

The existing structure provides roughly a 2-year level of protection against overtopping of 44th St., and is in relatively poor structural condition. No upstream structures are known to flood as a result of the deficient structure capacity.

Recommended Improvements

Replace the existing 3-9'x7' bridge with a triple 9'x9' RCB; raise approximately 450' of 44th St. a maximum of 1.6 feet (to approximate elevation 978.6). A further increase in roadway elevation would not be recommended due to a resultant increase in the headwater elevation occurring under the 100-year flood event.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Mohaska Ditch, Jackson to Moffett

Project Identification Number: 3-1

Pertinent Data Summary

Watershed:	Water Works
Priority No.:	11
Design Capacity:	Varies; 530-690 cfs (10-year)
Estimated Cost:	$593,104
Model ID No.:	3255, 3260, 3269
Map Reference Numbers:	
Master Plan Mapping:	8
Topographic (Section):	15-27-33

Existing Problem Description

The existing Mohaska Ditch provides a bankfull capacity of roughly 560 cfs, equivalent to roughly a 5-10 year level of service, dependent upon location. Discharges exceeding the ditch capacity result in flooding along the adjacent Mohaska Avenue, and damage to 3 residences. The danger to the travelling public resulting from the street flooding is exacerbated by the close proximity of the ditch to the existing roadway, and by the steepness (roughly 1:1) of the ditch side slope.

Structure 3260 consists of an 8'x2' RCB beneath Mohaska at its intersection with Sergeant; the existing structure provides less than a 2-year level of service prior to overtopping of Mohaska.

Recommended Improvements

Reaches 3255 and 3269 should be reconstructed to increase waterway area and to establish a suitable shoulder along Mohaska. Each reach is anticipated to consist of a gabion-lined trapezoidal channel having a bottom width of 10 feet and side slopes of 3:1. The overall depth of the lined channel in reach 3255 would be 4' below roadway shoulder; in reach 3269, the depth would be 4.5'. The 10-year water surface elevation would be 1.0' below roadway shoulder; each channel would be capable of carrying roughly the 100-year discharge when bankfull.

Structure 3260 should be replaced with a 10'x3' RCB.

Construction and subsequent maintenance of the improved open channels in reaches 3255 and 3269 will require the acquisition of permanent drainage easements roughly 50 feet in width adjacent to the Mohaska right-of-way.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Paved Ditch, 36th to Ferguson

Project Identification Number: 3-2

Pertinent Data Summary

Watershed:	Water Works
Priority No.:	22
Design Capacity:	380 cfs (10-year)
Estimated Cost:	$211,230
Model ID No.:	3155
Map Reference Numbers:	
Master Plan Mapping:	8
Topographic (Section):	23-27-33

Existing Problem Description

Reach 3155 consists of an unlined open channel having a bankfull capacity of roughly 50 cfs, much less than a 2-year capacity. Erosion is not considered a significant problem, but events exceeding the channel capacity result in wide overbank flow on the adjacent, relatively flat lands. Events exceeding roughly a 10-year discharge are expected to result in damage to 3 residential structures.

Recommended Improvements

Reach 3155 should be reconstructed as a concrete lined open channel having a bottom width of 8 feet, a lined depth of 2 feet, and side slopes of 3:1, yielding a bankfull (2' depth) capacity equal to the 10 year event. It will be necessary to acquire a 50' permanent easement for the construction and maintenance of this improved open channel.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Paved Ditch, 33rd to 32nd West of Connecticutt

Project Identification Number: 3-3

Pertinent Data Summary

Watershed:	Water Works
Priority No.:	39
Design Capacity:	110 cfs (10-year)
Estimated Cost:	$95,808
Model ID No.:	3175
Map Reference Numbers:	
Master Plan Mapping:	8
Topographic (Section):	23-27-33

Existing Problem Description

Reach 3175 consists of an unlined open channel having a bankfull capacity of roughly 40 cfs, much less than a 2-year capacity. Erosion is not considered a significant problem, but events exceeding the channel capacity result in overflow onto the adjacent storage yard of Midwest Lumber. Events exceeding roughly a 10-year discharge are expected to result in damage to 1 additional structure located just east of the existing ditch.

Recommended Improvements

Reach 3175 should be reconstructed as a concrete lined open channel having a bottom width of 4 feet, a lined depth of 2 feet, and side slopes of 2:1, yielding a bankfull (2' depth) capacity slightly greater than the 10 year discharge. It will be necessary to acquire a 32' permanent easement for the construction and maintenance of this improved open channel.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, Old 32nd E/O McClelland

Project Identification Number: 3-4

Pertinent Data Summary

Watershed:	Water Works
Priority No.:	37
Design Capacity:	690 cfs (10-year)
Estimated Cost:	$461,500
Model ID No.:	3350
Map Reference Numbers:	
Master Plan Mapping:	7
Topographic (Section):	15-27-33

Existing Problem Description

The existing structure beneath old 32nd consists of a 12'x5' RCB having a rated capacity, assuming the structure to be fully open and functional, roughly equal to a 2-year discharge. At present, the structure and its outlet are partially blocked by accumulated sediment; water stands to a depth of roughly 2.5 feet in the box. Immediately upstream of this structure are the outlets of a 60" RCP (line 3275) and a 48" RCP (line 3271); the crowns of those outlets are slightly above the roadway grade at 3350. Reach 3350 discharges to an unimproved open channel lying adjacent to the roadway; the horizontal and vertical geometrics of this channel contribute to the sedimentation and blockage at 3350. No structures are known to flood as a result of the deficient culvert capacity.

Recommended Improvements

Replace the existing 12'x5'x30'(approx) RCB with a 12'x5.5'x410' RCB crossing the roadway at a skew of roughly 45 degrees and extending downstream along and adjacent to the westerly edge of pavement of the roadway, constructed at a slope of roughly 0.4 %. The new culvert invert would be roughly 1' below the existing invert at the inlet end. Relay approx. 50' each of the existing upstream 60" RCP and 48" RCP to lower the outlet crown elevations, and construct a junction/inlet structure at the confluence of the three lines.

Downstream Controls: None.

Potential Alternative: Prior to construction of this project, the potential for permanent closure of old 32nd, coupled with removal of the existing culvert and development of an open connection to the downstream channel, should be evaluated.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, 38th & Jackson

Project Identification Number: 3-5

Pertinent Data Summary

Watershed:	Water Works
Priority No.:	19
Design Capacity:	950 cfs (10-year)
Estimated Cost:	$70,200
Model ID No.:	3050
Map Reference Numbers:	
Master Plan Mapping:	8
Topographic (Section):	22-27-33

Existing Problem Description

The existing structure beneath Jackson consists of a 12'x6' RCB having a rated capacity roughly 80% of the 2-year discharge. No upstream structures are known to flood as a result of the deficient culvert capacity. The relatively low structure capacity results in part from the limited available headwater depth prior to overtopping of Jackson (approx. 0.7' above the crown of the culvert).

Recommended Improvements

It is anticipated that replacement of the existing culvert will be scheduled concurrent with the eventual reconstruction of Jackson, irrespective of the priority computed for the structure replacement. At that time, replace the existing 12'x6' RCB with a double 8'x6' RCB; the profile grade of Jackson should be established to provide not less than 2.5' of allowable headwater depth above the crown elevation of the culvert inlet. The estimated cost for the culvert replacement includes only the new structure proper, plus associated engineering and contingent costs. All other costs for the new structure (earthwork, removal of existing structure, etc.) are considered as included in the eventual roadway construction cost for reconstruction of Jackson.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: 30th & McClelland Storm Sewers

Project Identification Number: 3-6

Pertinent Data Summary

Watershed:	Water Works
Priority No.:	16
Design Capacity:	Varies: 380-500 cfs (10-year)
Estimated Cost:	$666,278
Model ID No.:	3375, 3376, 3377
Map Reference Numbers:	
Master Plan Mapping:	7
Topographic (Section):	15-27-33 & 16-27-33

Existing Problem Description

These three reaches of the system provide roughly a 2-year level of service; for greater events, structure flooding occurs at 2 office buildings along 29th west of McClelland. In addition, for events greater than 2-year, ponding depths in a sump area on McClelland at 30th Street can exceed 1.5 ft.

Recommended Improvements

Retain the existing system in place, and construct a 60" RCP relief sewer. The upstream end of the relief sewer would be immediately east of the upstream end of existing reach 3377; from that point, the relief sewer would extend east to McClelland, then south along McClelland to a point north of and adjacent to the existing reach 3376 crossing of McClelland, then along and adjacent to reaches 3376 and 3375 to the lower end of 3375. The diverted discharge under a 10-year event would vary from 200 cfs west of McClelland to 220 cfs along and downstream of McClelland. The two systems should act in combination to limit headwater elevations at the upper end of 3377 to approximate elevation 978, providing a 10-year level of protection to the office buildings along 29th west of McClelland. Should a higher level of service be desired, it is recommended that floodproofing of openings beneath the main floor elevation of the buildings be considered.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, 5th & Murphy

Project Identification Number: 4-1

Pertinent Data Summary

Watershed:	Joplin Creek West
Priority No.:	12
Design Capacity:	1,640 cfs (2-year)
Estimated Cost:	$391,094
Model ID No.:	4000, 4005
Map Reference Numbers:	
Master Plan Mapping:	5
Topographic (Section):	2-27-33

Existing Problem Description

The existing 3-7'x6' RCB beneath the intersection of 5th & Murphy is in very poor structural condition, and presently provides slightly less than a 1-year level of protection to the overlying roadways. The hydraulic capacity of this structure (4005) is directly influenced by headwater elevations at reach no. 6085 (4th St. culvert on Joplin Creek), which is scheduled for replacement under Project No. 6-1, and is limited by the relatively low elevation of the roadway. Following completion of Project 6-1, the headwater elevation at 6085 under a 10-year event will be slightly above the roadway elevation at 5th & Murphy. As a result, it is not considered practicable to provide a 10-year level of service at 4005, at least for storm events in which both Joplin Creek East and Joplin Creek West are contributing to discharge at 6085.

Recommended Improvements

It is recommended that Structure 4005 be replaced with a 3-10'x6' RCB, and that the approximately 250 ft. of existing channel downstream of 4005 and upstream of the confluence of Joplin Creek West with Joplin Creek East be improved to the hydraulic equivalent of a gabion-lined rectangular channel having a bottom width of 30 feet and a lined height of roughly 7 feet; a similar channel improvement should be included upstream of 4005 for a length of roughly 50 feet. Those improvements can be expected to result in a 2-year level of service at 4005 for an instance in which both Joplin Creek West and Joplin Creek East are contributing to flow at 6085; for an instance in which Joplin Creek West is the primary contributor of flow at 6085 (e.g., little or no inflow from Joplin Creek East at 6085), those improvements would result in a level of service approaching 10 years at 4005.

Downstream Controls: None. However, this project will not operate at its design capacity until completion of Project No. 6-1.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: 6th St. Relief Sewers, Virginia to Byers

Project Identification Number: 4-2

Pertinent Data Summary

Watershed:	Joplin Creek West
Priority No.:	1
Design Capacity:	500 cfs (25-year diversion rate)
Estimated Cost:	$2,469,834
Model ID No.:	4045, 4050
Map Reference Numbers:	
Master Plan Mapping:	4, 5
Topographic (Section):	3-27-33, 10-27-33

Existing Problem Description

Throughout this reach, which extends from a point east of Virginia at 6th to a sump area in Byers north of 7th, the existing storm sewers provide in-system capacity roughly equal to a 2-year event, and pass directly beneath several commercial structures. The deficient storm sewer capacity, coupled with the lack of an effective surface overflow system, leads to frequent damages to commercial properties (approximately 12-15 properties at a frequency of from 2-5 years), as well as widespread surface flooding and ponding in the downtown area of Joplin.

Recommended Improvements

Construct a system of relief sewers to increase in-system capacity. Given the lack of an effective surface overflow system, the recommended rate of diversion is roughly 500 cfs throughout this reach, resulting in approximately a 25-year level of service. The relief system includes approximately 920 ft. of 7'x5' RCB extending west along 6th St. from the outlet of the existing system (roughly 100 ft. east of Virginia), constructed at a slope of roughly 0.90% and intersecting the existing 12'x4' RCB at its 6th St. crossing; and approx. 1,270' of 11'x5' RCB continuing west along 6th to Byers and south along Byers to the existing 8'x5' RCB crossing Byers north of 7th St. (approx. 0.3% slope).

Downstream Controls: None.

Potential Alternative: Should it be desired to limit the improved in-system capacity to a 10-year level of service, the diversion rate would reduce to approximately 350 cfs, and the height of the proposed relief sewers would reduce from 5' to 4'.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Moffett Relief Sewers, 7th to 8th

Project Identification Number: 4-3

Pertinent Data Summary

Watershed:	Joplin Creek West
Priority No.: 13	
Design Capacity:	200 cfs (10-year diversion rate)
Estimated Cost:	$625,790
Model ID No.:	4055, 4060
Map Reference Numbers:	
Master Plan Mapping:	4, 5
Topographic (Section):	3-27-33, 10-27-33

Existing Problem Description

Throughout this reach, which extends from a sump on Byers north of 7th St. to a point on 8th St. between Sergeant and Jackson, the existing storm sewers provide in-system capacity roughly equal to a 3-year event, and pass directly beneath and immediately adjacent to several residential structures. Demand discharges exceeding system capacity are carried along the curbed street system, leading eventually to the sump area on Byers north of 7th. Street flooding can be expected at roughly 3-5 year frequencies; damage to up to approximately 4 residences can be expected at return periods of 10 years or greater.

Recommended Improvements

Construct a system of relief sewers to increase in-system capacity. The relief system includes approximately 1,480 ft. of 60" dia. RCP. The lower end of the relief sewer would connect to the upper end of Project No. 4-2 in Byers north of 7th St. From that point, the relief sewer would be constructed south along Byers to 8th St., then west along 8th St. to the alley west of Sergeant, where it would connect to the lower end of an existing 9'x5' RCB (4067).

Downstream Controls: Project No. 4-2 should be completed prior to completion of this project.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Connor Ave. Relief Sewers, 9th to 10th

Project Identification Number: 4-4

Pertinent Data Summary

Watershed:	Joplin Creek West
Priority No.:	8
Design Capacity:	Varies, 150-230 cfs (10-year diversion rate)
Estimated Cost:	$508,880
Model ID No.:	4070, 4073
Map Reference Numbers:	
Master Plan Mapping:	4
Topographic (Section):	10-27-33

Existing Problem Description

Throughout this reach, which extends upstream from an existing 9'x5' RCB in 9th St. west of Jackson to 10th & Chestnut, the existing system is rated at roughly a 2-year capacity. Overflows are carried in the curbed street system, eventually leading to a sump area on Byers north of 7th St. Significant street flooding can be expected at intervals of less than 5 years; structure flooding would not be anticipated until roughly a 10-year event, with approximately 4 houses affected at that frequency.

Recommended Improvements

Construct a system of relief sewers to increase in-system capacity. The design capacity of the relief system varies from 230 cfs at the lower end (in 9th) to 150 cfs at the upper end (10th & Chestnut). The system would consist of approximately 300' of 5'x5' RCB in 9th St., extending west to Connor from the existing 9'x5' RCB (4067); 250' of 60" RCP in Connor, extending south from 9th to the existing 8'x3' RCB crossing Connor; and 550' of 54" RCP extending south along Connor to 10th, and west along 10th to Chestnut.

Downstream Controls: Project No. 4-3 should be completed prior to completion of this project.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Picher Ave. Channel Improvements, 10th to Junge

Project Identification Number: 4-5

Pertinent Data Summary

Watershed:	Joplin Creek West
Priority No.:	17
Design Capacity:	Varies, 270-360 cfs (10-year)
Estimated Cost:	$530,530
Model ID No.:	4075-4095
Map Reference Numbers:	
Master Plan Mapping:	4
Topographic (Section):	10-27-33

Existing Problem Description

Throughout this reach the existing system is rated at roughly a 2-year capacity. Discharges exceeding system capacity result in overtopping of Murphy, 11th, and 12th; in addition, a sump area on 12th at Empire will pond to objectionable depths at intervals of one year or less. It is estimated that 2 structures will receive damage at a 2-year frequency, and 2 additional structures will receive damage at a 5-10 year frequency.

Recommended Improvements

The existing open channel between the intersection of 10th & Chestnut (upstream end of Project 4-4) and the outlet of str. 4100 (8'x3.9' RCB beneath Junge) should be reconstructed to the hydraulic equivalent of an 8' wide concrete lined rectangular channel, 4' wall height. In addition, 2-30" CMP storm sewers draining the sump area on 12th at Empire should be replaced with a 5'x2.5' RCB. The recommended improvements will increase the rated capacity of existing culverts along this reach to 10-year; however, replacement of the existing culvert beneath Murphy (4077) is recommended due to its relatively poor structural condition.

Downstream Controls: Project No. 4-4 should be completed prior to completion of this project.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Maidenlane Storm Sewers, 17th to 20th

Project Identification Number: 4-6

Pertinent Data Summary

Watershed:	Joplin Creek West
Priority No.: 42	
Design Capacity:	Varies, 60-85 cfs (10-year)
Estimated Cost:	$593,339
Model ID No.:	4135, 4140, 4145
Map Reference Numbers:	
Master Plan Mapping:	4
Topographic (Section):	10-27-33

Existing Problem Description

Throughout this reach the existing system is rated at roughly a 2-year capacity. Discharges exceeding system capacity result in flooding of the northbound lanes of Maidenlane. In addition, the nature of the existing system (open channel on street right-of-way, little or no shoulder, guard rail at the edge of the travelled way) leads to substandard roadway cross section geometrics. No structure flooding is anticipated to result from the deficient hydraulic capacity of the system.

Recommended Improvements

Replace the existing undersized open channel along the east side of Maidenlane between 17th and 20th with enclosed storm sewers. The existing 5'x3' RCB beneath 17th has adequate capacity, and can be retained in place. From that structure, extend a 4'x3' RCB upstream to 19th; construct a 54"x34" RCHEP from 19th to 20th.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, 7th E/O Kentucky

Project Identification Number: 4-7

Pertinent Data Summary

Watershed:	Joplin Creek West
Priority No.:	2
Design Capacity:	500 cfs (25-year)
Estimated Cost:	$165,140
Model ID No.:	4156
Map Reference Numbers:	
Master Plan Mapping:	5
Topographic (Section):	11-27-33

Existing Problem Description

The existing 5'x3'RCB across 7th St. provides significantly less than a 2-year level of service. The limited capacity of this crossing prevents full utilization of the upstream system, which is rated at roughly a 5-year capacity. The lack of in-system capacity is made even more significant by the presence of sump areas upstream; significant system overflows result in damage to structures, with such damages occurring to an estimated 4 properties at roughly 2-year intervals due primarily to the constricted opening at the 7th St. crossing.

Recommended Improvements

Replace the existing 5'x3' RCB with an 8'x5' RCB across 7th, having an overall length of approximately 180 ft. The proposed culvert is sized for a 25-year return period, given the lack of a suitable overflow system upstream.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Kentucky Relief Storm Sewers, 7th to 10th

Project Identification Number: 4-8

Pertinent Data Summary

Watershed:	Joplin Creek West
Priority No.:	3
Design Capacity:	130-150 cfs (10-25 year overflow)
Estimated Cost:	$648,041
Model ID No.:	4160, 4165
Map Reference Numbers:	
Master Plan Mapping:	5
Topographic (Section):	11-27-33

Existing Problem Description

Upon completion of Project 4-7, the existing major system from 7th east of Kentucky to 10th and Main has adequate capacity for roughly a 5-year event. System overflows will gather in a sump area on Kentucky, generally extending from 8th to 9th. The lack of an effective overflow system from that sump area can be expected to lead to damage to roughly 8 structures at intervals of from 5-10 years.

Recommended Improvements

Construct a system of storm sewers to intercept and convey system overflows to the upper end of Project 4-7 (reach 4156, culvert beneath 7th east of Kentucky). That system should be designed to accept overflows ranging from 150 cfs at 8th St. to 130 cfs at 10th & Pennsylvania. Proposed improvements include: parallel the existing 6'x5' RCB in the alley east of Kentucky between 7th and 8th with a 60" RCP; construct a new 60" RCP in 8th from the alley west to Kentucky, and along Kentucky south to 9th; construct a new 48" RCP in 9th west from Kentucky to Pennsylvania, and south along Pennsylvania to 10th. Those improvements are intended to result in a 25-year level of protection to the adjacent buildings.

Downstream Controls: Project No. 4-7 should be completed in advance of this project.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Structure Replacement, Main Street at 10th

Project Identification Number: 4-9

Pertinent Data Summary

Watershed:	Joplin Creek West
Priority No.:	43
Design Capacity:	300 cfs (5-year)
Estimated Cost:	$47,269
Model ID No.:	4166
Map Reference Numbers:	
Master Plan Mapping:	5
Topographic (Section):	11-27-33

Existing Problem Description

The existing 6'x4.5' stone masonry arch across Main at 10th is in poor structural condition; the top slab consists of stone supported by heavily-corroded iron members.

Recommended Improvements

Replace the existing crossing with a 6'x5' RCB; the existing system upstream and downstream of the crossing provides roughly a 5-year level of service, which is the recommended level of service for this structure replacement.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Joplin Ave. Storm Sewers, 11th to 12th

Project Identification Number: 4-10

Pertinent Data Summary

Watershed:	Joplin Creek West
Priority No.:	30
Design Capacity:	310 cfs (10-year)
Estimated Cost:	$329,443
Model ID No.:	4177, 4178
Map Reference Numbers:	
Master Plan Mapping:	5
Topographic (Section):	10-27-33

Existing Problem Description

Reach No. 4177 consists of approx. 250' of 6'x4' RCB along the east side of Joplin north of 11th; this line provides a 2-year level of service, and limits the capacity of the upstream system (8'x4' RCB, reach no. 4178), which would otherwise provide roughly a 5-year level of service. Overflows from 4178 follow 12th St. to Joplin, and then north along Joplin. For the system as it exists, it is estimated that 4 structures may be subject to damage at intervals of 5-10 years.

Recommended Improvements

Replace the existing 6'x4' RCB (4177) with an 8'x5' RCB. Extend a 42" RCP south along Joplin to 12th St. to pick up overflows from reach no. 4178 (8'x4' RCB in the alley west of Joplin); the design overflow rate for this segment is roughly 50 cfs during a 10-year event.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Structure Replacement, 14th St. W/O Joplin Ave.

Project Identification Number: 4-11

Pertinent Data Summary

Watershed:	Joplin Creek West
Priority No.:	49
Design Capacity:	N.A.
Estimated Cost:	$222,211
Model ID No.:	4181
Map Reference Numbers:	
Master Plan Mapping:	5
Topographic (Section):	10-27-33

Existing Problem Description

Reach No. 4181 consists of approx. 330' of 6'x4' RCB along the alley west of Joplin, extending north of 14th St. The existing structure is adequately sized for hydraulic requirements, but has structurally failed.

Recommended Improvements

Replace the existing structure with a new 6'x4' RCB, replacing the original hydraulic capacity.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Iowa Ave. Storm Sewers, 20th to 24th

Project Identification Number: 4-12

Pertinent Data Summary

Watershed:	Joplin Creek West
Priority No.:	36
Design Capacity:	210-320 cfs (10-Year)
Estimated Cost:	$1,379,048
Model ID No.:	4292, 4296, 4298
Map Reference Numbers:	
Master Plan Mapping:	8
Topographic (Section):	14-27-33

Existing Problem Description

Throughout this reach, the existing storm sewers are rated at much less than a 2-year capacity. Despite that deficiency, no structures are known to flood, although it is probable that ponding depths in Iowa become excessive (hindrance to traffic) frequently.

Recommended Improvements

Replace the existing system with new storm sewers extending south from 20th St. (structure 4290) along the east side of Iowa to 24th Street. Downstream of 22nd St., the existing 58"x36" CMPA would be replaced with an 8'x4' RCB; upstream of 22nd St., the existing 58"x36" CMPA would be replaced with a 6'x4' RCB.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Indiana Ave. Storm Sewers, 20th to 22nd

Project Identification Number: 4-13

Pertinent Data Summary

Watershed:	Joplin Creek West
Priority No.:	35
Design Capacity:	250-330 cfs (10-Year)
Estimated Cost:	$1,324,861
Model ID No.:	4286, 4287, 4288, 4318
Map Reference Numbers:	
Master Plan Mapping:	8
Topographic (Section):	14-27-33

Existing Problem Description

Throughout this reach, the existing storm sewers are rated at much less than a 2-year capacity. Despite that deficiency, no structures are known to flood at frequent intervals, although it is probable that ponding depths in Indiana south of 20th become excessive (hindrance to traffic) frequently. In addition, objectionable surface overflows on properties east of Indiana and on the school property west of Indiana can be expected annually.

Recommended Improvements

Construct a new relief sewer from the upstream end of 4290 (dbl. 6'x4' RCB across 20th) to the downstream end of reach 4288 (sump on Indiana), parallelling existing reaches 4286 and 4288; the relief sewer would be a 5'x4' RCB extending on a direct route across the school property, designed for a relief rate of discharge of 200 cfs. Replace reach 4288 (Indiana Avenue crossing) with a 7'x4' RCB; replace reaches 4289 (48" RCP) and 4318 (65"x40" CMPA) with a 6'x4' RCB.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, 32nd W/O Schifferdecker
Project Identification Number: 5-1

Pertinent Data Summary

Watershed:	McClelland
Priority No.:	34
Design Capacity:	290 cfs (10-year)
Estimated Cost:	$56,912
Model ID No.:	5085
Map Reference Numbers:	
Master Plan Mapping:	7
Topographic (Section):	17-27-33

Existing Problem Description

The existing culvert consists of 4-27" vitrified clay pipes providing less than a 5-year capacity. The hydraulic deficiency of this structure is masked under events having return periods of 2 years and less due to the influence of existing detention storage east of Schifferdecker north of 32nd St.

Recommended Improvements

Replace the existing structure with a 10'x4' RCB.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, Schifferdecker N/O 32nd
Project Identification Number: 5-2

Pertinent Data Summary

Watershed:	McClelland
Priority No.:	34
Design Capacity:	230 cfs (10-year)
Estimated Cost:	$79,024
Model ID No.:	5105
Map Reference Numbers:	
Master Plan Mapping:	7
Topographic (Section):	16-27-33

Existing Problem Description

The existing culvert consists of 2-24" RCP's providing roughly a 2-year capacity. The true hydraulic deficiency of this structure is masked under events having return periods of 2 years and less due to the influence of existing detention storage east of Schifferdecker north of 32nd St.

Recommended Improvements

Replace the existing structure with a 10'x4' RCB. In order to develop adequate cover over the RCB, it will also be necessary to improve roughly 150 feet of the downstream channel in order to lower the channel invert. The lining is expected to consist of the hydraulic equivalent of a concrete-lined trapezoidal channel having a bottom width of 8 feet and a lined depth of 3 feet.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, 4th St. East of Murphy

Project Identification Number: 6-1

Pertinent Data Summary

Watershed:	Joplin Creek East
Priority No.:	6
Design Capacity:	5,200 cfs (10-year)
Estimated Cost:	$1,000,805
Model ID No.:	6085
Map Reference Numbers:	
Master Plan Mapping:	5
Topographic (Section):	2-27-33

Existing Problem Description

The existing culvert consists of a triple 10'x7' RCB beneath 4th Street. The culvert is rated at slightly less than a 2-year capacity, and is in an advanced state of structural deterioration. An 8-inch utility line is supported from the downstream face of the structure at an elevation below the crown of the culvert.

The structure acts as a significant obstruction to flow in Joplin Creek immediately downstream of the confluence of the Joplin Creek East and West primary tributaries. Backwater from this culvert inundates an existing structure at the intersection of Murphy and 5th under a 2-yr. event, as well as industrial yard areas on the left bank of Joplin Creek East downstream of 5th (2 year frequency) and industrial/commercial structures in that same area (approx. 20-year frequency).

Recommended Improvements

Replace the existing structure with a triple 20'x9' RCB; raise the profile of 4th St. along a length of approx. 500' extending east from Murphy, approx. min. roadway el. 967.0. Construct PCC paved downstream transition to the existing channel, approx. 140' long; construct PCC paved upstream transition to existing Joplin Creek East and West channels, total length upstream of structure of approx. 140' (includes approx. 80' along each channel).

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, 5th and Division

Project Identification Number: 6-2

Pertinent Data Summary

Watershed:	Joplin Creek East
Priority No.:	7
Design Capacity:	2,460 cfs (10-year)
Estimated Cost:	$951,180
Model ID No.:	6090, 6095
Map Reference Numbers:	
Master Plan Mapping:	5
Topographic (Section):	2-27-33

Existing Problem Description

The existing culvert consists of a 6' high concrete box culvert, having a basic width of 14 feet, roughly 220' in length. The inlet end (beneath the intersection of 5th and Division) is a double 6.5'x6' RCB in extremely poor structural condition. That inlet section is then followed by a 14'x6' RCB passing beneath the Drillers Supply Co. building; 12" columns supporting the building are situated at the mid-span of the box. Downstream of the building, the box is a true 14'x6' RCB. The downstream channel (reach 6090) is rock rubble lined and of irregular cross section.

The limited conveyance of the downstream channel results in damage to structures at a return period of roughly 25 years (after completion of project 6-1), and contributes to the limited capacity of the culvert, which is rated at but slightly greater than a 1-year return period. Backwater from this structure adversely affects the performance of the triple 12'x6' RCB railroad culvert just upstream, as well as the performance of a 48" culvert beneath 5th St. just upstream of the railroad (6103).

Recommended Improvements

Replace the existing structure with a double 14'x6' RCB constructed on a curvalinear alignment, generally following 5th St., between the existing termini of the structure. Improve the downstream channel (6090) to a gabion-lined trapezoidal section having a bottom width of 20' and 2:1 side slopes lined to a depth of 7'; the channel improvement would extend downstream to the approach transition to the proposed 4th St. culvert (6085). Extend a rectangular concrete channel between the upstream sidewalls of the new 2-14'x6' RCB and the existing 3-12'x6' RCB beneath the railroad.

Downstream Controls: Project No. 6-1 should be completed in advance of this project.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: 8th and Patterson Storm Sewers

Project Identification Number: 6-3

Pertinent Data Summary

Watershed:	Joplin Creek East
Priority No.:	26
Design Capacity:	125 cfs (10-year @ 6230, 5-year @ 6222)
Estimated Cost:	$284,577
Model ID No.:	6222, 6230
Map Reference Numbers:	
Master Plan Mapping:	5
Topographic (Section):	12-27-33

Existing Problem Description

Line 6230 extends south from 7th St. along Patterson, eventually discharging to open channel south of 8th St. west of Patterson. A sump is present on Patterson north of 8th; ponding depths can exceed 2' in Patterson prior to surface overflow from the sump. The capacity of this storm sewer is much less than 2-year, leading to frequent ponding of excessive depth in Patterson.

At the downstream end of the open channel, flows are carried beneath newly constructed 9th St. through 3-30" RCPs; those culverts are in poor condition. An existing 6'x4' RCB railroad culvert is situated immediately downstream of 9th; 9th was constructed too low to take advantage of the available capacity in this structure. New duplexes just north of 9th are subject to damage during 9th St. overflows.

Recommended Improvements

Replace line 6230 with a 48" RCP from the south curb line of 7th St. to the existing downstream terminus of the pipe. Replace the existing 3-30" RCPs beneath 9th St. with a 6'x3.5' RCB (top slab as roadway surface).

It is not recommended that 9th St. be raised, as upstream residences would be adversely impacted by increased headwater depths. It is not considered reasonably practicable to obtain a full 10-year level of service for the 9th St. culvert.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, Connecticutt Ave. North of 26th

Project Identification Number: 6-4

Pertinent Data Summary

Watershed:	Joplin Creek East
Priority No.:	40
Design Capacity:	125 cfs (10-year)
Estimated Cost:	$43,833
Model ID No.:	6315
Map Reference Numbers:	
Master Plan Mapping:	8
Topographic (Section):	14-27-33

Existing Problem Description

The existing 2-24" RCPs culvert afford less than a 1-year level of protection to Connecticutt (south of the culvert) and to existing upstream buildings. Computed demand discharges at this location have been greatly reduced to reflect the operation of an existing railroad culvert roughly 1,400' upstream (below subarea 6315) as an unplanned detention area. The actual capacity of this culvert is reduced due to its presence in the headwater pool of an additional unplanned detention area upstream of a 3'x3' RCB railroad culvert west of Connecticutt.

Recommended Improvements

Replace line 6315 with a 60" RCP; the available head loss across this structure is limited to slightly over 1' due to storage elevations in the unplanned detention area formed by the 3'x3' railroad culvert (6312).

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, Connecticutt Ave. South of Campbell

Project Identification Number: 6-5

Pertinent Data Summary

Watershed:	Joplin Creek East
Priority No.:	15
Design Capacity:	1,200 cfs (10-year)
Estimated Cost:	$156,000
Model ID No.:	6320
Map Reference Numbers:	
Master Plan Mapping:	5
Topographic (Section):	12-27-33

Existing Problem Description

The existing triple 54" CMP affords roughly a 1-year level of service prior to overtopping of Connecticutt.

Recommended Improvements

Replace the existing structure with a double 10'x5' RCB constructed at roughly a 25-degree skew to Connecticutt to align with the stream.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, 15th St. East of Delaware

Project Identification Number: 6-6

Pertinent Data Summary

Watershed:	Joplin Creek East
Priority No.:	32
Design Capacity:	1,060 cfs (10-year)
Estimated Cost:	$207,000
Model ID No.:	6330
Map Reference Numbers:	
Master Plan Mapping:	8
Topographic (Section):	12-27-33

Existing Problem Description

The existing double 66" RCP affords roughly a 1-year level of service prior to overtopping of 15th Street. The alignment of the existing structure contributes to debris accumulation and blockage in the westerly culvert.

Recommended Improvements

Replace the existing structure with a double 10'x5' RCB constructed at roughly a 30-degree skew to 15th Street to align with the stream.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: 16th and Texas Storm Sewers

Project Identification Number: 6-7

Pertinent Data Summary

Watershed: Joplin Creek East
Priority No.: 5
Design Capacity: Varies; 270-65 cfs (10-year)
Estimated Cost: $774,332
Model ID No.: 6351-6367
Map Reference Numbers:
Master Plan Mapping: 5,9
Topographic (Section): 12-27-33

Existing Problem Description

Throughout this reach of the system, which extends from the intersection of 16th and Texas to the west side of Range Line Road north of 15th Street, the existing system is rated at markedly less than 2-year capacity. Approximately 8 residences and 3 street crossings are subjected to frequent surface overflows, and are occasionally damaged thereby. Approximately 10 additional residences are regularly subjected to fairly wide spread, slowly draining storm water.

Recommended Improvements

Reconstruct this entire reach. The following is a summary listing of anticipated improvements:

Line No.	Disch. (cfs)	Length (ft)	Size	Slope (%)	Remarks
6355	270	350	8'x4' RCB	0.43	Follow Texas to NLL*
6359	270	300	8'x4.5'	0.27	PCC lined ditch
6363	240	290	6'x4' RCB	0.70	Crossing 15th
6365	180	350	6'x4.5'	1.40	Gabion lined ditch
6366	120	100	48" RCP	1.00	Crossing Highview
6367	65	500	36" RCP	2.00	End at 4'x2.5' RCB

* North Lot Line, 2nd tier of lots south of 15th

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Davis Blvd. Detention Basin

Project Identification Number: 6-8

Pertinent Data Summary

Watershed:	Joplin Creek East
Priority No.: 9	
Design Capacity:	Varies; 370/46 cfs (100-year)
Estimated Cost:	$502,275
Model ID No.:	6435
Map Reference Numbers:	
Master Plan Mapping:	9
Topographic (Section):	18-27-32

Existing Problem Description

The existing system between 20th St. at Texas and Davis Blvd. roughly 1/4-mile south of 20th St. has insufficient hydraulic capacity, with capacities generally ranging from 2 to 5 years. Construction of this detention basin will reduce or eliminate the need for improvements along 20th between Texas and Range Line, as well as replacement of the Davis Blvd. culvert (line no. 6435); it will also make practicable the improvements recommended for Project No. 6-9, and will substantially reduce the design discharges for Projects 6-5 and 6-6.

Recommended Improvements

Construct a stormwater detention basin just east of Davis Blvd. at a point roughly 1/4-mile south of 20th St. The basin would control discharges from a 148-acre area for all events up to and including the 100-year event, and should provide an active storage of roughly 30 acre-feet with a maximum controlled discharge of 46 cfs.

Downstream Controls: This project should be completed prior to Projects 6-5, 6-6 and 6-9, as the design of those projects will be influenced by the presence of this detention basin.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, Range Line Rd. S/O 20th St.

Project Identification Number: 6-9

Pertinent Data Summary

Watershed:	Joplin Creek East
Priority No.:	18
Design Capacity:	Varies; 400 cfs (10-year)
Estimated Cost:	$426,600
Model ID No.:	6417
Map Reference Numbers:	
Master Plan Mapping:	9
Topographic (Section):	18-27-32

Existing Problem Description

Structure No. 6415 consists of a 2-8'x3.2' RCB beneath Range Line Rd., and is rated at roughly a 10-year capacity. Just upstream of this structure, the main drainage channel passes beneath commercial entrances off Range Line through 6417, which consists of 3-65"x40" CMPA's having substantially less than a 2-year capacity. The restriction imposed by these culverts and the upstream 300' of open channel (downstream of Geneva) results in damage to commercial properties (in particular the Thunderbird Motel) under less than a 2-year event.

Recommended Improvements

The design rates of discharge are developed upon the assumption that the Davis Blvd. Detention Basin (Project No. 6-8) has been constructed. Structure 6417 should be removed; the existing 2-8'x3.2' RCB beneath Range Line should be extended approximately 185 feet; between the upstream end of that extension and Geneva (a length of approx. 330 feet), the open channel should be improved to a rectangular concrete-lined open channel having a bottom width of 16'-8" and sidewall heights of roughly 5 feet. In order to further improve the level of protection afforded the Thunderbird Motel, it is recommended that an earthen fill be placed along the left bank of the channel for a length of roughly 300 feet downstream (south) of the south end of Geneva, tieing to higher ground at elevation 1040.0.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Replacement Sewer, Maiden Lane N/O 7th

Project Identification Number: 7-1

Pertinent Data Summary

Watershed:	Lone Elm
Priority No.: 27	
Design Capacity:	300 cfs (10-year)
Estimated Cost:	$87,387
Model ID No.:	7182
Map Reference Numbers:	
Master Plan Mapping:	4
Topographic (Section):	3-27-33

Existing Problem Description

Reach 7182 consists of a 79"x49" CMPA crossing Maiden Lane and extending into the McDonald's parking lot northeast of the intersection of Maiden Lane with 7th, and is one part of what is essentially an enclosed system extending upstream to the alley south of 7th and west of Maiden Lane. Immediately upstream of the CMPA, the system consists of an 8'x4' RCB; the CMPA discharges to 2-60" RCP's. This reach represents a severe restriction in the overall capacity of the enclosed system, providing less than a 2-year level of service; the balance of the enclosed system would provide in excess of a 10-year level of service upon removal of the restriction. No structures are known to frequently flood as a result of the deficient hydraulic capacity, but nuisance flooding to 2 properties and excessive ponding depths in the sump on Maiden Lane can be expected at intervals of 2 years or less.

Recommended Improvements

Replace the existing 79"x49" CMPA with an 8'x4' RCB; the replacement extends from the west curb line of Maiden Lane to the upstream end of the 2-60" RCP's on the McDonald's parking lot.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, 6th W/O Porter

Project Identification Number: 7-2

Pertinent Data Summary

Watershed:	Lone Elm
Priority No.:	20
Design Capacity:	380 cfs (10-year)
Estimated Cost:	$307,035
Model ID No.:	7165, 7170, 7175
Map Reference Numbers:	
Master Plan Mapping:	4
Topographic (Section):	3-27-33

Existing Problem Description

The existing 5'x4' RCB beneath Porter (7170) provides less than a 2-year level of protection against overtopping of the street. The existing unlined ditches upstream and downstream of 6th St. provide less than 2-year capacity at bank full, and exhibit significant erosion.

Recommended Improvements

Improve the open channels between the upstream end of line 7160 (5'x5' RCB at 5th west of Porter) and the downstream end of line 7180 (2-60" RCP east of Maiden Lane south of 6th) with a gabion lined channel having a bottom width of 8 ft., a lined depth of 3 feet, and side slopes of 3:1. Replace the existing 5'x4' RCB beneath 6th west of Porter with an 8'x4' RCB.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, A St. W/O Porter

Project Identification Number: 7-3

Pertinent Data Summary

Watershed:	Lone Elm
Priority No.:	44
Design Capacity:	730 cfs (10-year)
Estimated Cost:	$88,529
Model ID No.:	7090
Map Reference Numbers:	
Master Plan Mapping:	4
Topographic (Section):	3-27-33

Existing Problem Description

The existing 3 cell 6.5'x3.5' RCB beneath A St. provides roughly a 5-year level of protection against overtopping of the street, and is in fairly poor structural condition. The above dimensions of the box are nominal; the total cross-sectional area of the box is roughly 60 square feet.

Recommended Improvements

Replace the existing structure with a 3-7'x3.5' RCB, increasing the waterway area by roughly 20-25%. The primary need for this project is replacement of the existing structure due to its advancing state of structural deterioration.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Removal, B St. W/O Porter

Project Identification Number: 7-4

Pertinent Data Summary

Watershed:	Lone Elm
Priority No.:	28
Design Capacity:	770 cfs (10-year)
Estimated Cost:	$62,626
Model ID No.:	7075
Map Reference Numbers:	
Master Plan Mapping:	4
Topographic (Section):	3-27-33

Existing Problem Description

The existing 3 cell 6.5'x3.5' RCB beneath B St. provides roughly a 2-year level of protection against overtopping of the street, and is in poor structural condition. The above dimensions of the box are nominal; the total cross-sectional area of the box is roughly 60 square feet. The limited hydraulic capacity of the structure is due in part to the presence of roughly a 45-degree bend in the culvert barrels.

Recommended Improvements

B Street immediately west of this structure is presently closed, but is used for private parking by a commercial interest northwest of the structure. It is recommended that this structure be removed in total and replaced with an open channel matching the cross section of the upstream and downstream improved open channels.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, C St. W/O Porter

Project Identification Number: 7-5

Pertinent Data Summary

Watershed:	Lone Elm
Priority No.:	25
Design Capacity:	900 cfs (5-year)
Estimated Cost:	$190,801
Model ID No.:	7065
Map Reference Numbers:	
Master Plan Mapping:	4
Topographic (Section):	3-27-33

Existing Problem Description

The existing 3 cell 6.5'x3.5' RCB beneath C St. provides less than a 2-year level of protection against overtopping of the street. The above dimensions of the box are nominal; the total cross-sectional area of the box is roughly 60 square feet. The capacity of the structure is limited by the alignment of the Eagle Picher retaining wall immediately downstream, which largely blocks the exit from the westerly cell of the structure. The existing channel upstream of C St. is improved (12 ft. bottom width, 4.5 ft. depth, 20 ft. top width, grouted rock lining), and provides a bankfull capacity (with no backwater from structure 7065) of roughly 900 cfs (approximately a 5-year level of service).

Recommended Improvements

Replace the existing structure with a new 2-8'x4.5' RCB, located east of the existing structure and crossing C St. on approximately a 45-degree skew. Realign the upstream channel to provide a smooth transition from the existing channel to the new structure.

The additional height of the structure (as compared to existing) would be accommodated by lowering the channel invert roughly one foot, requiring roughly a 150-ft. downstream extension of the channel improvement.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: B St. Storm Sewers, Harlem to Empire

Project Identification Number: 7-6

Pertinent Data Summary

Watershed:	Lone Elm
Priority No.: 23	
Design Capacity:	350 cfs (10-year)
Estimated Cost:	$796,800
Model ID No.:	7076, 7080
Map Reference Numbers:	
Master Plan Mapping:	4
Topographic (Section):	3-27-33

Existing Problem Description

Reach No. 7076 consists of approximately 450 ft. of 2-36" RCP storm sewers which provide less than a 2-year level of service. No structures are known to flood as a result of the deficient capacity, but frequent overflows across a parking area and into B Street do occur. That system is preceded by an open channel extending upstream to the intersection of B St. and Harlem; discharges are carried through that intersection by structure 7080 (a 72"x44" CMPA beneath Harlem, and a 49"x32" RCHEP beneath B St.). Reach 7080 provides much less than a 2-year capacity; nuisance flooding on 3 properties occurs almost annually.

Recommended Improvements

Construct an 8'x4' RCB from the open channel southwest of the intersection of B St. and Harlem to the outlet of the existing reach 7076 (at structure 7075).

Downstream Controls: Project 7-3 should be completed in advance of this project.

Potential Alternative: Consider the possibillity of a partial replacement of reach 7076 (where along B St.), followed by construction of a relief sewer continuing west along B St. to the west side of Harlem; the design capacity of the relief sewer would be 200 cfs; structure 7080 and the upstream segment of 7076 would be retained in place.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacements, McCoy & West 1st St.

Project Identification Number: 7-7

Pertinent Data Summary

Watershed:	Lone Elm
Priority No.:	24
Design Capacity:	250 cfs (10-year)
Estimated Cost:	$92,933
Model ID No.:	7082
Map Reference Numbers:	
Master Plan Mapping:	4
Topographic (Section):	9-27-33

Existing Problem Description

The existing culvert consists of a 48" RCP providing less than a 2-year level of service; nuisance flooding on 3 properties occurs under all events equal to or greater than a 2-year. Two additional properties are subject to nuisance flooding at similar return periods due to the limited capacity of the existing structure beneath West 1st St. west of McCoy.

Recommended Improvements

Replace each of these two structures with an 8'x4' RCB.

Downstream Controls: Project 7-6 should be completed in advance of this project.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, Roosevelt S/O 17th
Project Identification Number: 8-1

Pertinent Data Summary

Watershed:	Country Club
Priority No.:	14
Design Capacity:	240 cfs (10-year)
Estimated Cost:	$45,892
Model ID No.:	8100, 8105
Map Reference Numbers:	
Master Plan Mapping:	7
Topographic (Section):	9-27-33

Existing Problem Description

The existing culverts each consist of 2-36" RCP's providing roughly a 2-year capacity. The downstream structure (8105) is beneath an alley west of Roosevelt; channel improvements have previously been completed downstream of and between these structures; the bankfull capacity of that improved channel approaches the 100-year discharge. The constriction resulting from the presence of 8105 is estimated to result in damage to two upstream residential structures at roughly a 5-year frequency, and influences the performance of the culvert beneath Roosevelt. The constriction at Roosevelt (8100) is estimated to result in nuisance flooding on two properties for events having return periods of 5 years and greater.

Recommended Improvements

Remove structure 8105 (alley culvert) in total, and replace with a connecting segment of improved open channel matching the upstream and downstream cross section. Replace the existing 2-36" RCP culvert beneath Roosevelt with an 8'x3.5' RCB.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Schifferdecker Paved Ditch, Junge to S/O 17th
Project Identification Number: 8-2

Pertinent Data Summary

Watershed:	Country Club
Priority No.: 38	
Design Capacity:	200 cfs (10-year)
Estimated Cost:	$366,593
Model ID No.:	8045, 8056, 8057, 8058, 8059
Map Reference Numbers:	
Master Plan Mapping:	7
Topographic (Section):	9-27-33

Existing Problem Description

The existing system along the east side of Schifferdecker between Junge and structure 8045 (2-8'x4' RCB south of 17th) provides roughly a 2-year nominal capacity; that capacity cannot be fully realized due to the structural condition of existing entrance culverts. Flooding of Schifferdecker, as well as nuisance flooding on 4 properties east of Schifferdecker, can be expected under 5-year and greater events.

Recommended Improvements

Replace the existing system from structure 8045 to the north side of 16th with a PCC lined channel equivalent to a trapezoidal section having a bottom width of 6 feet, a lined depth of 3 feet, and 3:1 side slopes; construction on easement will probably be required. Construct a 6'x4' RCB beneath 16th at the upper end of the reach and at the lower end, crossing Schifferdecker (augmenting the capacity of structure 8045. At entrances, provide not less than 6'x3' RCB's.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: 20th St. Storm Sewers, W/O Roosevelt
Project Identification Number: 8-3

Pertinent Data Summary

Watershed:	Country Club
Priority No.:	41
Design Capacity:	100 cfs (10-year)
Estimated Cost:	$313,607
Model ID No.:	8108, 8080, 8087
Map Reference Numbers:	
Master Plan Mapping:	7
Topographic (Section):	9-27-33

Existing Problem Description

The existing system throughout this reach provides less than a 2 year level of protection. Nuisance flooding on roughly 4 properties can be expected at intervals of less than 5 years.

Recommended Improvements

Construct an enclosed system from the existing structure beneath the railroad (reach no. 8090) downstream to a point roughly 1,100 ft. west of Roosevelt and 300 ft. north of 20th. Throughout that length, the proposed sewer would consist of a 48" RCP.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: 24th & Meadow Storm Sewers
Project Identification Number: 8-4

Pertinent Data Summary

Watershed:	Country Club
Priority No.:	47
Design Capacity:	Varies, 85-310 cfs (10-year)
Estimated Cost:	$515,749
Model ID No.:	8022, 8023, 8024
Map Reference Numbers:	
Master Plan Mapping:	7
Topographic (Section):	17-27-33

Existing Problem Description

The existing system throughout this reach provides between a 2 and 5 year level of protection. Nuisance flooding on roughly 7 properties can be expected at intervals of less than 5 years. Downstream of Iron Gates Rd., the lack of gradient in the recently enlarged earthen channel is contributing to a ponded water condition.

Recommended Improvements

Construct an enclosed system from Iron Gates Rd. south of 23rd to Cleveland just south of 24th. From Cleveland to Meadow, the sewer would consist of a 42" RCP; from Meadow to a point upstream of Iron Gates, a 48" RCP; the Iron Gates crossing would be a 5'x4' RCB.

Downstream of Iron Gates, and extending to the railroad bridge (approx. 700' length), construct an improved open channel equivalent to a gabion-lined trapezoid having a bottom width of 8 ft., a lined depth of 4 ft., and 2:1 side slopes.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, 2nd St. W/O Walnut
Project Identification Number: 9-1

Pertinent Data Summary

Watershed:	Leadville
Priority No.:	31
Design Capacity:	550 cfs (10-year)
Estimated Cost:	$120,926
Model ID No.:	9070, 9080
Map Reference Numbers:	
Master Plan Mapping:	4
Topographic (Section):	4-27-33

Existing Problem Description

The existing 6'x6' RCB beneath 2nd St. provides less than a 2-year level of service; replacement of the structure with one of adequate capacity would be of little value without removal of structure 9070 (reinforced concrete arches beneath an abandoned railway grade), as backwater from that structure would flood 2nd St. at slightly more than 2 year intervals. The backwater from the railroad culverts can be expected to result in damage to 4 residential structures under events having return periods of 25 years and greater.

Recommended Improvements

Replace the existing 6'x6' RCB under 2nd St. with a 12'x6' RCB. Remove the existing reinforced concrete arches beneath the abandoned railroad grade.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, Perkins W/O Monroe
Project Identification Number: 9-2

Pertinent Data Summary

Watershed:	Leadville
Priority No.: 45	
Design Capacity:	730 cfs (10-year)
Estimated Cost:	$78,480
Model ID No.:	9045, 9046
Map Reference Numbers:	
Master Plan Mapping:	4
Topographic (Section):	4-27-33

Existing Problem Description

The existing 90" RCP beneath Perkins (structure 9046) provides roughly a 5-year level of service; no upstream structures are known to flood as a result of the deficient culvert capacity. The downstream segment of this structure (96" RCP) is exhibiting structural distress; the lower wall of the RCP has failed over roughly a 20-foot length. Structure 9045 consists of a 9'x8' RCB in very poor structural condition beneath an apparently abandoned mining road just downstream of Perkins.

Recommended Improvements

Replace the existing 90" RCP under Perkins with a 9'x7' RCB. Remove the existing 9'x8' RCB downstream of Perkins.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Canterbury Ditch, 3rd to 7th

Project Identification Number: 10-1

Pertinent Data Summary

Watershed:	Turkey Creek Central
Priority No.:	4
Design Capacity:	Varies; 280-480 cfs (10-year)
Estimated Cost:	$583,166
Model ID No.:	10457, 10480
Map Reference Numbers:	
Master Plan Mapping:	6
Topographic (Section):	6-27-32

Existing Problem Description

The existing unimproved ditch along the rear lot line east of Canterbury Lane from 3rd to 7th provides a bank-full capacity roughly equal to a 2-year event; for events having return periods of roughly 10 years, a total of 6 houses can be expected to receive damage.

Recommended Improvements

Recommended improvements include the construction of walled gabion-lined channels extending from 3rd Street (structure 10445) to 7th St. (structure 10485). The existing double arch pipe (structure 10455) beneath Northpark Lane would remain in place. Downstream of that structure, and extending to a point roughly 100 ft. upstream, the improved channel would have a bottom width of 10 feet and a lined height of 6 feet; between the upstream end of that reach and 7th Street, the improved channel would have a bottom width of 8 feet and a lined height of 4.5 feet. The proposed improvements would maintain the 10 year event within banks, and would provide a level of protection approaching 100 years to the affected residential structures.

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, 10th E/O Peters

Project Identification Number: 10-2

Pertinent Data Summary

Watershed:	Turkey Creek Central
Priority No.:	33
Design Capacity:	150 cfs (10-year)
Estimated Cost:	$46,606
Model ID No.:	10505
Map Reference Numbers:	
Master Plan Mapping:	6
Topographic (Section):	7-27-32

Existing Problem Description

The existing 3-24" RCP culvert beneath 10th immediately east of Peters provides roughly a 2-year level of service against overtopping of the roadway. An existing gravel surfaced parking area southwest of the intersection is overtopped at a more frequent interval; a building adjacent to that parking area is subject to damage at intervals estimated to be 10 years or less.

Recommended Improvements

Replace the existing 3-24" RCP culvert with an 8'x3' RCB

Downstream Controls: None.

JOPLIN, MISSOURI
STORMWATER MANAGEMENT MASTER PLAN
CAPITAL IMPROVEMENT PROJECT RECOMMENDATION

Project Name: Culvert Replacement, Zora E/O Park
Project Identification Number: 12-1

Pertinent Data Summary

Watershed:	Royal Heights
Priority No.:	48
Design Capacity:	350 cfs (10-year)
Estimated Cost:	$66,654
Model ID No.:	12035
Map Reference Numbers:	
Master Plan Mapping:	2
Topographic (Section):	25-28-33

Existing Problem Description

The existing reinforced concrete arch culvert provides adequate end area for the design discharge, but is in poor structural condition. The floor on roughly the upstream half of the structure has either washed out or collapsed, and undermining of the walls is in evidence.

Recommended Improvements

Replace the existing culvert with a 6'x6' RCB.

Downstream Controls: None.

Potential Alternative: Investigate the possibillity of structural repair of the existing structure; a slight (10% or less) loss of end area can be accommodated while maintaining the desired 10-year capacity of the structure.

PART VI

RECOMMENDED SYSTEM IMPROVEMENTS

PART VI

RECOMMENDED SYSTEM IMPROVEMENTS

A. ALTERNATIVE SYSTEM COMPONENTS

There are two basic types of drainage system components, "structural" and "nonstructural." Both types must be operated in a complementary way to avoid drainage "problems." Each element of the system has a cost associated with providing it. The goal of this plan is to recommend the best balanced combination of all system elements that will provide an acceptable level of service at the greatest economic benefit to the City as a whole.

1. NONSTRUCTURAL ELEMENTS

Nonstructural elements of a drainage system are generally those elements that don't involve significant capital construction but function as a part of the system of limiting runoff. Their "cost" is primarily measured by generally lowered tax revenue and economic activity, although some direct maintenance cost often applies to their continued performance. Once they become part of the "system" they can't readily be modified because such modifications will increase runoff to the entire downstream system reducing its level of service. Nonstructural elements include the following.

a. Zoning and Land Use

Zoning ordinances prescribe types of land use and density of development which determines, in part, relative runoff rates. Dense land use, such as commercial or industrial development, generates high runoff rates compared to residential or agricultural land use; areas of small lots will generate more runoff than areas developed in large lots. In real estate vernacular, the "highest and best use" of land produces the greatest tax revenue which corresponds with the densest types of development. Down-zoning to reduce runoff, and the associated

cost of the downstream drainage system, reduces the potential revenue from properties. This loss of revenues, then, can be viewed as the "cost" of zoning with respect to drainage.

b. Flowage Easements

Flowage easements involve the acquisition of the right to periodically use a natural channel and its overbank floodway or the overflow channel above an improved conveyance element to convey drainage. In some sense, these easements represent a form of limited conservation zoning in that they preclude any improvement of the land occupied by the easement. Flowage easements follow the natural channel or pipe alignment and vary in width to include all land below the elevation of the design hydraulic gradient plus a freeboard allowance. Representative easement widths are in the range of 50 to 100 feet for natural channels and 15 to 40 feet for improved system facilities. Natural channels and their overbank areas require little initial construction but must be maintained on a regular basis to remove obstructing debris and snags. Overflow channels above enclosed pipes or along improved channels must also be maintained to prevent obstructions to flow. Because these easements are typically located on private property, this responsibility generally falls to the individual property owners.

c. Regulatory Detention

Regulatory detention is the adoption of appropriate ordinances and implementation of regulations that, while permitting intense land uses, require the provision, operation, and maintenance of on-site detention facilities to limit the peak rate of discharge from the owner's, or developer's, site to the downstream system. They require no direct capital investment by the City but have the effect of either diminishing the net developable land by the area required for detention or requiring more costly structures as part of the development. They are most effective when physically located at the upper end of watersheds.

d. Removal of Improvements

The purchase, demolition, and removal of structures subject to damage from drainage is a viable method of providing drainage service to the City as a whole. Drainage "problems" are the damage and/or extreme nuisance resulting from the flow of storm water on private and public property. Removal of the affected improvements is a viable choice in cases where the cost of managing the water is disproportionately large compared with the value of the improvement.

2. STRUCTURAL ELEMENTS

Structural elements of a drainage system are those designed to collect and convey runoff. They include structures that require a significant capital investment to build, and will depreciate over a long period of time. Structural components of the system include conveyance facilities and public detention facilities.

a. Conveyance Facilities

Conveyance facilities are the conventional drainage structures such as:

- Pipes
- Inlets
- Culverts
- Bridges
- Lined open channels

b. Public Detention Facilities

Public detention facilities are ponds, dry ponds, and functionally similar structures constructed with controlled service and emergency spillways that are operated by the City to reduce the peak rate of flow in the drainage system. Land enclosed by some may be capable of other beneficial uses such as open parks and buffer zones between different land use areas. The construction cost of the facility is often moderate when compared with alternative structural conveyance facilities. Because they are

functionally most effective when located near the upper reaches of watersheds, the land occupied is valuable, and its acquisition forms a large part of the cost of their development. They require regular maintenance in the form of mowing and periodic removal of the sediment trapped by the facility.

3. COMPARISON OF ALTERNATIVES

Table VI-1 presents a qualitative comparison of the performance and cost impact typical of the alternative system components.

TABLE VI-1

COMPARISON OF ALTERNATIVES

System Component	Land Area Required	Land Value	Tax Base Effect	Regular Maint. Required	Capital Cost	Depr.
Nonstructural						
Downzoning	None	High	Negative	None	None	None
Flowage Easements	High	Low	None	High	None	None
Regulatory Detention	Moderate	High	Slight	None	None	None
Removal of Improvements	Moderate	High	Negative	None	None	None
Structural						
Enclosed Pipe/Culvert	Low	None	None	Moderate	High	High
Lined Open Channels	Moderate	None	None	Moderate	Moderate	High
Municipal Detention Basin	High	High	Slight	High	Moderate	Low

4. EVALUATION OF ALTERNATIVES

a. Zoning and Land Use

The majority of the undeveloped areas which are zoned for more intense future land uses are located within the Turkey Creek East, Silver Creek, McClelland, Turkey Creek Central, and Baker's Branch watersheds. Most of the undeveloped land is intended for low- to medium-density residential development. Turkey Creek East and Waterworks both contain some areas intended for industrial/commercial development, but are extensions of the existing industrial/commercial areas along Interstate 44.

Analysis of the runoff based on future development indicates that the impact of future developments on downstream drainage

structures does not necessitate a zoning change in these watersheds.

b. Flowage Easements

It is recommended that the City require dedication of flowage easements for all new or reconstructed conveyance elements, including natural channels retained in the system in developing areas, where the 10-year peak discharge exceeds 100 CFS. These easements should cover the overflow area for the element, whether open channel or enclosed system, determined as the 100-year flood elevation plus one foot. Limitations on permanent obstructions within the easement should be included in the dedication. Specific requirements for flowage easements are included in the proposed "Stormwater Management Criteria" document which has been furnished separately to City staff.

c. Regulatory Detention

The City's current drainage policies include the use of regulatory detention in connection with commercial development; however, continuation of this policy as currently applied is not recommended. In general, detention requirements should be based on actual need rather than an arbitrary rule. In most areas where existing problems have been identified, physical space for adequate detention facilities is not available and small, localized basins will not eliminate major problems. It is recommended, therefore, that the detention policy be revised as outlined in the "Stormwater Management Criteria" manual prepared as a separate document from this report.

As a result of the analyses conducted in connection with this study, we have identified certain areas, both interior and exterior to the City's corporate limits, where regulatory detection should regularly be required in connection with any significant new development. Those areas are depicted on Exhibit 1.

d. Removal of Improvements

The removal of improvements was not considered in any of the watersheds. Analysis did not reveal any cases where the cost of managing the water was disproportionately large compared to the value of improvements. Removing structures would not eliminate the street flooding and associated traffic problems or the need for improving the undersized downstream drainage system. Therefore, the removal of structures is not recommended except as a possible interim solution to structure flooding problems, or where demonstrated by subsequent analysis to be more cost-effective than constructing facilities to protect the improvements.

e. Conveyance Facilities

The recommended system improvements primarily involve enlarged or modified conveyance facilities, typically through replacement of existing facilities with larger pipes or box culverts. Open channels currently included in the system were generally retained with channel lining recommended in some instances.

f. Public Detention Facilities

The construction public detention facilities is included in the recommended plan of improvement where appropriate to reduce the extent and cost of downstream improvements.

B. CAPITAL IMPROVEMENT PROJECTS

The location of capital improvement projects recommended by the study to correct deficiencies in the existing drainage system are indicated on Exhibit 1. Projects include one or more deficient modeled reaches of the drainage system that have been grouped to define a project that is logically constructable as an entity and, when complete, will eliminate an existing deficiency within the drainage system.

Although all existing major drainage system components were included in the analysis and problem identification process, not all elements that fail to meet the proposed recommended hydraulic criteria for new construction are included in the project recommendations. Locations where deficiencies are indicated by the analysis but where there are no apparent or reported adverse effects are not recommended for improvement. In addition, facilities such as state highway culverts and privately-owned drainage facilities have not been recommended for improvement since the City does not have jurisdiction over those system elements.

Generally, only those system elements which are currently public facilities and where the existing deficiency has one or more of the following recurring adverse effects are included in the identified projects:

- Building flooding at 25 year or more frequent intervals.

- Overflow of public streets by the 2-year storm for a time duration greater than 15 minutes.

- Erosion on private property due to the direct discharge from public drainage facilities that, if permitted to continue, will eventually either endanger buildings or adversely affect the use of the property.

- Recurring nuisance and the lack of maintenance control created by the uncontrolled discharge of water collected in public right-of-way onto adjacent private property.

Forty-nine improvement projects are recommended to upgrade the existing municipal storm drainage system. Tables VI-2 and VI-3 summarize the projects and the costs included in the recommended improvements program; the total estimated cost of the recommended improvements is $20.782 million in current dollars.

Detailed information for each project is included immediately following this Part VI. It should be noted that the recommended improvements are limited to the major drainage system; there is without question a need for regular improvement to the minor system as well; definition of minor system improvement needs is beyond the scope of this study.

C. BASIS FOR COST ESTIMATES

Cost estimates for the recommended conveyance element improvements were prepared by the SYCOST computer model that generates planning grade estimates for both the capital and annual operating and maintenance cost of storm drainage system components. Although the program is capable of estimating land costs, the cost estimates for the recommended projects assume that all easements necessary for the construction and maintenance of improvements, including flowage easements, will be dedicated by property owners without charge to the City.

The time basis of cost estimates is July, 1996 with a corresponding Engineering News Record Construction Cost Index for the Kansas City Metropolitan Area of 5546. Recent price trends indicate that an annual cost escalation factor of 3 percent compounded annually is appropriate for escalating base year estimates to future year implementation schedules; that escalation rate is consistent with the current recommendations of the federal office of Management and Budget.

D. IMPROVEMENT PRIORITIES

Since there are many elements of the existing city-wide drainage system that do not provide an acceptable level of service, and all cannot be corrected "first," it is necessary for the City to establish priorities on an objective basis. The end objectives in setting these priorities should be to accomplish the following in order:

- Provide an equal minimum level of service to all citizens as soon as possible.

- Upgrade the drainage system as a whole to meet criteria standards for a higher level of service.

- Improve the system in order to yield the best practical benefit for the earliest investment.

- Accomplish the improvement in an order such that any isolated improvement does not add to an existing problem or create a new problem elsewhere.

- Directly benefit as many individual citizens as early as practical and reasonable to maintain continuing support for an orderly prioritized program of improving drainage service.

1. PRIORITY EVALUATION

Priority recommendations for capital improvement projects were formulated through use of the PRIOR computer model.

a. First Order

PRIOR uses the following factors and a calibrated scale of "priority points" to calculate a raw score of "priority points" for each project in the model:

(1) Frequency of Structure and Contents Damage.

(2) Relative Magnitude of Damage

(a) Structural and contents

(b) Erosion

(c) Nuisance

(3) Frequency of Hydraulic Inadequacy

(4) Effect on City Development

(5) Structural Condition of Existing Facility

(6) Magnitude of 10-year Hydraulic Deficiency

(7) Capital Cost per Benefitted Property

b. Second Order

After calculating the raw score, the model differentiates between projects having the same number of total points in the following order:

(1) Frequency of damaged is compared. Projects having the most frequent incidence of damage are assigned the highest priority. If there is no difference in this category then;

(2) Point scores in the structural and contents damage category are compared. Those projects having the higher score in this area are assigned the higher priorities. If there is no difference in this category then;

(3) Point scores in the category of capital cost per benefitted property are compared. Those projects having the lower cost per benefitted property are assigned the higher priority. If there is no difference in this category then;

(4) Point scores in the erosion damage category are compared. Those projects having the higher score in this area are assigned the higher priorities. If there is no difference in this category then;

(5) Point scores in the nuisance category are compared. Those projects having the higher score in this area are assigned the higher priority.

(6) Point scores in the category of absolute project cost are compared. Those projects having the lower cost are assigned the higher priority.

c. System Adjustments

After second order differentiation of priority without regard to the physical hydraulic relationship between projects, priorities are reevaluated on a "system" basis to insure that implementation of a high priority upstream project will not unreasonably worsen downstream conditions. Worsened conditions are defined as:

- Increasing discharge to an area already experiencing structure and contents damage at 10-year or more frequent return periods; or

- Increasing discharge to downstream areas having 2-year or less return period capacity, regardless of any associated damage; or

- Increasing discharge to a downstream area experiencing erosion damage at return periods more frequent than 5 years.

2. RECOMMENDED PLAN PRIORITIES

Exhibit 1 presents the recommended priorities for the recommended improvement projects; the recommended prioritization is also included on the project descriptions following this Part VI. It is important to note that the willingness of potentially benefitted property owners to dedicate easements for the construction of improvements is not a model factor. It is an important factor as the City implements an improvement plan. In addition, the prioritization does not consider the potential influence of other improvement programs on the desired relative timing of the storm drainage improvement projects. For those reasons, the priorities should not be considered as absolute.

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PART VII

OPERATION AND

MAINTENANCE

PART VII

OPERATION AND MAINTENANCE

A. GENERAL

Continuing regular maintenance of the storm drainage system is essential to assure that the system hydraulic capacity is available when storm runoff occurs. It is equally essential to preserve the considerable capital value of the system.

Generally, there is not a clear and accepted line of demarcation between street and drainage maintenance activities and budgets. Maintenance of the storm drainage system shares a need for many of the same types of equipment and labor as is common to sanitary sewer and street maintenance. Because of these common factors, it is logical to assign responsibility for storm drainage system maintenance to the Public Works Department.

The existing maintenance condition of Joplin's drainage system at the time of the field observation activities gave clear evidence of the lack of any systematic maintenance program. Conditions were characteristic of those developing over time under a maintenance program generally limited to responding to emergencies "after-the-fact" on the basis of complaints.

B. MAINTENANCE RESPONSIBILITY

The City currently assumes maintenance responsibility for improved drainage system facilities within the corporate limits and will continue to do so in the future. These facilities include enclosed pipe-inlet systems, road culverts, roadside ditches within city street right-of-way, and improved open channels, generally those which are concrete or riprap-lined. Maintenance of public detention facilities, if constructed in the future, will become the responsibility of the City.

Maintenance of natural or unimproved channels is currently not performed by City personnel which will continue to be policy in the future. Upkeep

of these facilities is the responsibility of the private property owner(s) whose land abuts the channels.

C. ORGANIZATION AND EQUIPMENT

A "typical" storm sewer system maintenance/repair crew would be assigned by the City's Public Works Department and comprised of two laborers, a loader and a dump truck, all from the street maintenance division, with additional personnel and equipment available for specific, larger jobs as needed. This "typical" crew would be capable of performing many of the routine maintenance tasks, described on the following pages, for the existing drainage system.

As the City grows and the system expands, however, additional crews will be required just to perform the routine tasks. The following labor and equipment availability is recommended for eventual normal maintenance of the storm drainage system (see Table VII-1). These recommendations assume that the City will continue its policy of not performing regular maintenance along unimproved channels which is particularly labor intensive. In the event that policy is reversed, additional labor and equipment will be required.

TABLE VII -1

ORGANIZATION AND EQUIPMENT FOR STORM SEWER SYSTEM MAINTENANCE

ITEM	DESCRIPTION	NO.
1.0	LABOR	
1.1	Foreman	1
1.2	Laborers/Equipment Operators	4
2.0	EQUIPMENT	
2.1	Jet Rodder	1
2.2	Industrial Tractor/Loader Backhoe	1
2.3	Tractor/Mower	1
2.4	Concrete Mixer - 3-1/2 cu ft	1
2.5	Portable Generator	1
2.6	Air Compressor	1
2.7	Chain Saws	2
2.8	Truck, Dump Body	1
2.9	Truck, Flat Bed Utility or Pickup	1
2.10	Hand Tools	-

D. MAINTENANCE TASKS

There is not a clear line of demarcation between work classified as maintenance and that more properly classified as construction. City maintenance in the context of this study is defined as work necessary to preserve the capacity and function of an existing facility which can be performed by reasonably available conventional city equipment and labor forces. The following types of maintenance tasks are those necessary to effectively maintain the storm drainage system.

1. INSPECTION

System facilities should be routinely inspected and maintenance scheduled to correct deficiencies noted during the inspection. A systematic method of record keeping should be initiated to record the

inspection and track the maintenance history of individual system components. Routine inspection can be performed by public works maintenance staff personnel with special follow-up inspections by staff professional engineers or consultants in those infrequent instances that the routine inspection identifies any unusual structural or operational defect in the facility. The following is the recommended inspection schedule for the various drainage facilities.

FACILITY TYPE	INSPECTION FREQUENCY
Inlet/Catch Basins	Annual
Open Channels	Annual
Culverts on Open Channels	Annual
Roadside Ditches	Annual
Detention Basins	Annual

Interior inspection of pipe storm sewers is not routinely necessary; however, those sections of pipe having a known history of becoming obstructed due to the entry of debris and sediment from upstream open ditches should be inspected annually. Television inspection is recommended for old existing pipe and box structures not accessible for visual inspection.

2. ROADSIDE DITCHES

Normal recurring maintenance needs are removal of sediment and debris from the ditch and driveway culverts. Although located in street right-of-way, regular mowing in season should be considered the responsibility of the abutting property owner. It is also recommended that replacement of private driveway culverts be the responsibility of the property owner. Since many driveway culverts are older, partly corroded metal pipes, a high initial incidence of failure during or after clean-out should be expected.

The rate of ditch sedimentation will vary across the City. Where grades are steep, the rate will be relatively slow while flatter ditch slopes will result in a higher sedimentation rate. A maintenance interval of two years is suggested for initial programming until

experience in specific areas indicates the need to shorten or lengthen the time period.

3. CULVERTS ON OPEN CHANNELS

Normal recurring maintenance needs are the removal of debris and sediment. Multi-barrel culverts are most prone to the accumulation of obstructing sediment. In areas where maintenance of natural open channels is adequate, the maintenance requirements for culverts will decrease.

Structural repairs such as minor patching of surface spalls, joint sealing, etc., will be necessary during the service life of the structures at irregular intervals. Sediment removal should be expected on an annual basis.

4. LINED OPEN CHANNELS

Annual maintenance requirements are usually limited to the removal of debris. Periodic surface patching and repair of joints in concrete-lined sections should be performed on an as-needed basis. Expansion joints and cracks that permit vegetation to lodge and produce root damage should be treated with an appropriate herbicide to control vegetation. Replacement or repair of lining material in riprap or gabion-lined channels should also be performed on an as-needed basis. Brush or other vegetation which obstructs the channel or causes deformation or displacement of the lining should be cut periodically.

Scheduled storm drainage system maintenance activities, especially those related to the maintenance of open channels, should be planned for the months of November through April to both assure maximum system capacity during the season of heaviest normal rain, and to take advantage of the most favorable conditions for accessibility of the work. Such seasonal scheduling of maintenance is also most conducive to efficient overall utilization of staff and equipment.

E. ANNUAL MAINTENANCE

The City's existing major drainage system includes 59.3 miles of pipe, culverts, and open channels. Average annual expenditures from maintenance of the storm drainage system in Joplin, excluding regular maintenance of unimproved open channels should be on the order of $200,000. With regular maintenance (snagging, etc.) of unimproved open channels, the average annual maintenance expenditures should be on the order of $300,000.

F. MAINTENANCE OF PRIVATE SYSTEM FACILITIES

Regular maintenance of all storm drainage facilities is necessary to insure the system's continuing function at an acceptable level of service. However, maintenance of components which are the responsibility of private property owners is often neglected, especially along natural channels, creating potential drainage problems. Depending on the size and location of the element, its failure to function properly can affect the system as a whole and impact a much larger group than just the residents in the immediate area. Maintenance of private components is generally difficult to regulate or enforce, though, since no ordinances currently exist that explicitly require the performance of such tasks. Annual maintenance of the natural channels comprising the major drainage system would require approximately 2,240 hours. This results in an annual cost to the City of roughly $100,000 for maintaining the natural channels alone. This assumes that drainage easements are acquired from the private property owners and the City is then responsible for maintenance. Alternative methods of dealing with this issue suggested in the following paragraphs will require revisions to municipal ordinances and codes.

To insure that adequate private storm drainage maintenance is performed, the City may want to consider regulations similar to existing codes requiring upkeep of houses, yards, buildings, vacant lots, etc. This approach would include periodic inspections of private drainage facilities, which could be incorporated into the routine inspections recommended for public facilities, with notices of required maintenance issued to property owners as necessary. Once the owner has been notified, a reasonable period of time would be allowed to accomplish the work and a

reinspection made at the end of the period. In the event the required maintenance has not been completed, City crews could perform the work and bill the property owner for the actual labor, equipment and administrative costs. Fines could also be imposed either in addition to, or in lieu of, the City billing the owner for the work. In extreme cases, a "last resort" approach could include revoking the occupancy or use permit for the property or possibly even condemning the property if the problems caused by the lack of maintenance are serious enough.

For private detention facilities, requiring an annual operating permit is also a possible solution to controlling private maintenance. The process would include an annual inspection, notices of required maintenance and follow-up activities similar to those for conveyance facilities. A nominal fee could be required to cover the City's inspection and administrative costs although this would, in a sense, penalize detention systems if similar charges are not required for conveyance facilities.

In addition to the requirements for maintaining the actual drainage system, it is recommended the City adopt a policy and appropriate regulations requiring erosion control plans for all new construction projects. These plans can be as simple as requiring a line of hay bales along the edges of a residential building lot, to a more complex system of silt fencing, filters and siltation ponds on larger projects. This recommendation is intended to prevent siltation on public streets and in the existing downstream drainage system which increases the City's maintenance program and costs.

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PART VIII

FUNDING

PART VIII

FUNDING

A. GENERAL

This section considers alternative methods of funding the City of Joplin's storm drainage system, considering not only the recommended improvements to the major drainage system, but also regular improvements to the minor drainage system and the cost for proper maintenance of the entire system.

The time span over which the capital improvement program is accomplished affects both the cost of the program and the choice of method, or combination of methods, for developing revenue to support the program. Even though it would be desirable to correct all present drainage problems immediately, it is not a practical concept. Besides the financing issues, the City staff available to administer the capital improvement program is a constraint on the speed at which improvements can be made. For the purposes of this analysis, it has been assumed that the desired duration of a capital program including all improvements to the major drainage system recommended in Part VI is no greater than 10 years.

B. FINANCING ALTERNATIVES

There are in essence but two alternatives for funding the recommended improvement projects: cash-basis and debt financing. The cash-basis method assumes that improvements will be constructed only as adequated funds become available from the identified revenue sources. Debt financing would be accomplished through the issuance of municipal bonds of one of the following types: general obligation bonds, revenue bonds and special assessment bonds. Of course, should the City opt to finance the improvement program through the issuance of bonds, it is recommended that a qualified financial advisor be consulted to develop and assess specific proposals and schedules.

1. GENERAL OBLIGATION BONDS

Missouri statutes require the approval of a four-sevenths majority of the voters for issuance of general obligation bonds, which are then typically retired by proceeds from ad valorem taxes.

Under the Missouri Constitution, general obligation bonded indebtedness is limited to 10 percent of the most recent assessed valuation. Given that limitation, the legal debt margin in Joplin is roughly $22,000,000 (based on a November, 1993 total assessed valuation of roughly $220,000,000). The City has recently approved the issuance of $20,000,000 in general obligation bonds for improvements at the Wastewater Treatment Plant. As a result, the use of general obligation bonds is not considered an implementable strategy for the proposed storm drainage improvements.

2. REVENUE BONDS

Revenue bonds require the approval of a simple majority, and are applicable to this discussion assuming the creation of a stormwater utility. Such bonds may be issued to finance improvements to any City utility and are payable solely for the fees collected for the use of that utility. Disadvantages of revenue bonds as compared to general obligation bonds include: greater issuance costs, higher interest rates, and the requirement to fund a debt-service reserve account when the bonds are issued.

Unlike general obligation bonds, indebtedness due to the issuance of revenue bonds are not limited by the Missouri Constitution. However, the use of such bonds can affect the City's credit rating, potentially impacting the rates for both the revenue bonds and any future issuance of general obligation bonds.

3. SPECIAL ASSESSMENT BONDS

The third alternative, special assessment bonds, are also subject to voter approval, and are retired by a combination of city-at-large contributions and special assessments on benefitted properties. Difficulties in application of this alternative are primarily associated with determination of the appropriate relative contributions of city-at-large and special assessment

revenues, and in distribution of assigned benefits to specially assessed properties on an equitable basis. Such bonds have not been typically employed for storm drainage improvements in Missouri, and would tend to place a disproportionate burden on assessed properties. As a result, this potential financing method is not further considered.

C. POTENTIAL REVENUE SOURCES

A number of traditional and innovative financing techniques are available to the City to fund its proposed program, each with its own legal restraints. Explicit statutory authority exists to utilize traditional funding sources such as ad valorem taxes, special assessments, sales taxes, occupational taxes and fees and excise taxes. In addition, authority to utilize innovative funding techniques exists pursuant to the City's home rule power or pursuant to authority implied from specific statutory grants of power including creation of a stormwater utility and imposition of impact fees on new development to recoup the cost of public facilities necessary to support new development. At this time there are no known grants or subsidies available from either state or federal sources specifically for funding storm drainage improvements. Community Development Block Grants can include storm drainage improvements which are incidental to grant projects but are not intended to fund drainage projects as such. There have also been matching funds for storm drainage improvements made available from the federal Economic Development Administration for certain projects in which the potential for urban redevelopment and jobs creation had been limited by the lack of an effective storm drainage system.

1. SALES TAX

The City of Joplin's current sales tax rates include: a 1-percent sales tax with revenues applied to the City's general fund; a 1/2-percent sales tax for transportation improvements; and a 1/8-percent sales tax for funding the "911" emergency response system. Sales taxes in the City of Joplin currently generate roughly $8.7 million annually for each 1-percent sales tax increment.

2. STORMWATER UTILITY

Although commonly utilized in other parts of the country, the utility concept relative to the improvement, operation and maintenance of a municipal storm drainage system has not been extensively employed in the Midwest thus far. In recent years, however, the cities of Wichita, Olathe, Topeka, Manhattan and Lawrence, Kansas and Columbia and Kansas City, Missouri have implemented the stormwater utility concept. The City of Kansas City, Kansas is now planning the conduct of feasibility study to investigate the advantages and disadvantages of a stormwater utility, and to develop an implementation plan and a probable user fee/rate for such a utility. Brief summaries of some of these existing utilities, including basic identification of the rate base and annual income, are included as an appendix to this Part VIII for reference. The potential annual income to be derived from such a source would be directly dependent upon the basic rate(s) established by the City.

The stormwater utility can act as the organizational unit for all stormwater management activities, including implementation of the stormwater management plan policies, oversight of the completion of the associated capital improvement projects, and continuing management and maintenance of the City's drainage system. The authority to charge user fees through a stormwater utility for the use of stormwater services or facilities is derived from the City's authority to tax. Therefore, utility rates need not be restricted to use on facilities which are needed due to new development. Revenue can generally be used for any service or facility directly related to stormwater management including planning, consultant services, educational programs, administrative costs, water quality monitoring, Best Management Practices (such as street sweeping) and capital facility costs. Utility revenues must be deposited in a dedicated fund, earmarked solely for stormwater management activities, which can be restricted from use for other governmental purposes. A dedicated revenue source also enables the City to issue revenue bonds to pay for the cost of major capital projects if that is determined to be a desirable financing method.

Stormwater utility rates generally include two primary components: user fees and development or connection charges. Rates charged by utilities must be reasonable, just, nondiscriminatory, and uniform within a defined class of users. The user fee is normally based on the relative contribution of runoff to the storm sewer system for general categories of individual properties determined by the amount of impervious, or improved, area on each parcel. The development or connection charge should be tied to the cost for improvements to the storm drainage system necessitated by the development.

A common approach in the determination of user fees is definition a basic unit of measurement, the Equivalent Residential Unit (or ERU); the imervious area associated with a typical single family residential dwelling unit is determined, and the number of ERU's for other classes of land use established relative to the ERU. Billings to any given property are on the basis of the number of ERU's associated with the property. The number of ERU's for a given classes of residential properties can be varied based on the total impervious area relative to the ERU.

The structure of impact or development fees must be carefully tailored to ensure that a relationship exists between the required fee and the burden imposed on the community by the new development. These financing techniques can equitably and defensibly be used only to address demands for new or expanded public facilities created by new growth in a developing area, not the correction of existing drainage problems (which is the focus of the capital improvement program recommended in Part VI).

In the City of Joplin, one possible application of impact or development fees would be to finance the development of municipally-constructed stormwater detention facilities of a regional scale, in lieu of the direct construction of regulatory detention by developers intended to control runoff from their development only. As the construction of such facilities would be in lieu of regulatory detention, and the cost for those facilities is not included in the recommended capital program, the potential income from such fees is excluded from this discussion.

Analysis of the potential income from a stormwater utility, and definition of associated utility rates and income, is beyond the scope of this study, as it requires the specific, extensive analysis of all available land use data. However, we would anticipate, based on a limited review of such data as is presently available to us, that such a utility could generate approximately $650,000 per year for each $1.00/month/ERU. That figure is highly speculative in nature, but is in our opinion representative what might be realized from such a fee.

3. CURRENT FUNDING

At present, the City of Joplin funds the maintenance and improvement of the storm drainage system from the City's general fund in the approximate amount of $500,000 per year.

D. ALTERNATIVES CONSIDERED

As might be inferred from the preceding discussion, there exists a wide variety of potential means for funding the improvement and maintenance of Joplin's City's storm drainage system. For this analysis, three basic alternatives have been considered in some detail. The first consists of a cash-basis approach to construction of the recommended major system capital improvement program, with revenues derived from a combination of the continuance of the City's existing funding, supplemented by an additional sales tax for construction of the capital improvement program over a 10 year period. The second consists of the potential establishment of a stormwater utility, with proceeds from the utility fees used to finance all stormwater-related activities in Joplin; revenue bonds, retired by proceeds from the utility, would be issued to accelerate the major system improvements for completion within a 5 year period. The third alternative consists of establishment of a stormwater utility, with proceeds from the utility fees used to finance all stormwater-related activities, including major system capital improvements completed over a 10 year period on cash-basis.

1. PROGRAM COSTS

The basic program costs considered in the analysis include: an average annual amount of $250,000 for maintenance of the City's storm drainage system; an average annual amount of $250,000 for improvements to the minor drainage system in the City (e.g.,

necessary improvements not included in the scope of the major system capital improvement program recommended in Part VI); and those funds necessary for completion of the major system capital improvement program.

2. CASH-BASIS FUNDING WITH SALES TAX

For this alternative, it is assumed that the City will continue its current general-fund contributions to storm drainage system maintenance and construction (in the current amount of $500,000 per year), with construction funding utilized for minor system improvements, supplemented by a new sales tax for construction of the recommended major system improvements. The total estimated capital cost of the major system improvement program is $20.782 million, in current dollars. Average annual expenditures over a 10-year period necessary to complete those improvements would thus be $2.08 million. A 1/2 percent sales tax would be expected to generate roughly $2.175 million in its first full year.

A cash-flow analysis for this alternative is presented in Table VIII-1. That analysis is developed upon the assumption of a fixed annual general-fund contribution of $500,000; all other revenues and expenditures are escalated at an average annual rate of 3 percent. Annual expenditures for capital improvements are uniformly distributed (on the basis of current dollars) throughout the proposed 10-year duration of the capital improvement program (and sales tax life). The data summarized in Table VIII-1 verifies the adequacy of a 1/4-percent sales tax, coupled with continuation of the current general-fund expenditures, to fund the proposed capital improvement program, ongoing minor system improvements, and operation and maintenance of the City's storm drainage system.

3. REVENUE BONDS WITH STORMWATER UTILITY

Program costs for this alternative are generally as described above, with the exception that there would be additional costs for debt service on bonds, and additional administrative costs for establishment and operation of the utility. An average annual allowance of $100,000 (in current dollars) is made for the additional administrative costs, primarily for two additional

positions on City staff (stormwater utility engineer and clerical assistant) and billing costs. Total debt service on revenue bonds is estimated based on a 20-year term and a 7 percent interest rate. A cash-flow and financing analysis for this alternative is presented in Table VIII-2. That analysis is based on completion of the major system improvements in a five-year period, and indicates that the annual revenue from the utility would need to be roughly $2.7 million per year (applied in the first year, assumed to grow at 2 percent per year thereafter as the City grows). It is anticipated that a utility billing of roughly $4.00 per ERU per month would be needed to generate that level of income; as earlier discussed, that estimated ERU charge is quite preliminary. Final determination of the rate would require extensive additional analysis.

3. CASH-BASIS FUNDING WITH STORMWATER UTILITY

For this alternative, it is assumed that a stormwater utility would be implemented, and that existing general fund contributions to storm drainage system construction and maintenance would end. The recommended major system improvements would be completed on a cash basis over a 10 year period. A cash flow analysis for this alternative is presented in Table VIII-3; that analysis indicates the need for an initial annual income from the utility of $2.8 million.

* * * * *

TABLE VIII–1

JOPLIN, MISSOURI STORMWATER MANAGEMENT PLAN FINANCIAL WORKSHEET
10–YEAR CAPITAL IMPROVEMENTS PROGRAM FINANCED BY 1/4% SALES TAX

CASHFLOW

Cashflow Table

Line No.	System Operations	1	2	3	4	5	6	7	8	9	10	Increase
1	Revenues – 1/4% Sales Tax	2,175,000	2,240,300	2,307,500	2,376,700	2,448,000	2,521,400	2,597,000	2,674,900	2,755,100	2,837,800	3.00%
2	General Fund Contribution	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	0.00%
3	Storm Drainage Expenditures											
	a Maintenance incl. maint crew salaries,equip.,etc.	250,000	257,500	265,200	273,200	281,400	289,800	298,500	307,500	316,700	326,200	3.00%
	b Minor System Improvements	250,000	257,500	265,200	273,200	281,400	289,800	298,500	307,500	316,700	326,200	3.00%
	Total	500,000	515,000	530,400	546,400	562,800	579,600	597,000	615,000	633,400	652,400	
4	Outstanding Debt Service	0	0	0	0	0	0	0	0	0	0	
	Proposed Debt Service:											
	Year / Month / Amount / Type / Interest / Term											
5	1 / 1 / 0	0	0	0	0	0	0	0	0	0	0	
6	2 / 1 / 0		0	0	0	0	0	0	0	0	0	
7	3 / 1 / 0			0	0	0	0	0	0	0	0	
8	4 / 1 / 0				0	0	0	0	0	0	0	
9	5 / 1 / 0					0	0	0	0	0	0	
10	6 / 1 / 0						0	0	0	0	0	
11	7 / 1 / 0							0	0	0	0	
12	8 / 1 / 0								0	0	0	
13	9 / 1 / 0									0	0	
14	10 / 1 / 0										0	
15	Total Proposed Debt Service	0	0	0	0	0	0	0	0	0	0	
16	Total Operating Expenses	500,000	515,000	530,400	546,400	562,800	579,600	597,000	615,000	633,400	652,400	
17	Annual Balance	2,175,000	2,225,300	2,277,100	2,330,300	2,385,200	2,441,800	2,500,000	2,559,900	2,621,700	2,685,400	
	Major Capital Improvement Financing											
19	Beginning Balance – Capital Funds	0	96,800	181,554	253,892	313,286	359,454	392,051	410,571	414,547	403,646	
20	Bond or Note Issue	0	0	0	0	0	0	0	0	0	0	
21	Issuance Costs	0	0	0	0	0	0	0	0	0	0	
22	Reserve Fund	0	0	0	0	0	0	0	0	0	0	
	Revenue Available for Capital Funds	2,175,000	2,225,300	2,277,100	2,330,300	2,385,200	2,441,800	2,500,000	2,559,900	2,621,700	2,685,400	
23	Interest Earnings – Capital Funds	0	0	0	0	0	0	0	0	0	0	
24	Total Available Capital Funds	2,175,000	2,322,100	2,458,654	2,584,192	2,698,486	2,801,254	2,892,051	2,970,471	3,036,247	3,089,046	
25	Major Capital Improvements	2,078,200	2,140,546	2,204,762	2,270,905	2,339,032	2,409,203	2,481,479	2,555,924	2,632,602	2,711,580	
26	Ending Balance – Capital Funds	96,800	181,554	253,892	313,286	359,454	392,051	410,571	414,547	403,646	377,466	

TABLE VIII-2

JOPLIN, MISSOURI STORMWATER MANAGEMENT PLAN FINANCIAL WORKSHEET
5-YEAR CAPITAL IMPROVEMENTS PROGRAM FINANCED BY 20-YEAR REVENUE BONDS

CASHFLOW

Cashflow Table **********

Line No.	System Operations						1	2	3	4	5	6	7	8	9	10	Increase
1	Revenues – Stormwater Utility Fees @ $4/ERU						2,680,000	2,733,600	2,788,300	2,844,100	2,901,000	2,959,000	3,018,200	3,078,600	3,140,200	3,203,000	2.00%
2	Operating Fund Interest Earnings						0	0	0	0	0	0	0	0	0	0	0.00%
3	Stormwater Utility Expenses																
	a Administrative incl. engr & clerk salaries, rent, etc.						100,000	103,000	106,100	109,300	112,600	116,000	119,500	123,100	126,800	130,600	3.00%
	b Maintenance incl. maint crew salaries,equip.,etc.						250,000	257,500	265,200	273,200	281,400	289,800	298,500	307,500	316,700	326,200	3.00%
	c Minor System Improvements						250,000	257,500	265,200	273,200	281,400	289,800	298,500	307,500	316,700	326,200	3.00%
	Total						600,000	618,000	636,500	655,700	675,400	695,600	716,500	738,100	760,200	783,000	
4	Outstanding Debt Service						0	0	0	0	0	0	0	0	0	0	
	Proposed Debt Service:																
	Year	Month	Amount	Type	Interest	Term											
5	1	1	11,000,000	Revenue	7.00%	20	1,038,320	1,038,320	1,038,320	1,038,320	1,038,320	1,038,320	1,038,320	1,038,320	1,038,320	1,038,320	
6	2	1	0	Revenue	7.00%	20		0	0	0	0	0	0	0	0	0	
7	3	1	0	Revenue	7.00%	20			0	0	0	0	0	0	0	0	
8	4	1	9,000,000	Revenue	7.00%	20				849,540	849,540	849,540	849,540	849,540	849,540	849,540	
9	5	1	0	Revenue	7.00%	20					0	0	0	0	0	0	
10	6	1	0	Revenue	7.00%	20						0	0	0	0	0	
11	7	1	0	Revenue	7.00%	20							0	0	0	0	
12	8	1	0	Revenue	7.00%	20								0	0	0	
13	9	1	0	Revenue	7.00%	20									0	0	
14	10	1	0	Revenue	7.00%	20										0	
15	Total Proposed Debt Service						1,038,320	1,038,320	1,038,320	1,887,860	1,887,860	1,887,860	1,887,860	1,887,860	1,887,860	1,887,860	
16	Total Operating Expenses						1,638,320	1,656,320	1,674,820	2,543,560	2,563,260	2,583,460	2,604,360	2,625,960	2,648,060	2,670,860	
17	Annual Balance						1,041,680	1,077,280	1,113,480	300,540	337,740	375,540	413,840	452,640	492,140	532,140	
	Major Capital Improvement Financing																
19	Beginning Balance – Capital Funds						0	6,703,400	3,703,648	489,633	4,267,303	10,868	394,358	832,248	1,327,228	1,882,298	
20	Bond or Note Issue						11,000,000	0	0	9,000,000	0	0	0	0	0	0	
21	Issuance Costs						(275,000)	0	0	(225,000)	0	0	0	0	0	0	
22	Reserve Fund						(1,038,320)	0	0	(849,540)	0	0	0	0	0	0	
	Revenue Available for Capital Funds						1,041,680	1,077,280	1,113,480	300,540	337,740	375,540	413,840	452,640	492,140	532,140	
23	Interest Earnings – Capital Funds						131,440	204,060	82,230	93,260	83,890	7,950	24,050	42,340	62,930	85,930	
24	Total Available Capital Funds						10,859,800	7,984,740	4,899,358	6,809,113	4,688,933	394,358	832,248	1,327,228	1,882,298	2,500,368	
25	Major Capital Improvements						4,156,400	4,281,092	4,409,525	4,541,811	4,678,065	0	0	0	0	0	
26	Ending Balance – Capital Funds						6,703,400	3,703,648	489,833	4,267,303	10,868	394,358	832,248	1,327,228	1,882,298	2,500,368	

TABLE VIII-3

JOPLIN, MISSOURI STORMWATER MANAGEMENT PLAN FINANCIAL WORKSHEET
10-YEAR CAPITAL IMPROVEMENTS PROGRAM FINANCED BY UTILITY, CASH-BASIS

CASHFLOW

Cashflow Table

Line No.	System Operations	1	2	3	4	5	6	7	8	9	10	Increase
1	Revenues - Stormwater Utility Fees	2,800,000	2,856,000	2,913,100	2,971,400	3,030,800	3,091,400	3,153,200	3,216,300	3,280,600	3,346,200	2.00%
2	General Fund Contribution	0	0	0	0	0	0	0	0	0	0	0.00%
3	Storm Drainage Expenditures											
	a Administrative incl. engr & clerk salaries, rent, etc.	100,000	103,000	106,100	109,300	112,600	116,000	119,500	123,100	126,800	130,600	3.00%
	b Maintenance incl. maint crew salaries,equip.,etc.	250,000	257,500	265,200	273,200	281,400	289,800	298,500	307,500	316,700	326,200	3.00%
	c Minor System Improvements	250,000	257,500	265,200	273,200	281,400	289,800	298,500	307,500	316,700	326,200	3.00%
	Total	600,000	618,000	636,500	655,700	675,400	695,600	716,500	738,100	760,200	783,000	
4	Outstanding Debt Service	0	0	0	0	0	0	0	0	0	0	
	Proposed Debt Service:											
	Year / Month / Amount / Type / Interest / Term											
5	1 / 1 / 0	0	0	0	0	0	0	0	0	0	0	
6	2 / 1 / 0		0	0	0	0	0	0	0	0	0	
7	3 / 1 / 0			0	0	0	0	0	0	0	0	
8	4 / 1 / 0				0	0	0	0	0	0	0	
9	5 / 1 / 0					0	0	0	0	0	0	
10	6 / 1 / 0						0	0	0	0	0	
11	7 / 1 / 0							0	0	0	0	
12	8 / 1 / 0								0	0	0	
13	9 / 1 / 0									0	0	
14	10 / 1 / 0										0	
15	Total Proposed Debt Service	0	0	0	0	0	0	0	0	0	0	
16	Total Operating Expenses	600,000	618,000	636,500	655,700	675,400	695,600	716,500	738,100	760,200	783,000	
17	Annual Balance	2,200,000	2,238,000	2,276,600	2,315,700	2,355,400	2,395,800	2,436,700	2,478,200	2,520,400	2,563,200	
	Major Capital Improvement Financing											
19	Beginning Balance - Capital Funds	0	124,236	226,124	303,921	355,690	379,498	373,417	335,210	262,636	153,443	
20	Bond or Note Issue	0	0	0	0	0	0	0	0	0	0	
21	Issuance Costs	0	0	0	0	0	0	0	0	0	0	
22	Reserve Fund	0	0	0	0	0	0	0	0	0	0	
	Revenue Available for Capital Funds	2,200,000	2,238,000	2,276,600	2,315,700	2,355,400	2,395,800	2,436,700	2,478,200	2,520,400	2,563,200	
23	Interest Earnings - Capital Funds @ 4%	2,436	4,434	5,959	6,974	7,441	7,322	6,573	5,150	3,009	101	
24	Total Available Capital Funds	2,202,436	2,366,670	2,508,683	2,626,595	2,718,531	2,782,620	2,816,690	2,818,560	2,786,045	2,716,744	
25	Major Capital Improvements	2,078,200	2,140,546	2,204,762	2,270,905	2,339,032	2,409,203	2,481,479	2,555,924	2,632,602	2,711,580	
26	Ending Balance - Capital Funds	124,236	226,124	303,921	355,690	379,498	373,417	335,210	262,636	153,443	5,165	

SUMMARY OF EXISTING STORMWATER UTILITIES

SUMMARY OF EXISTING STORMWATER UTILITIES

One of the many ways to administer and fund storm drainage system operation, maintenance, expansion and improvements is through the formation of a stormwater utility. Although utilized in other parts of the country rather extensively, this approach is relatively new to the Midwest. The basic concept is the same as for municipal water, wastewater or other utility organizations and is gaining acceptance in this area as public awareness of storm drainage issues increases.

Within this region several cities have established stormwater utilities. These include Lawrence, Olathe, Manhattan, Topeka and Wichita, Kansas, and Columbia and Kansas City, Missouri. Kansas City, Kansas is also investigating and evaluating implementation of a stormwater utility. The following are summaries of some of these utilities for reference and comparison.

CITY OF LAWRENCE, KANSAS

The City of Lawrence is in the early stages of development of a stormwater utility. The *Stormwater Master Plan,* completed by Burns & McDonnell in May 1996, outlined the basic structure of the proposed utility. The formation of the new utility was proposed to pay for capital improvements to the existing storm drainage system and to fund maintenance and staff positions for daily operations. Both the City and local property owner's have endorsed the utility, and implementation is currently underway. The proposed utility will be under the jurisdiction of the Director of Public works and will generate an estimated two million dollars annually.

The rate structure divides properties into four residential and six commercial classifications. Each property is assigned an Equivalent Residential Unit (ERU) based on the amount of total improved area within the property; described as follows:

Property Category	Total Improved Area/Parcel (square ft)	No. Of ERUs Billed
Single-family Residential	<1,200	0.67
	1,200 to 3,000	1.00
	>3,000	1.50
Multi-family Residential	N/A	0.67
Commercial	<10,000	2.5
	10,000 to 25,000	8.5
	25,000 to 50,000	18.0
	50,000 to 75,000	32.0
	75,000 to 100,000	44.5
	>100,000	Actual No. ERUs

The standard property (ERU equal to 1.00) is defined as 11,320 square feet of land with 1,888 square feet of total improved area. A monthly rate of $4.00 per ERU will be billed to each property owner through the City Water Department.

CITY OF OLATHE, KANSAS

Olathe's utility has been in operation for approximately five years. It was enacted by an ordinance which must be renewed annually in conjunction with the city's budget. Originally, the utility was implemented for and authorized to fund only storm drainage capital improvements. It's purpose has recently been expanded to include funding of utility staff positions and system maintenance. Currently the utility generates approximately $750,000 annually.

The rate structure is divided into two main categories, residential and non-residential, with the equivalent residential unit (ERU) based on 10,000 square feet of land area. All residential customers pay the same fee of $2.00 per month. Non-residential customers are further divided into classes based on increments of 20,000 square feet of land area. The fees range from $2.00 per month for 20,000 square feet or less, up to $100.00 per month (the maximum fee for any class) for over 500,000 square feet. Fees are billed through the City's water utility.

CITY OF TOPEKA, KANSAS

Topeka's stormwater utility began operation in 1993, and is under the jurisdiction of the Department of Public Works. Property is divided into two basic classifications, residential and nonresidential. Charges are based on Equivalent Residential Units which is defined as 2,018 square feet of impervious area. This impervious area includes all buildings, driveways, parking areas, etc. The basic rate for one ERU is $2.85 per month although all residential customers do not pay the same fee. The residential classification is further divided into three rate groups as follows.

Total Impervious Area	No. of ERU's	Monthly Billing
<1,500	0.65	$1.85
>1,500, <3,500	1.00	$2.85
>3,500	1.56	$4.45

All nonresidential properties are billed on the basis of the number of ERU's for the specific parcel calculated as the total impervious area (determined from aerial photo analysis) divided by 2,018. The total charge for a parcel is then determined by multiplying the number of ERU's by $2.85. Governmental entities, including the State of Kansas, pay stormwater utility fees. The only areas excepted are impervious surfaces in public rights-of-way (streets, highways, etc.) and impervious areas at the airfield.

Billings are included with the City's water billing. Actual charges are computed daily, with the result that payments vary slightly by month. Topeka's stormwater utility generates approximately $3.66 million per year.

CITY OF WICHITA, KANSAS

Wichita's stormwater utility operates similarly to Topeka's. It is also under the jurisdiction of the Department of Public Works with two basic classifications, residential and nonresidential,

although the residential classification is not further broken down as in Topeka. An ERU in Wichita is defined as 2,139 square feet with the monthly charge set at $1.66/month/ERU.

Residential customers are charged for one ERU, irrespective of lot or house size. Multi-family units also are charged one ERU per unit. Nonresidential properties are billed on the basis of the number of ERU's for the parcel times the basic ERU rate. Billings are handled as a separate line item on the City's water and sewer billing system. Governmental and tax-exempt properties are included in the rate base. Streets and highways are excluded. The airport, including the runway, is included in the rate base. Wichita's stormwater utility generates approximately $5.0 million per year.

CITY OF MANHATTAN, KANSAS

Manhattan's stormwater utility is presently funded through the imposition of a fee billed with the water and sewer billing. Residential properties, including multi-family units, are assessed at a monthly rate of $0.25 per living unit irrespective of lot or building size. Properties devoted to any use other than residential are assessed on the basis of total developed area (e.g., tract size), not impervious area. A total of six rate groups are defined with monthly fees varying from $1.30 for tracts less than or equal to 20,000 square feet, to $150.00 for tracts greater than 1,000,000 square feet. The campus of Kansas State University is specifically included in the rate base by direct reference in the ordinance.

Manhattan's stormwater utility presently generates approximately $112,000 per year. This amount, and the associated billing rates, was established as a start-up, or phase in, measure. The City's recently completed storm drainage master plan reviews the City's rates and rate base, and recommends adjustments or modifications necessary or desirable to properly fund the stormwater utility and recommended capital improvements.

CITY OF COLUMBIA, MISSOURI

Establishment of Columbia's stormwater utility, initial fee structure, and stormwater development

charge on new construction were authorized by a special election in 1993. The initial proposal was based on the need to fund a $5,000,000 storm drainage capital improvements program outlined in an earlier master plan.

The rate structure is based on four residential tiers with commercial property rates based on actual impervious area. The University of Missouri's properties are included in the utility customer base although they are billed a negotiated fee rather than charges based on actual impervious area.

Initially, the residential fee was $0.65 per month for all units and $4.00 per month for all nonresidential properties. The utility fees were revised in 1994 as indicated in the following table while development charges remained as originally approved. Annual revenues from the combination of utility fees and development charges are approximately $830,000.

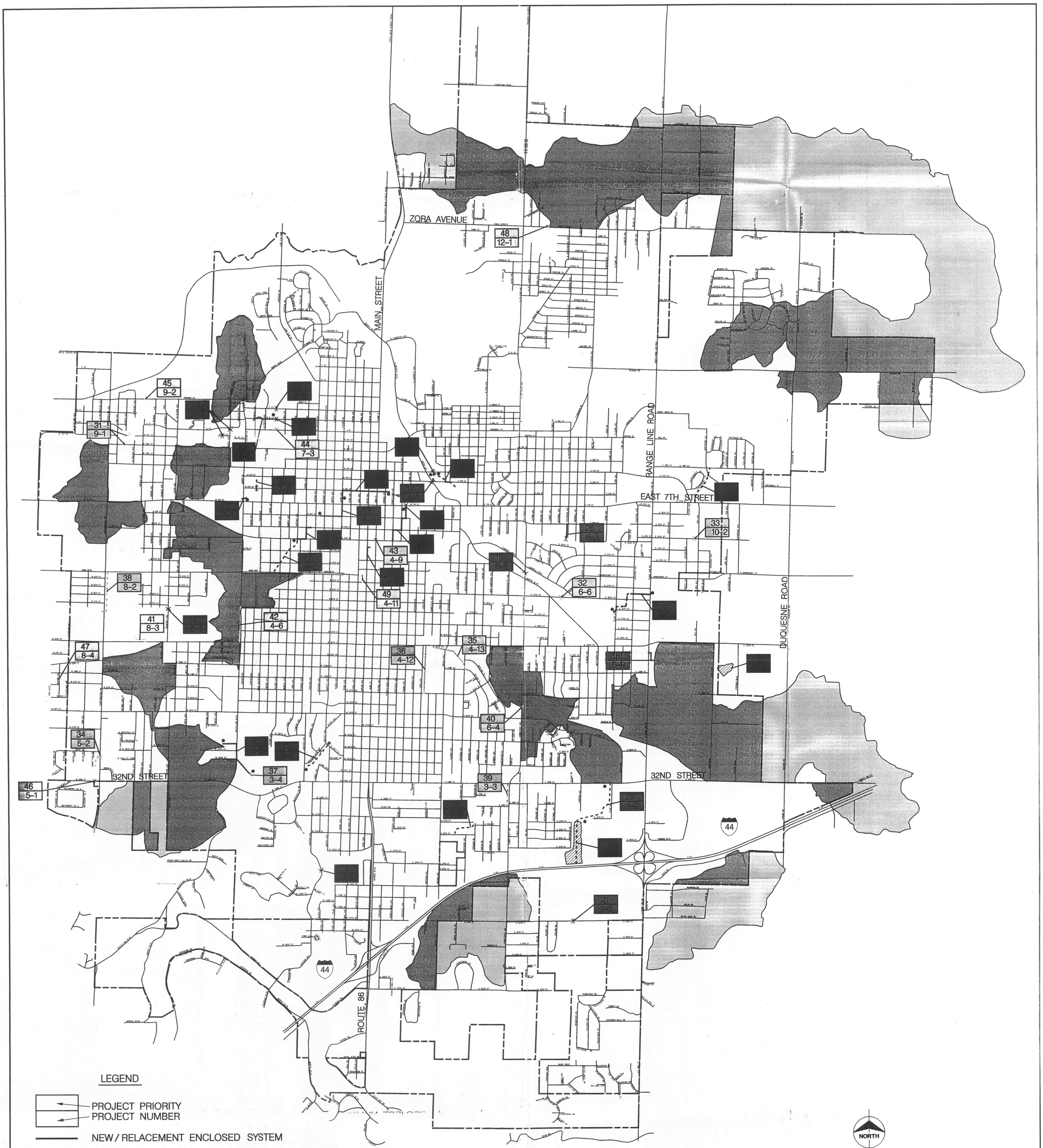
COLUMBIA, MISSOURI STORMWATER CHARGES

Utility Charges	
Multifamily dwellings with more than 4 units	$0.65/month
Single-family homes less than 750 sq. ft.	$0.65/month
Multifamily dwellings with 4 or fewer units	$0.85/month
Single-family homes 750 to 1,250 sq.ft.	$0.85/month
Single-family homes 1,250 to 2,000 sq.ft.	$1.15/month
Single-family homes more than 2,000 sq. ft.	$1.35/month
Non-residential uses of developed land	$4.00 or $0.04/100 SF imperv. area per mo., whichever is greater
Development Charges on New Building Permits	
Single-family homes and duplexes	$0.09/SF
Multifamily buildings, offices, schools, churches	$0.16/SF
Commercial and industrial	$0.195/SF
Use categories not listed above	$0.195/SF

The utility charges are based on "main floor area" as opposed to total impervious area per property and development charges on "total floor area." Total floor area is defined as the area within the perimeter of the outside walls of a building including basement area, main and upper floor areas, carports, garages, decks and porches. This development charge is similar in concept

to an impact fee although the rates are somewhat arbitrary and not based on the actual impact of increased impervious area on the existing drainage system. The charge is waived, however, for any property served by a private detention facility constructed in accordance with City criteria and privately maintained.

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LEGEND

- PROJECT PRIORITY / PROJECT NUMBER
- NEW / RELACEMENT ENCLOSED SYSTEM
- IMPROVED OPEN CHANNEL
- CULVERT REPLACEMENT
- DETENTION BASIN OR FLOWAGE EASEMENT
- PROJECT LIMITS

RECOMMENDED AREAS OF REGULATORY DETENTION (SEE REPORT TEXT)

- WITHIN CORPORATE LIMITS
- OUTSIDE CORPORATE LIMITS

PRIORITIES

- 1–10
- 11–20
- 21–30
- 31–40
- 41–49

NORTH

1200' 0' 1200' 2400'

SCALE IN FEET

EXHIBIT 1

RECOMMENDED STORM DRAINAGE IMPROVEMENTS

Burns & McDonnell

City of Joplin

JOPEXH01.DGN/11-JUN-97 10:56/MDH