Stormwater Master Plan

Hutchinson, Kansas

June 2000

Report

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Water Resource Engineers . . . . WRE
Watershed Management Model . . . . WMM
Zinc . . . . Zn

Executive Summary

Introduction

The City of Hutchinson retained Camp Dresser & McKee Inc. (CDM) to prepare a Stormwater Master Plan (SWMP) encompassing the area within the City boundaries. The goals of the SWMP are to:

- Control flooding and erosion;
- Control pollution from runoff to protect water quality;
- Identify operation and maintenance needs;
- Protect aquifer recharge where possible;
- Identify environmental benefits;
- Consider long term financing options; and
- Establish community acceptance.

The SWMP identifies improvements to the City's stormwater management system that meet the above goals. The improvements address both stormwater quantity and quality issues for present and future land use. The improvements solve both current problems and potential problems related to new development.

The City currently experiences frequent street ponding and overbank flooding in many areas in the central and west portion of the City due to an inadequately sized stormwater system. In addition, the Environmental Protection Agency (EPA) recently prepared National Pollutant Discharge Elimination System (NPDES) regulations that will require the City of Hutchinson to comply in the near future with non point source water quality standards established by the EPA. This SWMP identifies improvements that control the existing frequent ponding problems and provide best management practice (BMP) options that will improve water quality and help the City comply with the future NPDES regulations.

Figure ES-1 shows the City's study area and Primary Stormwater Management System (PSWMS) which consists of major creeks, ditches, culverts, storm drains, and roadways. CDM identified reported problem areas, evaluated the City's PSWMS, identified and quantified system capacities and deficiencies, evaluated five conceptual improvement alternatives, prepared cost estimates for the five alternatives, and ranked the improvements according to priority needs. CDM worked with BG consultants, a local engineering firm, to complete the tasks.

Levels of Service

Stormwater management has become a complex national issue in the last decade. In the past, ditching and draining to convey stormwater away from development, coupled with filling of floodplains and wetlands, was the accepted practice. Over the years, flood damages along with adverse impacts to water quality, fisheries, scenic areas, recharge areas, and wildlife habitats have forced a change in the accepted approaches to manage stormwater.

Hutchinson is similar in characteristics to other communities regarding stormwater service. Many of the City's older stormwater management systems provide inadequate flood protection for streets and provide little or no treatment of the runoff prior to release. This is due mainly to the "piecemeal approach" to stormwater management and the aging condition of the existing infrastructure.

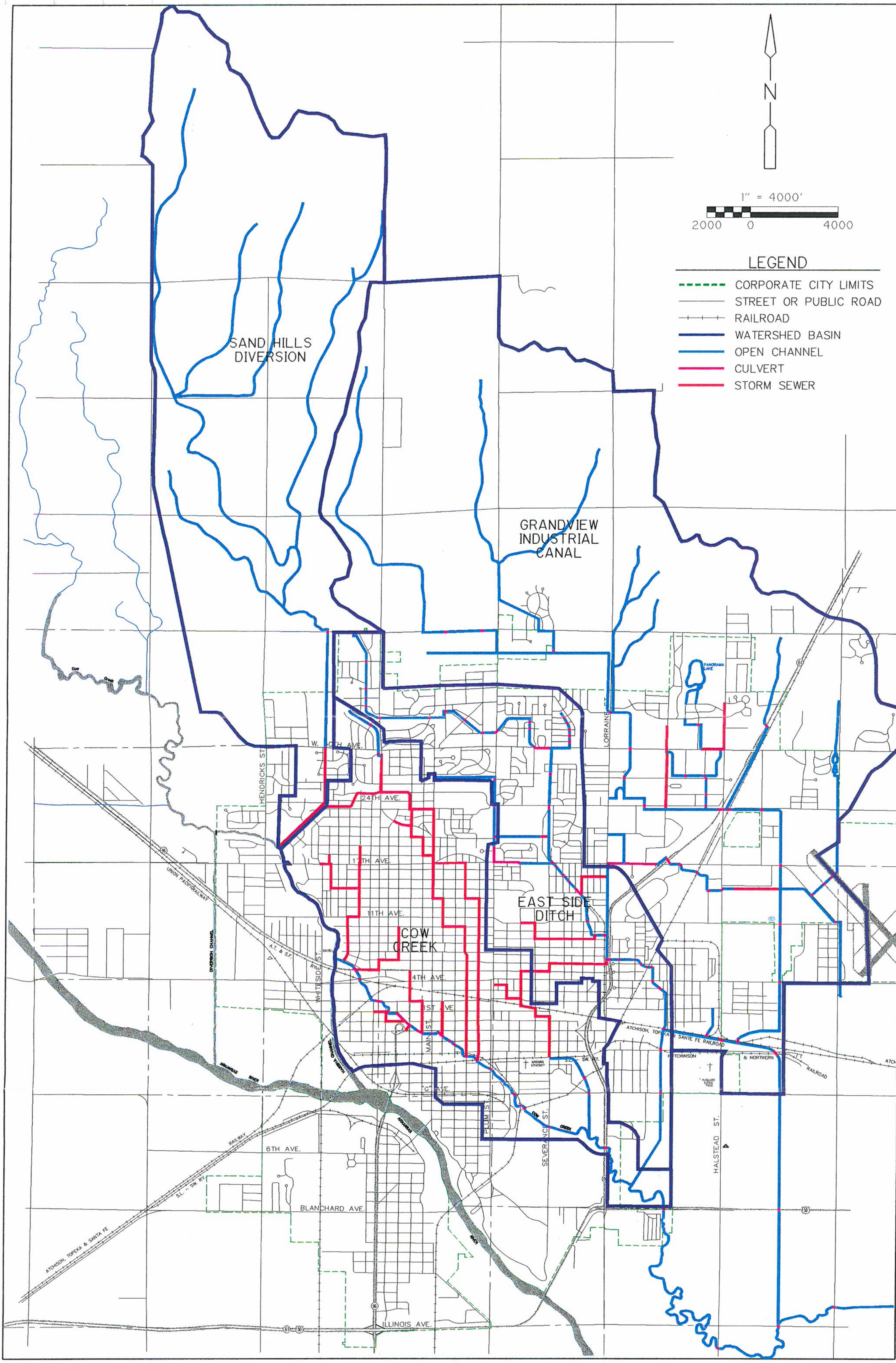

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Figure No. ES-1
PRIMARY STORMWATER MANAGEMENT SYSTEM
STORMWATER MASTER PLAN
HUTCHINSON, KANSAS

Level of Service (LOS) is a measure of benefit or protection provided by stormwater systems. Proper LOS decisions for water quantity (flooding) and water quality protection are essential for the City. LOS decisions set the goals for a Capital Improvement Program (CIP) that establishes the intent of public involvement. LOS recommendations in this plan have been based on CDM's evaluations of Hutchinson and experience with similar programs. They have been formulated to protect or enhance public safety and to provide benefits for the goals of the program.

Water Quantity LOS

The LOS for water quantity (flood control) retrofit is an essential decision for the City because it will directly affect the size and cost of facilities. Stated simply, the improvements are developed to protect public safety by keeping major roads passable and protecting buildings from flooding. **Figure ES-2** shows examples of various water quantity LOS. For example, Class D provides for flood protection of first-floor elevations (FFE), and arterial roads, while Class C provides control of flood waters to less than 0.5 feet over the arterial road crowns. **Table ES-1** provides a list of water quantity LOS goals used in the alternatives evaluations.

Table ES-1
Water Quantity Levels of Service
Flood Protection Goals and Classes [1]

	10-Year		*25-Year*		*100-Year*	
Structure/ Facility	*10-Year*	*Class*	*25-Year*	*Class*	*100-Year*	*Class*
Houses/ Buildings	<FFE[2]	E	<FFE	E	<FFE	E
Arterial Roads[3]	½ W[4]	B	Crown	C	<0.5 ft	C
Other Roads[5]	<0.5 ft	D	<0.75 ft	E	<1 ft	NA

(1) All storm durations are 24 hours.
(2) Peak flood stages less than the FFE based on available data.
(3) Roads with four or more travel lanes, or roads that are the only access to a respective area/development.
(4) Flood inundation limited to each side of the road such that half of the roadway width (W) or one travel land width is not flooded.
(5) Other roads that are not critical for evacuation, but that will be used to estimate encroachment of FFEs.

As defined by the scope of services, CDM evaluated five alternative solutions, including a "no action" alternative. For urban areas, a diminishing return for public expenditures occurs sooner than for new developments due to severe space constraints, and low-lying first-floor and road elevations. It is also important to note that some storm events greater than the 100-year may exceed LOS goals.

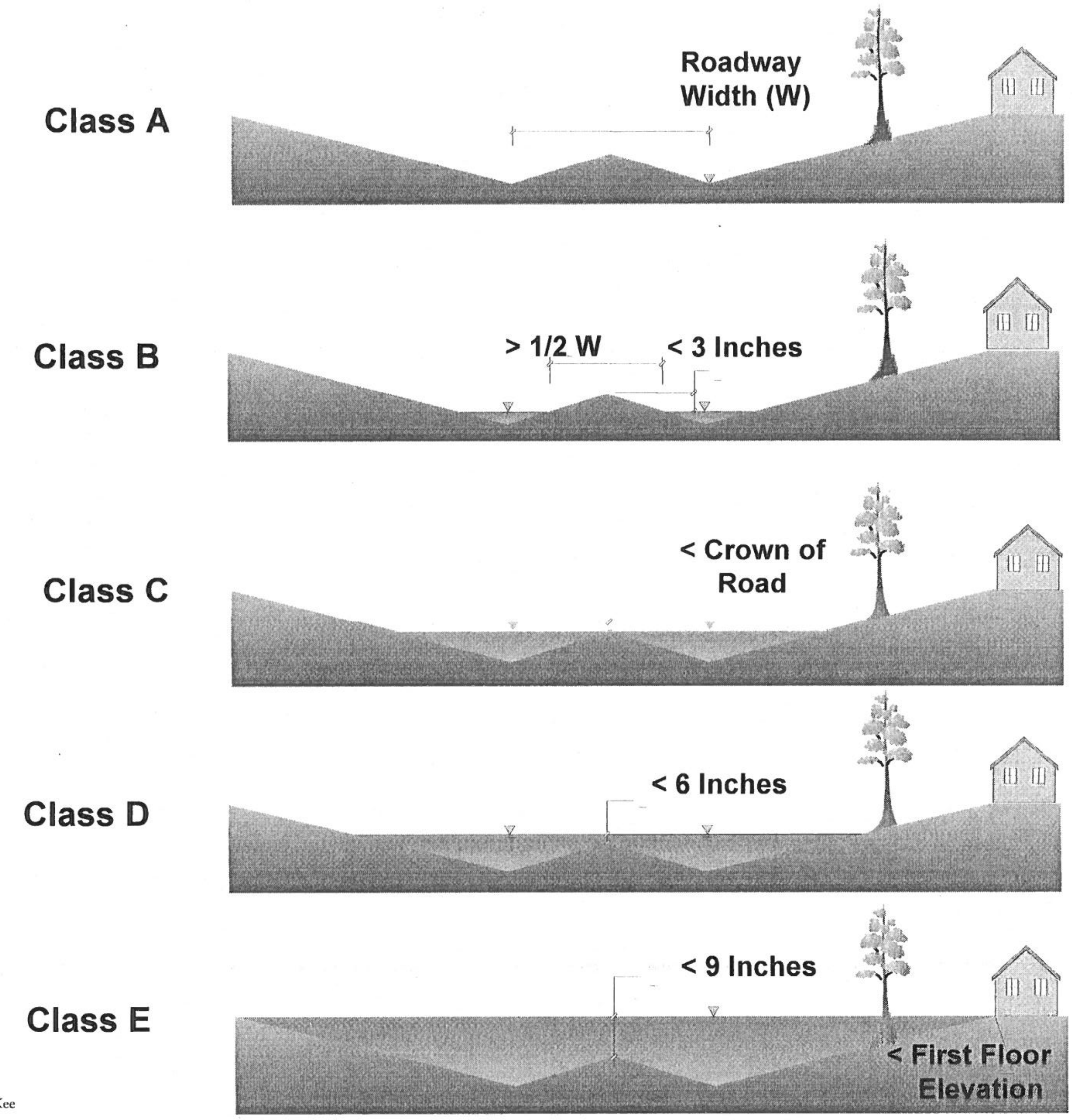


Figure ES-2
Water Quantity
Levels of Service
Hutchinson,
Kansas

CDM Camp Dresser & McKee

Water Quality LOS

Water quality LOS are generally based on a "first flush" abatement of pollutants for new developments (see **Figure ES-3**). Retrofit water quality LOS are often limited due to technical and financial constraints. In general, water quality retrofits are considered if flooding solutions are implemented or if a clear cause-and-effect relationship of water quality degradation or impaired use can be attributed to a source. Potential federal NPDES regulations may require water quality treatment within a framework of basin-specific goals or rules. For these SWMP solution evaluations, technical and financial constraints were considered in the recommendations for water quality retrofit LOS. **CDM recommends that the City consider water quality benefits in design features for new developments and in retrofit projects.**

Physical Description

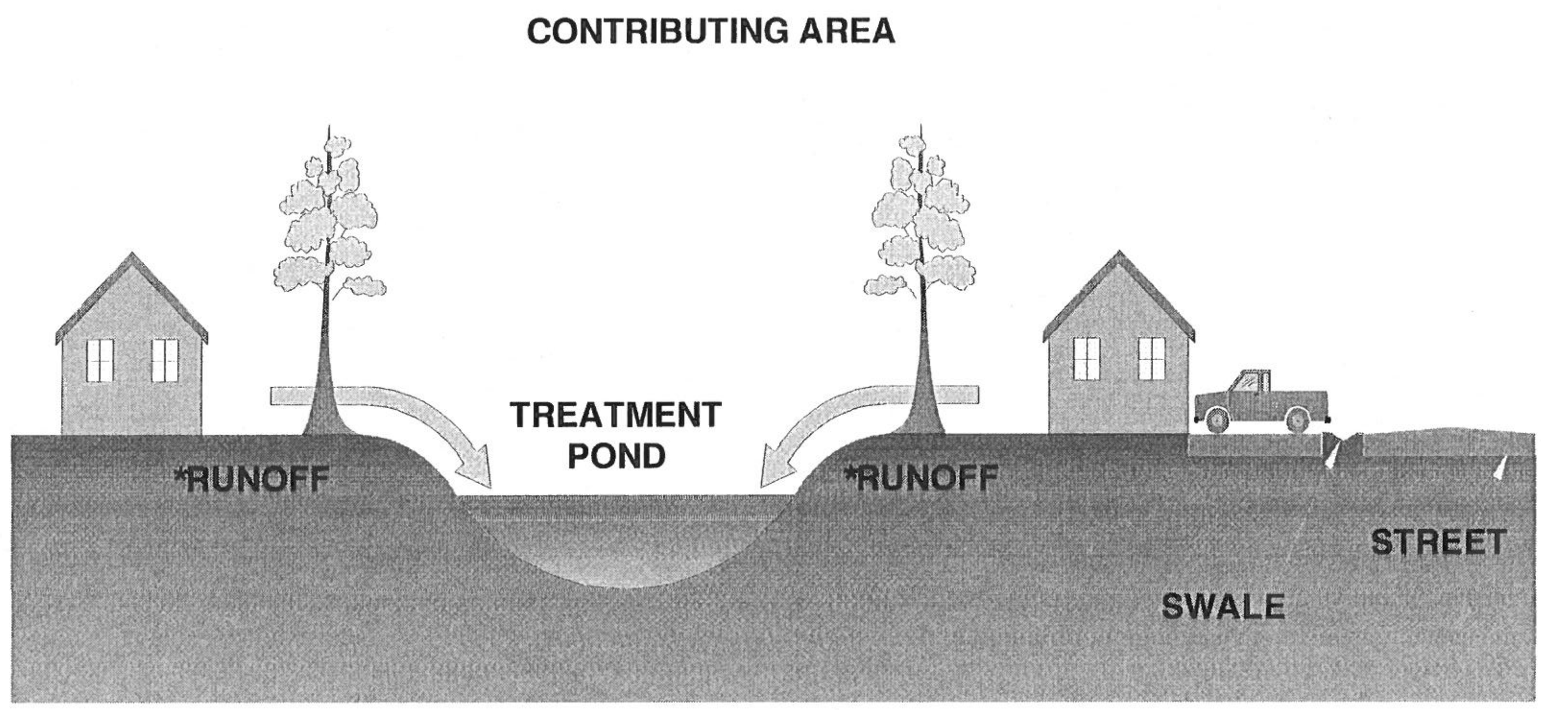
The City of Hutchinson has five PSWMSs; Arkansas River (Ark), Cow Creek (COW), Sand Hill Drain (SHD), East Side Drain (ESD), and the Grandview Industrial Drain (GVI). The total watershed area served by these PSWMSs is 39.3 square miles, as shown in **Table ES-2**. The City of Hutchinson comprises 21.1 square miles of the watershed, or 54%. The remaining 46% of the watershed is unincorporated Reno County north of the City. Therefore, cooperation with Reno County on future development will be important for the success of this program.

Table ES-2
PSWMS Characteristics

PSWMS	*Watershed Area (mi.^{2})*	*Portion of Watershed within City*	*Portion of Watershed Developed*	*Channel Length*[3] *(feet)*	*Number of Crossings*
Arkansas River (Ark)	3.5	100%	80%	15,400	4
Sand Hill Drain (SHD)	9.5	6%	4%	4,800	1
Cow Creek (COW)	5.5[1]	100%	89%	31,300	20
East Side Drain (ESD)	4.6	100%	88%	38,200	36
Grandview Industrial Drain (GVI)	16.2[2]	36%	21%	59,900	32
Total	**39.3**	**54%**	**40%**	**149,600**	**93**

(1) At U.S. 50.
(2) At G Avenue.
(3) Includes bridges, culverts, and tributary lengths. Arkansas River length from City boundaries. SHD length from Harsha Diversion to 43rd Avenue. Cow Creek length from City Boundary near U.S. 50 to 43rd Avenue. GVI length from G Avenue to 43rd Avenue.

Approximately 3.5 square miles of the southwest portion of the City flows directly to the Arkansas River (Ark). The Cow Creek PSWMS serves the west central portion of the City comprising 5.5 square miles. The Sand Hill Drain is located on the west edge of Hutchinson and diverts a total of 9.5 square miles to the Harsha Channel, with 8.9 square miles in unincorporated Reno County. The East Side Drain (ESD) is located in the north and central portions of the City and serves 4.6 square miles. The GVI channel serves the east portion of the City draining a 16.2 square mile watershed, with 10.4 square miles in unincorporated Reno County.



* THE "FIRST-FLUSH" OF RUNOFF FROM THE CONTRIBUTION AREA RECEIVES TREATMENT PRIOR TO DISCHARGE TO RECEIVING WATERS

Figure ES-3
First Flush Abatement of Pollutants
Hutchinson, Kansas

The soils in the watersheds are comprised of loamy sand (hydrologic soil group A) to fine sandy loam with a clay subsoil (hydrologic soil group D). About 75% of the soils are within the hydrologic soil groups A and B, and the remaining 25% are in group D.

Land uses range from agriculture north of 43rd Avenue to industrial within the City of Hutchinson. Approximately 60% of the watershed is undeveloped. The development in the watershed is about 2% industrial, 2% commercial, 2% institutional, 2% open space, and 32% residential. The average imperviousness is 14%.

Public Involvement

CDM prepared a questionnaire asking the residents and businesses in the City of Hutchinson to identify historical stormwater problems they may have observed. 2,012 responses (1,940 residences, 68 businesses, and 4 churches) were received by the City identifying 155 problem areas. The reported problems were evaluated and the location and severity summarized on the base map as shown in **Figure ES-4** and listed in **Table ES-3**. Reported problems typically are frequent and/or excessive ponding in low, flat areas with poor surface drainage and served by storm sewers with inadequate capacity, or lack storm sewers all together. Several areas have adequate storm sewer capacity, but lack sufficient inlet capacity to allow water to enter the system with minimal ponding on the streets. As shown below, Cow Creek has by far the most reported problem areas, followed by the ESD. Together, these two systems account for 94% of the problems.

Table ES-3
Reported Problem Areas by PSWMS

PSWMS	*No. of Reported Problem Areas*
Arkansas River	0
Sand Hill Drain	2
Cow Creek	96
East Side Drain	49
GVI Canal	8
Total	**155**

Existing Stormwater System

The PSWMSs were evaluated using the EPAs Stormwater Management Model (SWMM). The RUNOFF block of SWMM was used to evaluate the hydrologic components, and the EXTRAN block of SWMM was used to evaluate the hydraulics. The watersheds were subdivided into 125 hydrologic units. The hydraulic system was modeled as 499 conduits, including 94 bridge and culvert crossings, over 130,000 feet of open channel, and 87,900 feet of storm sewers. The models were used to estimate the existing system capacities and to size and site improvements. Verification of the model was performed by comparing predicted flooding with reported flooding problems.

The capacity of the Cow Creek PSWMS ranges from less than a 5-year event (more than 3-inches of ponding occurs for the 5-year design rainfall storm event) to more than a 100-year event, depending on the location. Cow Creek has less than a 5-year level of protection downstream of Severance and

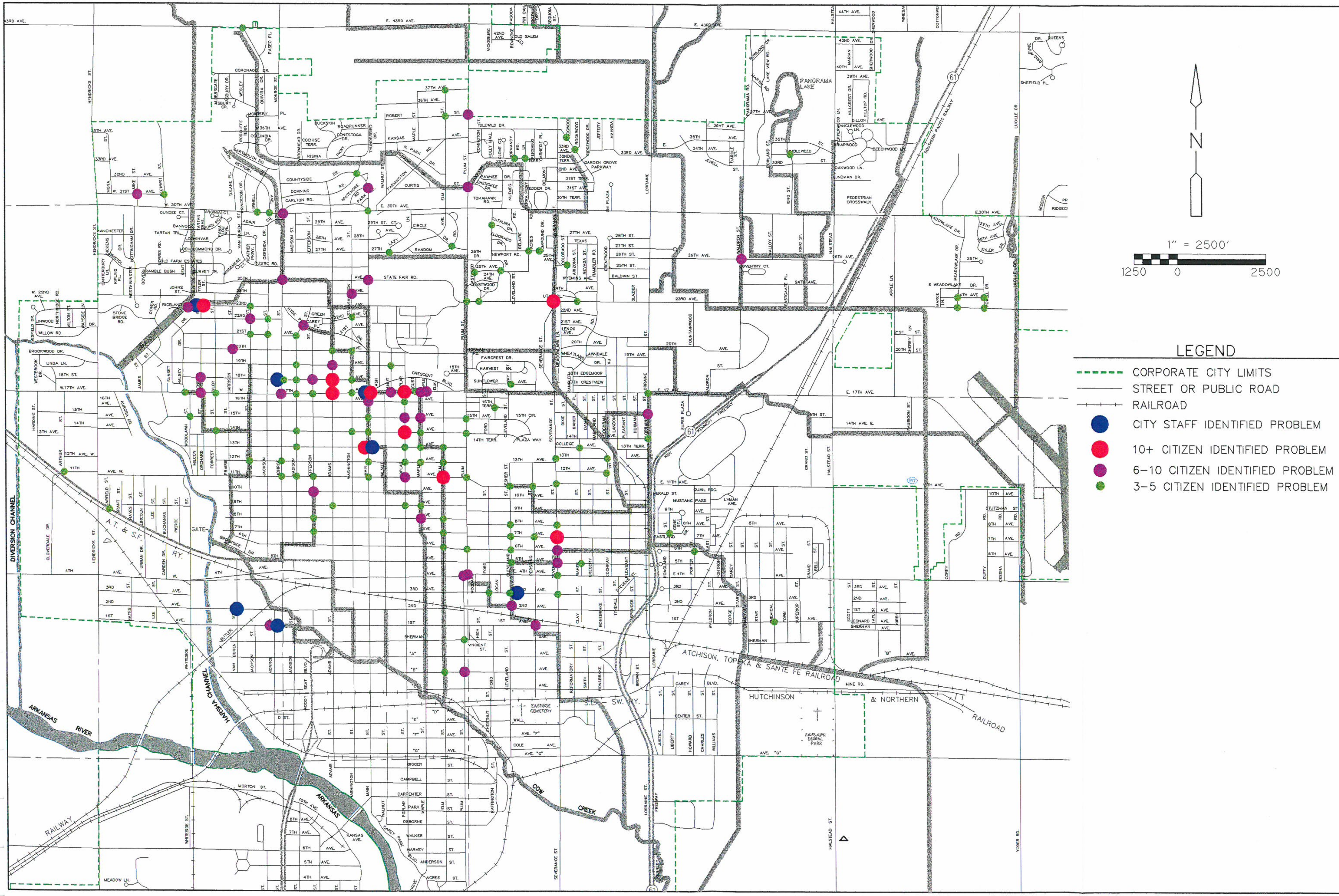


Figure No. ES-4
PROBLEM AREAS
STORMWATER MASTER PLAN
HUTCHINSON, KANSAS

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at Plum Street, and has a 100-year level of protection at Main Street and upstream of 2nd Avenue as shown on **Figure ES-5**. Approximately 80% of the storm sewers in the Cow Creek PSWMS have far less than a 5-year level of protection, confirming the reported problem areas. Also, there is up to two feet of sediment in the channel upstream of 2nd Avenue; therefore, potentially reducing the capacity of storm sewers that outfall to the area. This would be expected because of larger flows diverted by the Harsha Channel eliminating high velocities in the channel through this reach.

The Sand Hill Drain PSWMS has a 100-year capacity. This is based on the modeling assumption that water does not overtop 43rd Avenue and ponds in the area north of 43rd Avenue for the 100-year event. Hydraulic improvements upstream of 43rd Avenue will significantly reduce the level of protection provided by the diversion channel and culvert. There are two reported localized stormwater problems, but the problems are not associated with the PSWMS.

The East Side Drain ranges in capacity from a 5-year event at O'Daniels Street, the Kennedy Freeway, and the Fair Grounds, to a 100-year event at G Avenue and Elm Street. The primary storm sewers serving the ESD PSWMS have less than a 5-year level of protection, confirming the reported problems in the area.

The GVI canal has a minimum of a 25-year capacity near the AT & SF Railroad, and increases to a 100-year capacity from 30th to 43rd Avenue. Flows from the unincorporated area north of the 43rd Avenue are limited to the GVI channel by several 30-inch storm sewers underneath 43rd Avenue. The area north of 43rd Avenue functions as a large detention area regulated by the 30-inch pipes. Hydraulically improving the stormwater system upstream of, and at 43rd Avenue could reduce the LOS of the GVI canal system in Hutchinson by more efficiently delivering flows to the City portion of the system. Coordination with the County on this issue is very important.

The City has insufficient capacity in its Cow Creek and ESD PSWMSs. The problems can be attributed to undersized storm sewers, lack of storm sewers to localized areas, and limited outlets for the storm sewers. A combination of relief sewers and detention facilities mitigate the City's storm water quantity problems and allow incorporation of BMPs to help meet the anticipated new NPDES permit requirements. Measures should be taken to mitigate increased flows from development north of 43rd Avenue to maintain existing channel capacities on the SHD and GVI PSWMSs.

Alternative Improvements

CDM evaluated five improvement alternatives to meet the established ponding depth design criteria for existing development. They are:

1. No action.
2. Replacing the existing primary storm sewers and channels with larger capacity storm sewers and channels.
3. Adding parallel storm sewers along those with insufficient capacities.
4. Local detention basins throughout the system.
5. Relief storm sewers and regional detention basins.

Alternative 1 involves maintaining the current stormwater system with no capital improvements. This Alternative was considered in the ultimate decision on implementation to fully understand the problems, the solutions, and the true benefits. The 155 reported problem areas will continue to exist and new problems will arise as runoff from new development increases flows and volumes to the existing system.

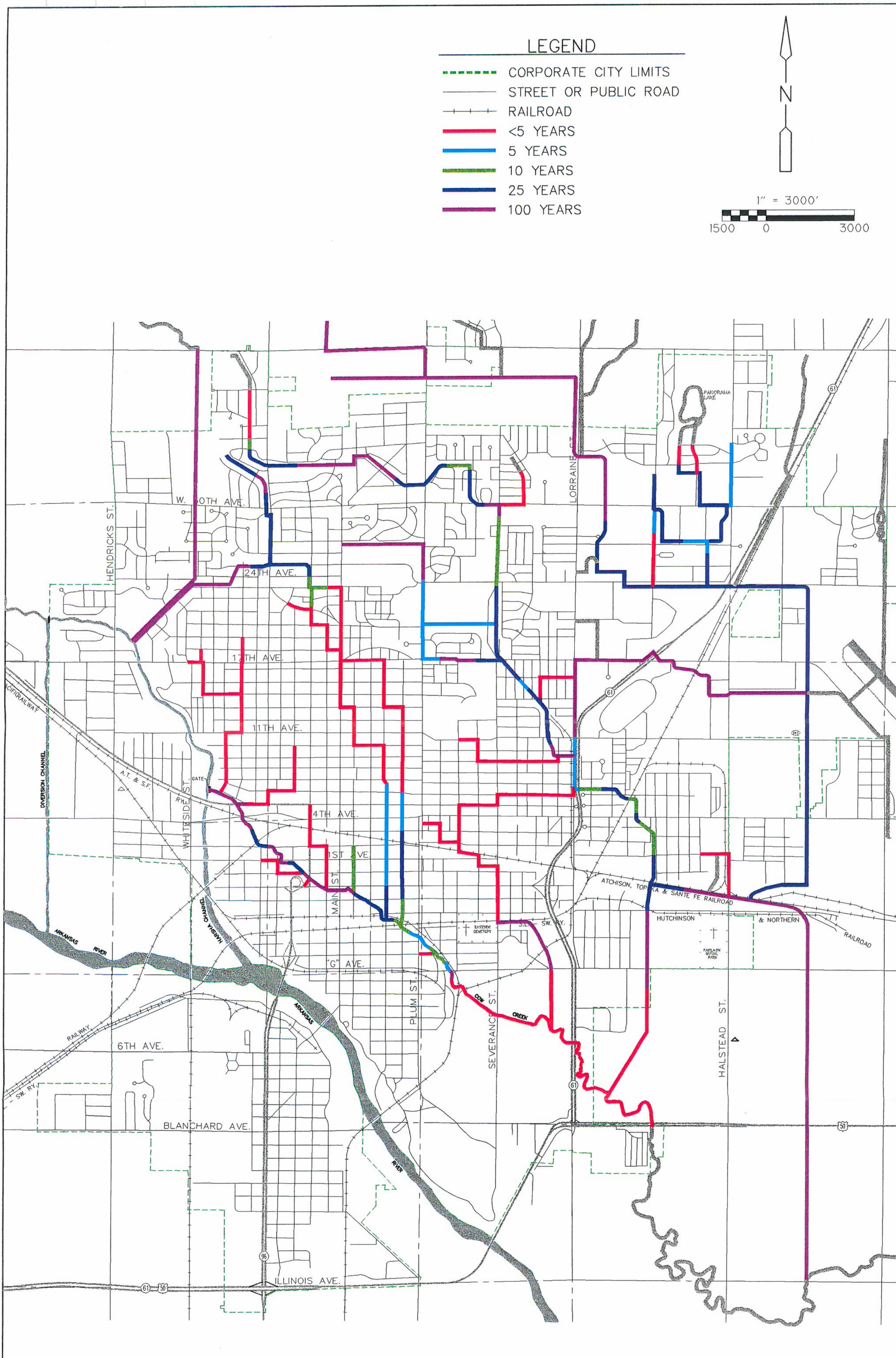

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Figure No. ES-5
PSWMS EXISTING CAPACITIES
STORMWATER MASTER PLANS
HUTCHINSON, KANSAS

Alternative 2 requires 55,750 feet of new storm sewers ranging in size from 10-feet wide by 4-feet high concrete box culverts (CBCs) to 24-inches in diameter. A total of 24,600 feet of open channel needs to be improved, with 7,000 feet of Cow Creek channel from Plum Ave to the City limits at US 50, and 12,800 feet of the ESD channel at various locations, as shown on **Figure ES-6**. The estimated construction cost is $40 million to improve the PSWMSs, as shown in **Table ES-4**. This alternative replaces the existing storm sewer and channel system and would provide a longer service life. Little opportunity exists to incorporate BMPs. The new storm sewers increase flows to the ESD and Cow Creek, further increasing the required channel improvements. The components of the improvements are summarized in **Table ES-4**.

Alternative 3 requires 55,750 feet of new storm sewers ranging in size from 10 feet wide by 4 feet high CBCs to 24-inch diameter storm sewers, as shown on **Figure ES-7**. A total of 24,600 feet of open channel needs to be improved, with 7,000 feet of Cow Creek channel from Plum Ave to the City limits at US 50, and 12,800 feet of the ESD channel at various locations, as shown on **Figure ES-7**. The estimated construction cost is $34 million. This alternative takes advantage of the existing system conveyance capacity reducing the required size of the parallel sewers. Little opportunity exists to incorporate BMPs. The new storm sewers increase flows to the ESD and Cow Creek, further increasing the required channel improvements.

Alternative 4 includes up to 26 local detention facilities located on the Cow Creek, ESD, and GVI PSWMS, as shown on **Figure ES-8**. The facilities would range in volume from 5 to 25 acre-feet with a surface area of 2 to 8 acres (0.5 to 2 city blocks). The basins would be approximately 4 feet deep, have 4:1 side slopes, and drain by gravity. The cost is estimated at $44 million. These detention ponds would function both as flood storage and as BMPs for water quality with this alternative.

Alternative 5 incorporates 27,370 feet of new relief storm sewers on the Cow Creek and ESD PSWMS's. An 8 feet wide by 4 feet high CBC would be constructed on 17th Avenue from the Harsha Channel to Plum Street, as shown on **Figure ES-9**. The west 3,500 feet of storm sewer from Monroe Street would divert flows from 170 acres of watershed to the Harsha Channel, relieving the existing storm sewers in the area, and reducing flows to Cow Creek. The 6,600 feet of relief storm sewer east of Monroe Street would capture flows from 335 acres of watershed, relieving the existing storm sewers on Main, Maple, and Elm Streets, and reduce flows to Cow Creek. The relief storm sewer would outlet to the open area between Plum Street, Severance Street, and 23rd Avenue east of the State Fair Grounds. The open area would be converted into a 150 acre-feet regional detention facility controlling flows from the 17th Avenue relief storm sewer, the existing ditch along the State Fair grounds, and ESD channel north of 17th Avenue. The facility would reduce flows on the ESD channel by controlling flows from the upper 2.2 square miles of the ESD watershed, increasing the downstream level of protection. The facility would relieve problems in the immediate vicinity of the basin. A second relief storm sewer would connect to the existing storm sewers at Maple Street and 6th Avenue and continue southeast to the existing open ditch at the State Reformatory. The relief storm sewer would be 8 by 3 feet and 10,400 feet in length. The ditch would need to be improved to handle the increased flow from the new relief storm sewer. The estimated cost is $27 million. Opportunities exist to incorporate BMPs at the regional detention facility.

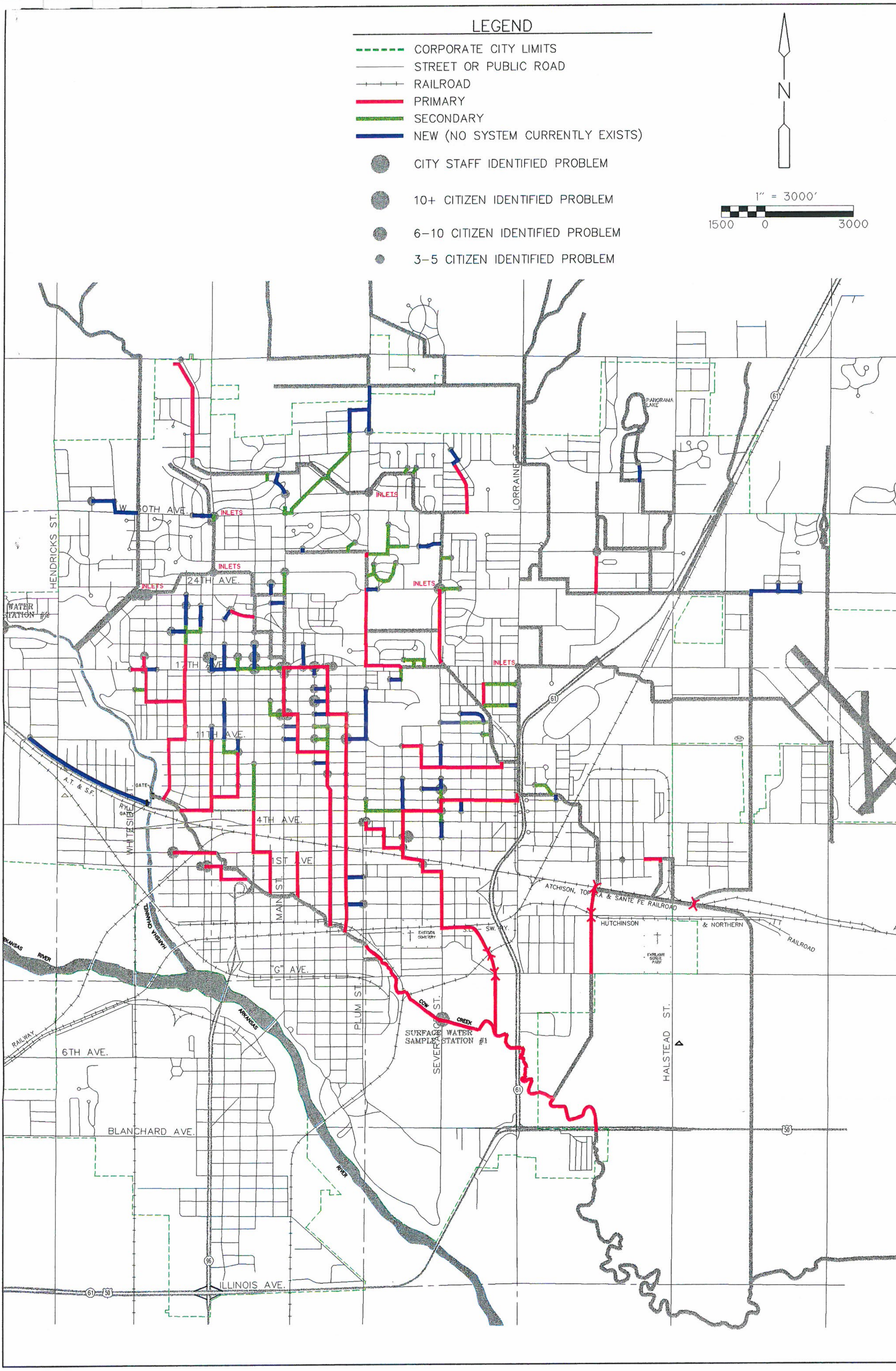

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Figure No. ES-6
ALTERNATE NO. 2 - ENLARGE EXISTING STORM SYSTEM
STORMWATER MASTER PLAN
HUTCHINSON, KANSAS

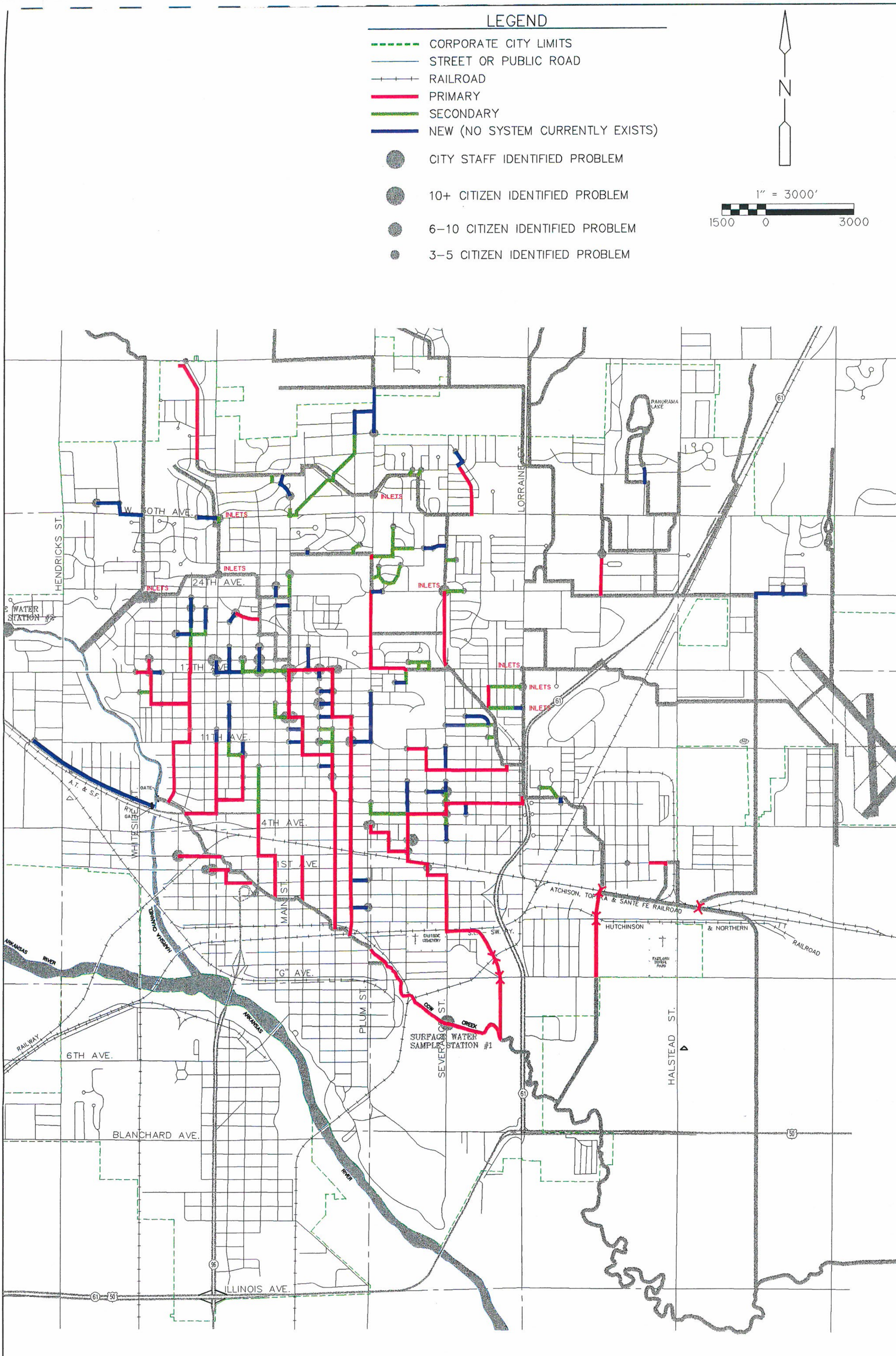

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Figure No. ES-7
ALTERNATE NO. 3 - PARALLEL CONVEYANCES
STORMWATER MASTER PLAN
HUTCHINSON, KANSAS

Table ES-4 PSWMS Improvement Alternatives					
Alternative No.	Length of New Storm Sewer (ft.)	Length of Channel Improvements (ft.)	Number of Detention Facilities	Total Detention Volume (acre-feet)	Probable Conceptual Capital Cost (Millions)
1	0	0	0	0	$0.0
2	55,750	24,600	0	0	$40
3	55,750	24,600	0	0	$34
4	0	0	26	285	$44
5	27,370	24,600	1	150	$27

Recommendations and Priorities

CDM recommends that the City implement Alternative 5 along with consideration for some of the detention ponds in Alternative 4. The construction of storage at or near the problem areas coupled with the relief pipes will allow a phased solution to flooding problems that also treats runoff where practicable to proactively comply with pending EPA NPDES stormwater requirements. **Table ES-5** lists the priority projects based on a logical implementation schedule and benefits for the investment costs.

Table ES-5 Implementation Schedule for Recommended PSWMS Improvements			
Phase	Description	Date (Yr)	Cost ($ Million)
I	150 acre-feet detention facility	2000-2002	5.2
II	East 17th Avenue relief storm sewer	2003-2005	4.6
III	Cow Creek Tributary channel improvements and relief storm sewers	2006-2008	5.4
IV	Relief storm sewers on west 17th Ave., Van Buren St., 10th Ave., 2nd Ave., and 1st Ave.	2009-2011	5.3
V	ESD and GVI channel improvements and relief storm sewers, and Cow Creek Channel Improvements	2012-2020	6.9

In addition, CDM recommends that the City consider a stormwater utility to fund the recommended improvements in a fair and equitable manner.

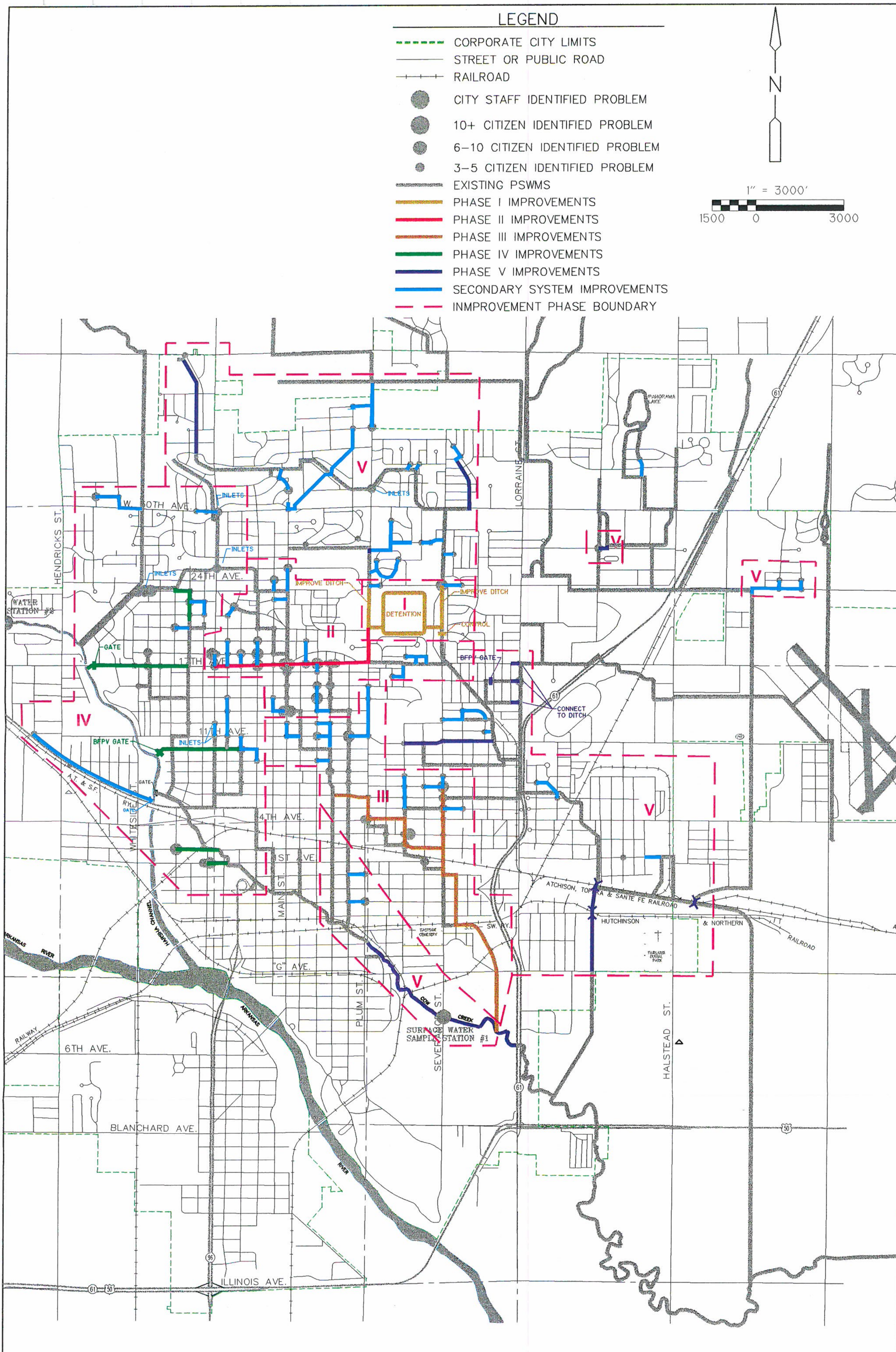

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Figure No. ES-10
RECOMMENDED IMPROVEMENT PLAN
STORMWATER MASTER PLAN
HUTCHINSON, KANSAS

Section 1
Background

1.1 Introduction

In May 1997, the City of Hutchinson contracted with Camp Dresser and McKee Inc.(CDM) and BG Consultants, Inc., to prepare a comprehensive Stormwater Management Master Plan (SWMP). This effort is intended to evaluate the performance of the City's primary stormwater system, identify and solve flooding throughout the developed portion of the City, and to develop an approach to managing stormwater in developing areas. This was accomplished using computer models to simulate the system based on existing conditions and then applying future conditions to identify potential future problems.

In addition to the above, the SWMP goals include:

- Control flooding and erosion;
- Control pollution from runoff and protect water quality;
- Identify operation and maintenance needs;
- Identify environmental benefits;
- Consider long term financing options; and
- Establish community acceptance.

The city currently experiences frequent street ponding and overbank flooding in many areas in the central and west portion of the City due to an inadequately sized stormwater system. In addition, the Environmental Protection Agency is in the process of issuing new National Discharge Elimination System (NPDES) regulations dealing with the management of nonpoint source pollution in the stormwater system. This SWMP identifies improvements that control the existing frequent ponding problems and provide Best Management Practices (BMP) options that will improve the water quality and help the City comply with the future NPDES regulations.

1.2 Physical Description

The City of Hutchinson is located along Cow Creek just upstream of its confluence with the Arkansas River. Cow Creek has a drainage area of approximately 980 square miles and flows generally from the northwest to the southeast. Flooding along Cow Creek has been a problem for the City for many years. To address this issue, the City and Army Corps of Engineers (ACOE) have constructed a series of diversion canals and levee's to control flooding along the Creek. The first diversion was constructed during the 1950's and is known as the Harsha Canal. This canal was designed to allow flood waters to by-pass downtown Hutchinson and flow directly to the Arkansas River. Flood events which occurred after the construction of the Harsha Canal proved the Harsha was not capable of handling large flood events. To provide a greater level of protection, the ACOE constructed a larger by-pass canal west of the Harsha. This canal, known simply as the Cow Creek Diversion Ditch, was designed for larger flood events. Under current operations, the gate structures at both the Cow Creek Diversion Ditch and Harsha Canal are maintained in an open position to allow some base flow to pass through the City. During storm events, the gates are closed to stop the flood flow from entering the City.

In addition to the large flood-control by-pass canals, the City has other significant drainage facilities. As part of this study, the City was divided into 5 major drainage basins (**Figure 1-1**). These consist of the following and are described in detail below:

- Cow Creek (COW)
- Sandhill Drain (SHD)
- East Side Drain (ESD)
- Grandview Industrial Drain (GVI)
- Arkansas River (ARK)

Cow Creek - The Cow Creek basin consists of the majority of the downtown portion of the City. The drainage basin consists of several storm drain systems which discharge directly to Cow Creek.

Sandhill Drain - The Sandhill Drain is located in the northwestern portion of the City. This system, which discharges to the Cow Creek upstream of the Harsha Canal, drains an area west of Main Street and north of 17th Avenue. The northern portion of the basin is mainly agricultural with open channels and ditches, while the lower portions of the basin are mostly developed. This system discharges to Cow Creek through two main conveyance structures consisting of a box culvert and a corrugated metal pipe near Swarens Street.

East Side Drain - The East Side Drain discharges to Cow Creek to the east of the downtown area, just west of the Ken Kennedy Expressway. From Cow Creek, the system runs along the east side of the downtown area until is reaches Severance near 17th Avenue. At this point it runs next to or in the middle of Severance north to 23rd Avenue where it turns west toward the Sandhill Drain.

Grandview Industrial Drain - Better known as the GVI, this system is the newest of the major drains and runs along the eastern most edge of the city from the Cow Creek north to the Airport. Just north of the Airport, this system turns west and runs along the northern edge of the City. Current plans are to extend this drain to the north to serve many of the new developments and allow stormwater from these areas to by-pass the developed portion of the City.

Arkansas River Basin - This basin includes the extreme southern portion of the City which drains directly to the Arkansas River. This system consists of a mix of open and closed channels. Due to the direct discharge to the Arkansas River, this basin is hydrologically independent from the other basins discussed.

Table 1-1 provides a breakdown of the drainage area and channel lengths for each of the major basins . **Figures 1-1 and 1-2** show the study area and primary stormwater management system.

Table 1-1
PSWMS Characteristics

PSWMS	Watershed Area (mi.^{2})	Portion of Watershed within City	Portion of Watershed Developed	Channel Length[3] (feet)	Number of Crossings
Arkansas River (Ark)	3.5	1	80%	15,400	4
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(3) Includes bridges, culverts, and tributary lengths. Arkansas River length from City boundaries. SHD length from Harsha Canal to 43rd Avenue. Cow Creek length from City Boundary near U.S. 50 to 43rd Avenue. GVI length from G Avenue to 43rd Avenue.

1.3 Citizen Advisory Committee

As part of the public participation element of this project, the City established a citizen Stormwater Management Advisory Committee. This committee met regularly throughout the master planning process to discuss the direction of the master plan and review preliminary results. The goal of this committee was to provide an avenue to better understand the needs of the Citizens of Hutchinson and the communities goals for stormwater management. This committee is envisioned to continue after the completion of this plan to address other issues, such as implementation, funding, and NPDES permitting.

1.4 Organization of Report

The report has been organized in a manner which simplifies the review and understanding of the master plan. Below is a brief description of the report sections.

Section 2 - Data and Methodology -This section describes the process used to develop the stormwater model and evaluate the system. This includes technical details on how the models simulate the system and detailed description of stormwater management practices.

Section 3 - Results - This section describes the results of the evaluation, including identification is existing system deficiencies.

Section 4- Alternatives Evaluation - This section describes the alternatives which were evaluated and the effectiveness of each. This includes a discussion on costs and implementation issues.

Section 5 - Recommendations - This section describes the recommended alternative and provides additional details on implementation including a recommended phasing plan.

Section 6 - Drainage Policies and Implementation Requirements - This section describes the City's existing drainage policies and makes recommendations to provide the City with the regulatory framework to effectively manage the stormwater system.

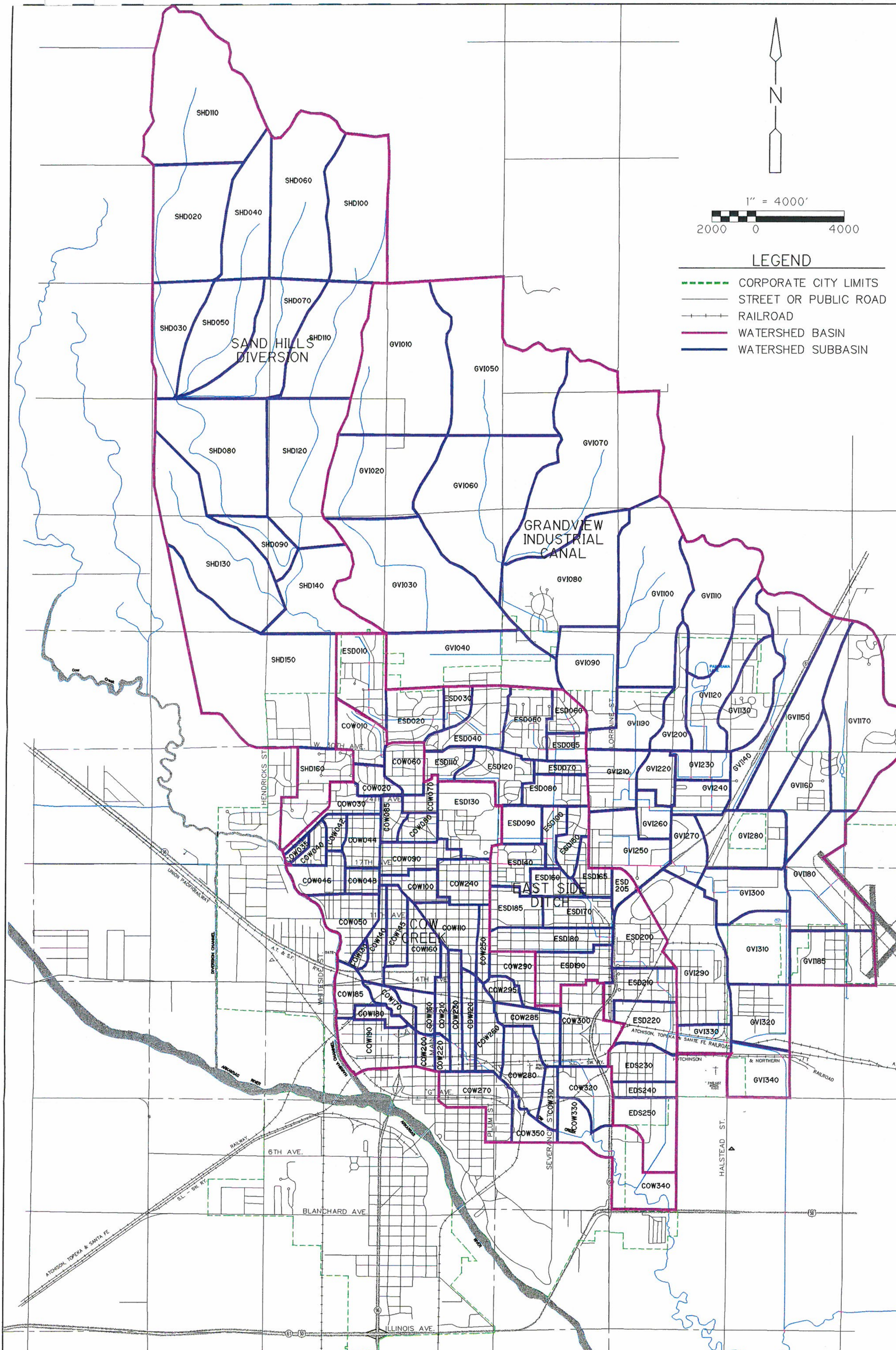

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Figure No. 1-1
STUDY AREA
STORMWATER MASTER PLAN
HUTCHINSON, KANSAS

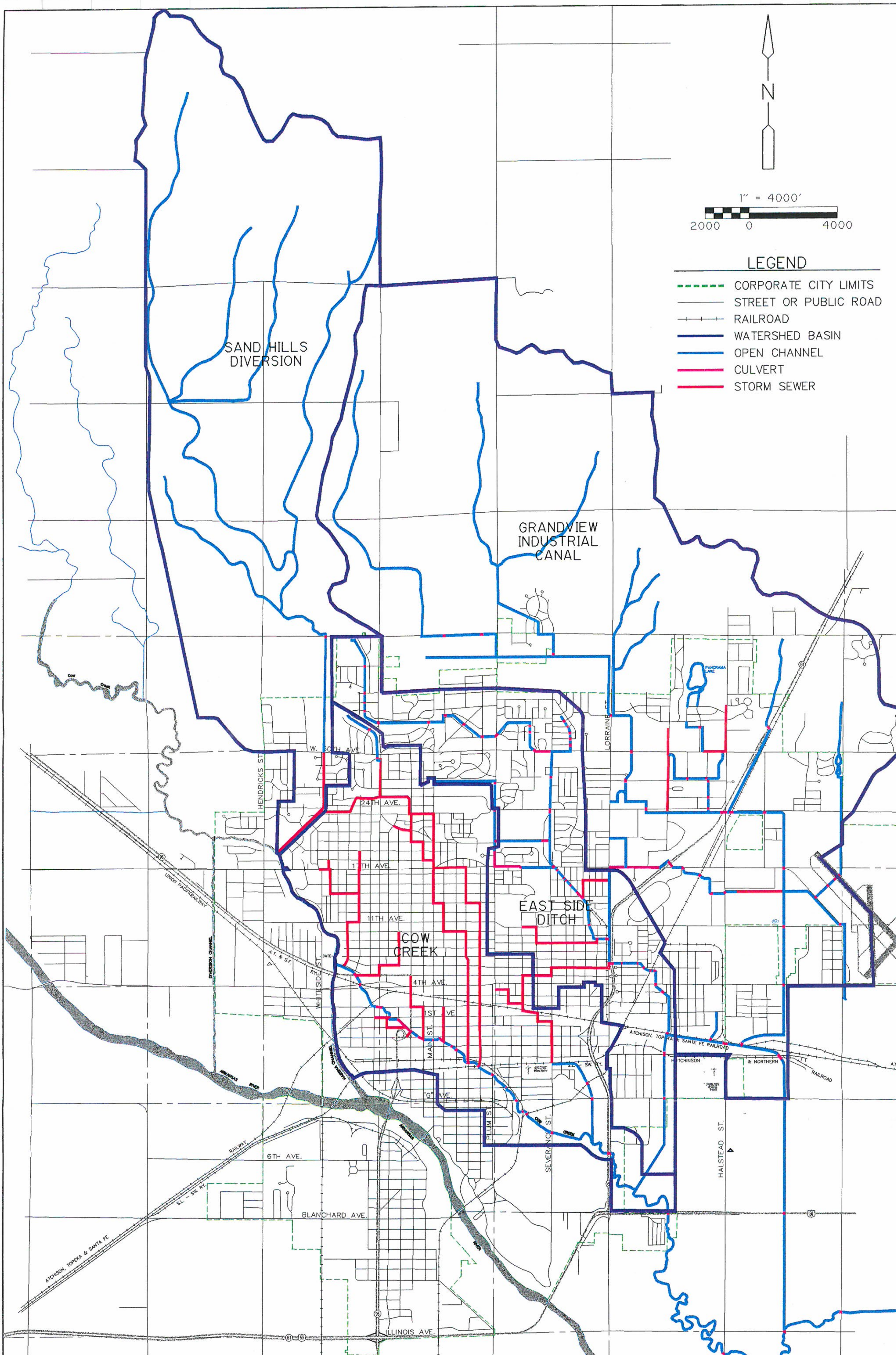

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Figure No. 1-2
PRIMARY STORMWATER MANAGEMENT SYSTEM
STORMWATER MASTER PLAN
HUTCHINSON, KANSAS

Section 2
Data and Methodology

This section details the data and methodology used to perform the stormwater management evaluations. Hydrologic data are presented in **Appendix A**, and water quality data are presented in **Appendix B**.

2.1 Stormwater Model Framework

The stormwater management master plan for the City of Hutchinson was prepared using several surface water models to simulate conditions. Computer models allow for the simulation of stormwater runoff and water quality under existing conditions, as well as, allow for the evaluation of alternative solutions to problems or changes in conditions, such as new development. For the purposes of this study, three models were used. These are the EPA SWMM RUNOFF Block, EPA SWMM EXTRAN Block, and the Watershed Management Model (WMM). The RUNOFF and EXTRAN models were used to simulate the hydrologic and hydraulic conditions. The WMM was used to evaluate water quality issues. These models and how they were applied is described in detail in the following sections.

2.2 Water Quantity Modeling

An important aspect of this City of Hutchinson Stormwater Master Plan (SWMP) is the proper evaluation of water quantity (flooding). A good understanding of water quantity helps determine the most effective methods of controlling flooding and protecting public safety. Camp Dresser & McKee Inc. (CDM) used recent versions of the RUNOFF and EXTRAN blocks of the United States Environmental Protection Agency (EPA) Stormwater Management Model (SWMM, Version 4.4) because these models best meet the requirements of the program. The models have been verified in stormwater master plan uses throughout Kansas and the US. The hydrologic model, RUNOFF, is used to evaluate rainfall, runoff, and infiltration characteristics of an area. It can also perform simple hydrologic routing of channels, pipes, and lakes where gradients are known. RUNOFF output is delivered to EXTRAN, which is the hydraulic model. EXTRAN provides dynamic flood routing of channels, lakes, and control structures such as bridges, culverts, and weirs. EXTRAN accounts for conservation of mass, energy, and momentum; thereby predicting looping, flow reversals, etc. should they occur.

CDM also prepared an XP-SWMM model. XP-SWMM is a proprietary version of EPA-SWMM and adds graphical display of input and output to the programs' capabilities.

2.2.1 Hydrologic Model

The hydrologic model used for this study is the RUNOFF block of the EPA SWMM, Version 4.4, which was originally developed by CDM. The program simulates the rates of runoff developed from subareas using an overland flow model (kinematic wave approximation) equation. Hydrologic routing techniques are then used to route the overland flows through the pipe, culvert, and channel as required. Program results can be saved for input to the EXTRAN block of SWMM to perform hydraulic routing in downstream reaches.

RUNOFF was originally developed in 1970 as part of the original EPA SWMM. The program has been applied many times since its inception and has gained worldwide acceptance. Over the years, the program has undergone many changes and modifications, although the main formulations and calculations remain mostly unchanged from the original codes.

Program modifications have been performed over the years by CDM and others to streamline program functions and expand channel routing capabilities for use in stormwater master plan studies. A more complete documentation of the model's background and theory can be found in the *SWMM User's Manual*.

2.2.2 Hydraulic Model

EXTRAN

The primary hydraulic model used for this study was SWMM EXTRAN, which is a hydraulic flow routing model for open channel and/or closed conduit systems. It uses a link-node (conduit-junction) representation of the drainage system in an explicit finite difference solution of the equations of gradually varied, unsteady flow. EXTRAN receives hydrograph input at specific junctions by file transfer from a hydrologic model such as RUNOFF or Technical Release (TR) 20, and/or by manual input. The model performs dynamic routing of stormwater flows through the major storm drainage system to the points of outfall in the receiving water system. The program will simulate branched or looped networks; backwater due to tidal or nontidal conditions; free-surface flow; pressure flow or surcharge; flow reversals; flow transfer by weirs, orifices, and pumping facilities; and storage at online or off-line facilities. Types of conduits that can be simulated include circular, rectangular, horseshoe, elliptical, and basket handle pipes, plus trapezoidal or irregular channel cross sections. Simulation output takes the form of water surface elevations and discharges at each node and conduit, respectively.

EXTRAN was developed for the City of San Francisco in 1973. At that time, it was called the San Francisco Model or the Water Resources Engineers Inc (WRE) Transport Model. In 1974, EPA acquired this model and incorporated it into the SWMM package, calling it the Extended Transport Model - EXTRAN - to distinguish it from the TRANSPORT Model developed by the University of Florida as part of the original SWMM package. Since that time, the model has been refined, particularly in the way the flow routing is performed under surcharge conditions and in large open channel networks.

Several enhancements to EXTRAN have been implemented over the years since EXTRAN was originally released. A sampling of these are summarized below:

- Input and simulation of channels with irregular cross sections from select Hydrologic Engineering Center (HEC) -2 data cards

- Variable stage-area junctions
- Pump curves
- Different boundary conditions at each system outfall
- "Hot start" input and output from binary files
- On-screen printout of the simulation percentage of completion

In addition, minor changes were made to several algorithms for program efficiency and accuracy.

2.2.3 Water Quantity Model Schematic

A necessary task of any stormwater master plan is the creation of a simplified representation of the actual system for input into the stormwater models. The first step to accomplish this task is developing a model schematic, which also aids in checking input data and interpreting output data.

An overall RUNOFF/EXTRAN schematic for the City of Hutchinson PSWMS is presented in **Appendix A**. The schematic shows the hydrologic unit load points for inflow, conveyance channels, and structures, as well as the storage and linking junctions. It also illustrates how the RUNOFF and EXTRAN programs were set up to simulate each area's runoff hydrograph and the routing of the runoff through the stormwater management system. Identification numbers for various system elements are also shown on the schematic. The schematic provides a quick reference between the actual physical situation and the modeled system.

2.2.4 Model Calibration and Verification

Calibration and verification are desirable to establish a "reality check" of predicted stages, flows, and velocities. In order to calibrate/verify, data must be available in the form of rainfall, stage, flow, and/or high water marks for specific storm events, land use, and hydraulic conditions. A verification was performed by CDM using available problem area information within the City. The verification included both hydrologic and hydraulic parameters.

2.3 Water Quality Modeling

This section documents the methods used to perform the water quality modeling evaluations. The water quality modeling framework involves identification of the water quality problems to be addressed by the modeling study, the structure of the model software, and the assumptions and guidelines for using the model to represent the study areas within the City.

The CDM Watershed Management Model (WMM) provides annual point and nonpoint source pollutant load estimates for each hydrologic unit. Twelve pollutant loads are estimated: five-day biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), total suspended solids (TSS), total dissolved solids (TDS), total phosphorus(TP), dissolved phosphorus (DP), total Kjeldahl nitrogen (TKN), nitrate/nitrite (NO_3/NO_2), lead (Pb), copper (Cu), zinc (Zn), and cadmium (Cd). For NPDES MS4 purposes, total nitrogen can be calculated as the sum of TKN and NO_3/NO_2

nitrogen. The CDM WMM results may be used for relative comparisons of land use changes, BMP changes and changes to point source loadings in a standard framework. Potentially, absolute load and EMC estimates can be derived. Therefore, the model results were used to estimate nonpoint source pollutant loads, compare point versus nonpoint source loads, and identify effectiveness of BMP control options.

A modeling study of this type often relies on local monitoring data to validate the pollutant loading factors used in the simulation model. Hutchinson has initiated a Cow Creek ambient water quality monitoring program. This data could be used for future model validation in a subsequent phase or authorization. Section 2.7 discusses the water quality parameters for this project.

As a long-term monitoring record is compiled, pollution loading statistics can be compared with the water quality model projections from this study to provide further justification of the planning tools that serve as the basis of the watershed management plan. In addition, a long-term water quality monitoring program can be used to evaluate the need for any mid-course corrections in the management plan (i.e., need for retrofit detention ponds to treat runoff).

2.3.1 Nonpoint Source Pollution Loading Model

CDM used the Watershed Management Model (WMM) to estimate relative nonpoint source loads from the study area. WMM incorporates a land-use approach to estimate annual or seasonal nonpoint source loads from direct runoff based upon the event mean concentrations (EMCs) and runoff volumes. The approach is based on the fact that the type and concentration of pollutants in stormwater is partially based on the type of land use contributing to the runoff. Data required to execute the nonpoint source module of WMM include EMCs for each pollutant type and land use, average annual precipitation, annual base flow, and average base flow pollutant concentrations. The following summarizes some of the features of the WMM:

- Estimates annual runoff pollution loads and concentrations for nutrients (total phosphorus, dissolved phosphorus, total nitrogen, ammonia plus organic nitrogen), heavy metals (lead, copper, zinc, cadmium), and oxygen demand and sediment (BOD_5, COD, total suspended solids, total dissolved solids) based upon EMCs, land use, percent impervious, and annual rainfall.

- Estimates runoff pollution load reduction due to partial or full scale implementation of up to five types of onsite or regional Best Management Practices (BMPs).

- Applies a delivery ratio to account for reduction in runoff pollution load due to settling in stream courses.

- Estimates annual pollution loads from stream base flow.

- Estimates point source loads for comparison with relative magnitude of nonpoint pollution loads.

- Estimates pollution loads from failing septic tanks.

Stormwater pollution control strategies that can be evaluated using the WMM include:

- Non-structural controls (e.g., land use controls, buffer zones, etc.)
- Structural controls (e.g., onsite and regional detention basins, wet detention ponds, dry detention ponds, swales, etc.)

The model provides a basis for planning level evaluations of the long term (annual or seasonal) nonpoint pollution loads and the relative benefits of nonpoint pollution management strategies to reduce these loads. WMM evaluates alternative management strategies (combinations of non-structural and structural controls) to develop the stormwater management plan.

CDM's WMM was used to generate estimates of average annual pollutant loadings for existing and future conditions based upon local rainfall statistics. The model relies upon EMC factors for different land use categories to calculate pollution loadings. The derivation of the EMC factors is documented and discussed in Section 2.7.

2.4 Hydrologic Unit Delineations

Hydrologic unit delineations or boundaries in the City were derived using United States Geological Survey (USGS) 7.5-minute series quadrangle (5-foot contour, 1" = 2,000') and City of Hutchinson 2-foot contour Stormwater Atlas (1996) coupled with topography from as-builts and construction plans. Hydrologic units are generally defined by natural physical features or constructed stormwater conveyance systems which control and direct stormwater runoff to a common outfall. The following criteria were used to determine hydrologic unit boundaries:

- Large scale physical features such as sand ridges, railroad grades, large buildings, and major roads were used to establish hydrologic divides.
- The 10-, 25- and 100-year storm events were considered to be the most important in terms of flood protection since these events are used to size conveyance systems. The 100 year event is used to determine the regulatory peak discharges from a basin, as well as to establish flood-insured, first-floor elevations for buildings. Therefore, boundaries were delineated for these events.
- Hydrologic unit boundaries were delineated where structures or topographic features could appreciably impound water for the 25- and 100-year events.
- The present condition hydrologic unit delineations were considered to be approximately the same as the future development conditions.
- Existing reports/studies were used, along with field verification, to verify ambiguous boundaries.
- The level of detail used in the delineations was consistent with the PSWMS analysis.

The hydrologic-unit-identification scheme is a six character alphanumeric code; the first three letters represent the PSWMS, and the last three numbers represent the hydrologic unit number. Examples of the identification for the PSWMSs are listed in **Table 2-1**.

Table 2-1
Hydrologic Unit Identification Scheme

Hydrologic Unit	*Description*
ARK010	Arkansas River PSWMS, hydrologic unit number 10
COW010	Cow Creek PSWMS, hydrologic unit number 10
ESD010	East Side Ditch PSWMS, hydrologic unit number 10
SHD010	Sand Hill Diversion PSWMS, hydrologic unit number 10
GVI010	Grand View Industrial PSWMS, hydrologic unit number 10

Table 2-2 lists PSWMSs in the planning area, number of hydrologic units in the planning area, and the respective areas for each planning area, while **Appendix A** provides a table listing individual hydrologic units and their characteristics. Hydrologic units are shown in various figures in Section 1.

Table 2-2
Hydrologic Units

PSWMS	*Number of Hydrologic Units*	*Tributary Area (Sq. Mi.)*
Arkansas River	1	3.5
Cow Creek[1]	45	5.51[2]
East Side Ditch	29	4.59
Sand Hills Diversion	16	9.52
Grand View Industrial	35	16.21[3]
Total	**125**	**39.3**

[1]Tributary area does not include the 952 square mile watershed of Cow Creek diverted to the Arkansas River west of Prairie Street. (Cow Creek Diversion Ditch)
[2]At U.S. 50
[3]At G Avenue

2.5 Hydrologic Parameters

Hydrologic model parameters used for the model simulations are described below. **Appendix A** provides the resultant RUNOFF model data by hydrologic unit (hydrologic unit number, width, area, percent directly connected impervious area (DCIA), slope, Manning's roughness values, initial abstractions, and infiltration rates.

2.5.1 Topographic Data

Topographic data were used to define hydrologic boundaries, overland flow slopes, channel slopes, critical flood elevations, and stage-area-storage relationships. Topographic data were available in the watershed from three major sources:

1. USGS 7.5-minute series quadrangle maps (1" = 2,000', 5' contours, **Table 2-3**)

2. Topographic map of Hutchinson (revised November 1996)

3. Stormwater Utility Maps with storm sewers and inlet elevations (revised June 1997)

Figure 2-1 shows the available 2' contour topographic data coverage, and **Figure 2-2** shows the USGS quadrangle coverage for the City of Hutchinson.

Table 2-3
United States Geological Survey Quadrangles

Quadrangle Name	*Year Published*	*Year Photo Revised*
Hutchinson SE	1961	1978
Hutchinson NW	1965	1978
Hutchinson	1960	1978

2.5.2 Hydrologic Unit Areas

Areas were determined by planimetering the hydrologic unit delineations. Each area was measured at least two times, outlier or suspect values were investigated and measured if necessary, and the average area was used for model input.

2.5.3 Rainfall Intensities and Quantities

Rainfall data were used to generate the basis for stormwater evaluations. Data are generally characterized by amount (inches), intensity (inches per hour), frequency (years), duration (hours), spatial distribution (locational variance), and temporal distribution (time variance). The National Climatic Data Center (NCDC) keeps rainfall records in daily or hourly intervals for major rainfall gages. In Hutchinson, these records are compiled at the Airport (hourly data; 1958 - 71).

In addition to the rain gage located in Hutchinson, CDM identified a gage in Wichita (hourly data, 1956-96). This additional station may be used in developing rainfall data which are useful in the verification of the stormwater models. The locations of available and proposed rainfall gages are provided in **Appendix A**.

Rainfall data are also used to generate the stormwater runoff for the WMM evaluations. Unlike stormwater quantity modeling, longer time steps are appropriate for estimating stormwater

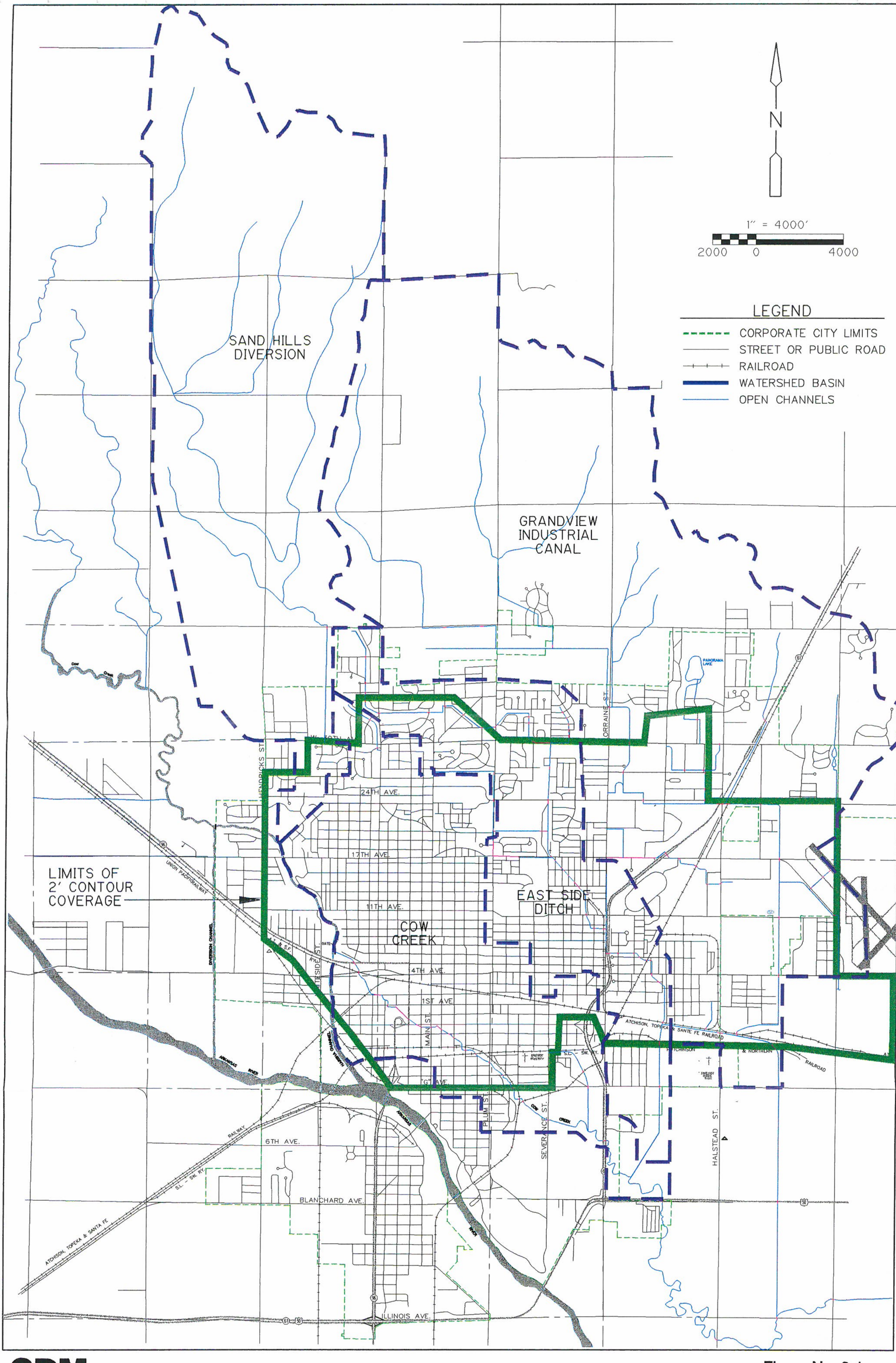

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Figure No. 2-1
TOPOGRAPHIC DATA COVERAGE
STORMWATER MASTER PLAN
HUTCHINSON, KANSAS

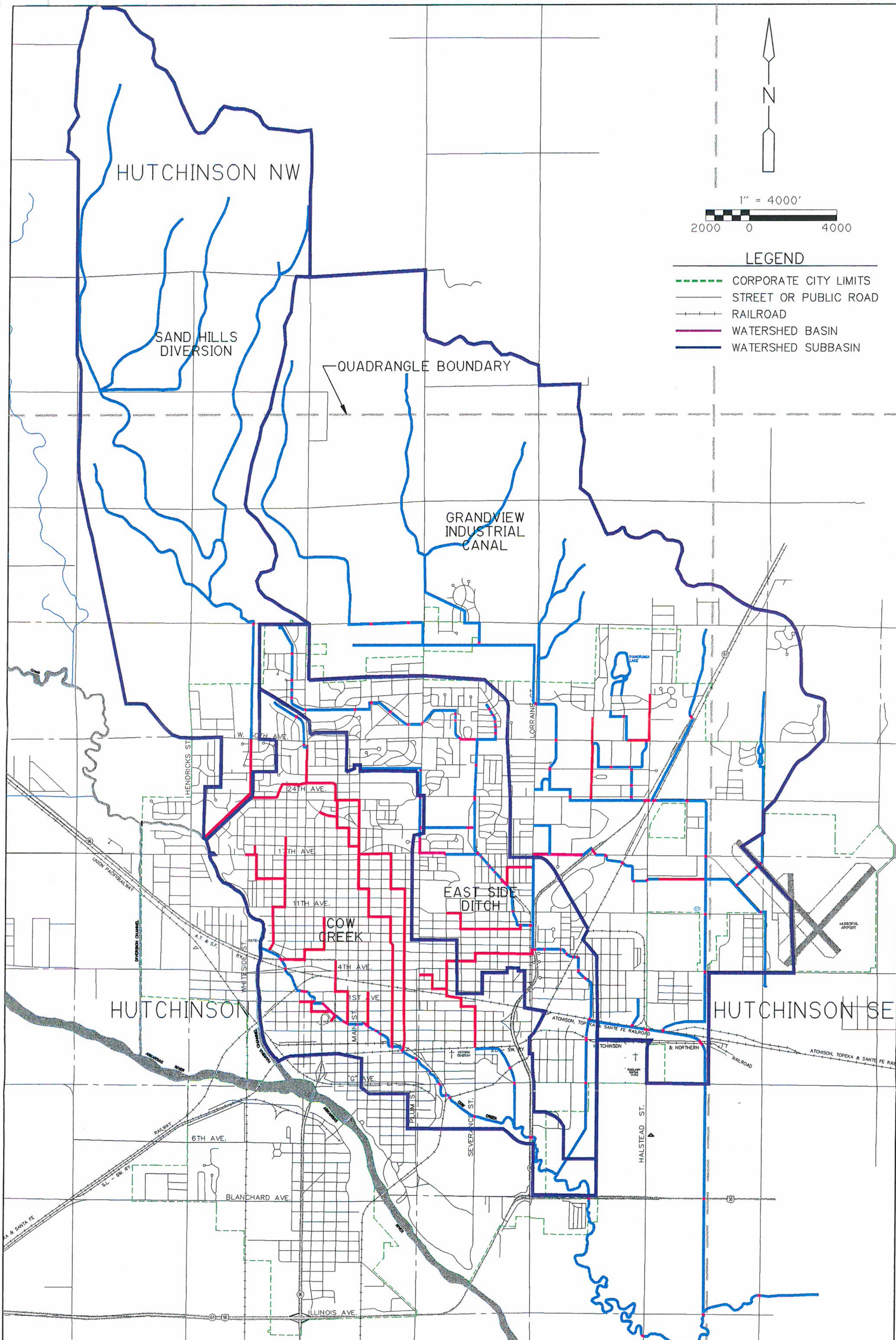

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Figure No. 2-2
USGS QUADRANGLE COVERAGE
STORMWATER MASTER PLAN
HUTCHINSON, KANSAS

pollutant loads. In the case of WMM, monthly rainfall records from the Hutchinson 10SW rain gage were obtained from the NCDC (http://www.ncdc.noaa.gov/ ol/climate/online/ coop-precip.html) and summarized into an annual average. The period of record obtained for the Hutchinson area was 1953 through 1996. Monthly totals for the period of record are given in **Table 2-4**. The annual average rainfall for 1953 through 1996 was 28.41 inches.

National Weather Service Technical Paper 40 (TP-40) 24-hour design rainfall depths were used for the SWMP. Depths were derived for the 5-, 10-, 25-, and 100-year events. The Soil Conservation Service 24-hour Type II synthetic rainfall distribution was used to distribute the design rainfall depths over time and develop rainfall intensities. The rainfall was distributed in 15-minute increments. **Appendix A** contains the design rainfall depths.

2.5.4 Infiltration Rates and Capacities

Soils data are used to evaluate stormwater runoff, infiltration, and recharge potential. Soil infiltration rates were taken from the United States Department of Agriculture (USDA) Soil Conservation Service (SCS) Soil Survey for Reno County (March 1966), based upon the soil hydrologic group. This agency has been renamed the Natural Resource Conservation Service (NRCS). For the City of Hutchinson SWMP, CDM used soil storage as well as infiltration rates. Soil capacity (or soil storage) is a measure of the amount of storage (in inches) available in the soil type for a given antecedent moisture condition. The average antecedent moisture condition (AMC II) was used for all design storm analyses. Soil storage capacities were estimated based on available depth-to-water-table. Sensitivity and verification analyses of rainfall versus runoff were used as a basis for soils parameters for the design storms in this SWMP.

The soil series within each hydrologic unit were grouped by hydrologic soil. **Appendix A** provides a summary of hydrologic soil group percentages by hydrologic unit.

2.5.5 Overland Flow Parameters

The overland flow hydraulic length (H_L) is the weighted-average travel length to the point of interest. The need for this is apparent for areas with odd geometry where a long, thin portion of the area may bias the H_L. For ponded areas, the point of interest chosen was the centroid of ponding. For areas where ponding does not occur, the point of interest is the outflow from the area. Overland flow slope is the average slope over the hydraulic length and is calculated by dividing the difference in elevation by the hydraulic length. Length and slope information were obtained from the two-foot topographic data and USGS 7.5-minute quadrangle maps.

2.5.6 Impervious Areas

Land use data are used to estimate imperviousness, runoff, and pollutant load potential in stormwater evaluations. Relative changes in land use can also be used to identify areas of high growth for the establishment of priorities for study. For this SWMP, the land uses were grouped into 10 categories of relatively homogeneous imperviousness. Present land uses within the watershed include residential, commercial, industrial, institutional, wetlands, waterbodies and watercourses, and rural (which includes agricultural). For a given land use, the percent of directly connected impervious area (DCIA) is relatively consistent throughout the country. That is, a

Table 2-4
Hutchinson, KS Rainfall (inches)
NWS Station 143930

	January	February	March	April	May	June	July	August	September	October	November	December	Total
1953					2.67	2.26	2.65	0.37	0.67	2.33	1.54	1.39	
1954	0.00	0.68	0.24	1.47	3.63	1.51	1.09	2.89	1.30	1.00	0.00	0.15	13.96
1955	0.46	0.96	0.13	1.84	3.25	4.84	0.71	1.39	4.15	4.80	0.00	0.00	22.53
1956	0.42	0.57	0.23	0.75	2.92	0.52	4.54	0.26	0.00	3.10	0.50	0.51	14.32
1957	0.06	0.53	4.09	3.54	10.00	10.81	2.67	2.00	3.62	2.25	1.32	0.55	41.44
1958	0.47	2.07	3.28	1.54	3.48	2.45	10.23	1.05	6.54	0.35		0.19	
1959	0.10	0.57	2.33	1.27	5.95	2.49	5.60	1.56	1.58	5.01	0.10	0.70	27.26
1960	1.34	1.89	0.86	1.40	5.12	3.48	2.49	1.94	2.92	3.48	0.58	1.33	26.83
1961	0.02	0.81	2.05	1.77	5.05	2.53	6.04	2.20	3.07	1.43	1.95	0.58	27.50
1962	1.01	0.61	0.31	1.07	2.68	6.70	8.79	3.82	3.60	1.24	1.19	0.33	31.35
1963	0.39	0.00	1.82	0.33	2.07	2.92	4.08	2.61	9.04	2.55	1.05	0.20	27.06
1964	0.54	0.34	0.95	0.81	4.24	1.63	1.46	6.48	2.45	0.25	4.48	0.90	24.53
1965	0.26	0.63	0.22	2.07	3.66	9.78	3.09	2.94	4.83	0.48	0.00	2.15	30.11
1966	0.50	0.91	0.03	1.39	0.43	2.93	4.77	2.43	1.21	0.40	0.00	0.56	15.56
1967	0.30	0.15	0.12	2.71	1.76	10.75	5.32	1.16	4.19	1.78	1.06	1.32	30.62
1968	0.10	0.20	0.04	2.76	5.78	2.35	1.74	4.81	2.78	5.58	2.58	0.88	29.60
1969	0.20	1.42	1.49	4.25	2.37	4.40	2.01	3.59	1.93	1.98	0.00	0.75	24.39
1970	0.16	0.10	1.97	3.62	2.18	6.23	1.10	0.83	5.93	5.42	0.15	0.15	27.84
1971	0.86	2.89	0.17	0.95	3.05	2.13	5.00	1.09	1.93	3.88	2.21	0.29	24.45
1972	0.18	0.15	0.84	1.24	3.81	4.34	2.95	2.91	2.14	1.05	2.99	1.53	24.13
1973	2.12	1.78	9.49	2.82	1.32	0.29	3.73	0.95	9.96	4.87	0.61	2.12	40.06
1974	0.25	0.13	2.48	8.30	6.63	1.92	0.21	4.93	1.63	2.08	1.10	1.72	31.38
1975	1.08	2.20	1.46	1.33	4.80	8.48	0.25	3.71	1.07	0.19	2.88	0.63	28.08
1976	0.09	0.30	1.42	8.52	4.46	1.64	2.72	0.08	5.02	2.87	0.08	0.03	27.23
1977	0.66	0.05	3.13	3.86	7.63	8.15	1.86	9.55	8.02	2.37	1.90	0.46	47.64
1978	0.22	1.76	1.40	1.98	6.38	2.50	0.85	1.85	3.64	0.15	1.67	0.57	22.97
1979	1.64	0.17	4.91	1.04	3.73	2.94	7.55	1.57	0.09	11.52	1.68	1.01	37.85
1980	1.51	1.74	4.40	1.08	3.39	1.13	1.93	5.40	0.67	1.29	0.02	1.61	24.17
1981	0.03	0.21	2.15	1.49	6.46	2.95	2.92	1.13	2.87	3.57	4.52	0.15	28.45
1982		1.20	1.83	0.24	6.96	4.93	3.61	2.13	2.04	0.70	0.81	1.51	
1983	0.52	2.43	3.08	3.46	6.98	3.64	2.23	1.46	0.58	2.77	2.80	0.87	30.82
1984	0.12	0.87	6.55	5.79	1.48	3.67	0.67	0.03	0.50	4.17	0.92	3.52	28.29
1985	0.73	1.75	1.00	5.34	0.96	5.78	4.34	3.59	6.00	3.60	1.18	0.71	34.98
1986	0.00	0.45	1.09	4.67	4.48	2.92	7.28	7.25	5.82	4.25	0.57	1.21	39.99
1987	1.11	1.63	4.53	0.87	5.31	6.61	4.45	6.71	1.66	1.06	0.86	1.50	36.30
1988	1.13	0.05	1.53	3.63	2.41	3.53	5.86	0.69	1.37	0.75	0.11	0.12	21.18
1989	0.36	0.21	1.44	0.17	5.86	9.18	2.85	6.13	2.78	0.32	0.01	0.07	29.38
1990	0.80	2.29	2.75	1.98	3.32	1.80	0.75	2.42	5.12	0.50	1.59	0.44	23.76
1991	0.34	0.02	2.04	4.95	4.15	0.97	2.23	3.72	2.34	1.90	1.71	1.28	25.65
1992	0.79	0.33	1.90	0.98	3.68	7.15	3.80	4.48	1.27	1.81	3.79	1.54	31.52
1993			2.90	1.38	9.07	2.98	7.70	1.83	1.76	0.76	1.11	0.42	
1994	0.67	0.77	0.16	4.38	0.62	4.27	6.48	0.70	1.65	1.75	1.45	1.11	24.01
1995	0.60	0.11	3.83	1.98	10.91	6.32	1.60	3.05	3.84	0.07	0.05	0.95	33.31
1996	0.08	0.02	1.71	1.57	4.41	1.25	3.82	3.78	4.74	1.41	3.00	0.22	26.01
Mean	0.54	0.86	2.05	2.48	4.34	4.13	3.57	2.86	3.20	2.34	1.30	0.86	28.41
Median	0.42	0.59	1.71	1.77	3.81	2.98	2.95	2.42	2.78	1.81	1.08	0.70	27.67

medium density residential neighborhood has a comparable mix of roof-tops, roadways and driveways throughout the United States. The present land use and impervious areas for each hydrologic unit were calculated in percentages of homogenous (or nearly homogenous) land use obtained from the City of Table 2-4 Hutchinson February 1996 aerials, then applying guideline impervious and DCIA percentages. These guideline percentages are based on SCS methodology, CDM experience, verification results, and impervious percentage checks within the SWMP analyses. **Table 2-5** lists land use types, their percent impervious, percent DCIA, percent non-directly connected impervious area (NDCIA), and the percent pervious. The DCIA represents all the impervious surfaces that are directly connected to the stormwater system. The NDCIA represents the impervious surfaces that have a previous buffer between the stormwater system. Based on this information, the area-weighted average percent imperviousness for each hydrologic unit is computed by WMMs using the percent of each land use category within a hydrologic unit for existing land use conditions. The Hutchinson watershed generally consists almost entirely of low DCIA agriculture (64%) and moderate DCIA residential land uses (29%). A summary of the original land use definitions for each hydrologic unit is included as **Appendix B**.

Table 2-5
Imperviousness by Land Use Category

Land Use Category	*Percent Impervious*[1]	*Percent DCIA*[2]	*Percent NDCIA*[3]	*Percent Pervious*
1.Forest, Open, & Park	1	1	0	99
2.Pasture	1	1	0	99
3.Agricultural & Golf Courses	1	1	0	99
4.Low Density Residential	30	16	14	70
5.Medium Density Residential	34	19	25	66
6.High Density Residential	57	38	19	43
7.Institutional	65	46	19	35
7Commercial	87	79	8	13
8.Light Industrial	87	79	8	13
9.Heavy Industrial	87	79	8	13
10.Wetlands	100	100	0	0
11.Watercourses & Waterbodies	100	100	0	0

(1) Total Impervious Area
(2) Directly Connected Impervious Area (DCIA)
(3) Non-Directly Connected Impervious Area (NDCIA)

2.5.7 Stage-Area Relationships

Stage-area information was developed by planimetering topographic contours for major depressional areas which could not be uniformly incorporated into channel cross sections. This process was done to more accurately reflect street and floodplain storage. The volume of storage was internally calculated by stormwater models using the trapezoidal method. The area, and therefore the volume, of buildings and houses within the flood prone areas was included in the calculations to account for floodplain storage within the structures.

2.5.8 Stage and Discharge Data

A desirable component of any water resources investigation is the availability of measured stages and/or discharges at selected points of interest, or the availability of calibrated hydrologic/hydraulic models from the area to serve as a "reality check". These data are often used to establish base flows, as well as predict extreme flood and/or drought event conditions.

Diversion Structure data

Typically, for a watershed management plan, stages and/or discharges are used in conjunction with known rainfall amounts/distributions and other hydrologic/hydraulic conditions to calibrate and verify models. These calibrated and verified models can then be used in evaluations of present problem area solutions or future conditions planning. It is often desirable to acquire this data in at least hourly intervals to predict and plan for relatively short-term, yet potentially damaging, flood peaks.

Staff stage data are available in the City of Hutchinson on the Arkansas River and the Cow Creek diversion channel from manually read staff gages. Stage and flow data are not available in Hutchinson. Therefore, model verification was performed by comparing model results to problem areas.

2.6 Hydraulic Parameters

Hydraulic data for the analyses were gathered for the PSWMSs, which is comprised primarily of open channels, storm sewers, and culverts. The PSWMSs for the City are shown in Section 1 and **Appendix A**. Hutchinson provides stormwater management services in the incorporated areas and operates and maintains the Cow Creek diversions, ditches, and other facilities within City limits.

A detailed inventory of the facilities currently maintained by the City of Hutchinson is available on the stormwater utility maps. This inventory includes information on the locations and types of facilities or structures with available details. Important hydraulic data were obtained from this source. Additional hydraulic data came from bridge design plans and field surveys.

2.6.1 Structures/Facilities

Hydraulic data for culverts, storm sewers, control structures, and watercourse cross sections were obtained from the present stormwater utility maps, field surveys, previous studies, previous computer models, and field identification. Data collected included elevations, lengths, geometries, surface roughnesses, local loss characteristics, and other pertinent features. The facility locations, sizes, and lengths have been entered into the stormwater model in their equivalent form.

2.6.2 Floodplains and Floodways

A floodplain is the area inundated, or flooded, by a particular rainfall event. Floodplains are often described by their frequency of occurrence (e.g., 25-year or 100-year).

The Federal Emergency Management Agency (FEMA) establishes nationwide flood levels and flood insurance standards. It is common practice for FEMA Flood Insurance Studies (FIS) to consider flood events to be independent and superimpose the results to produce floodplain maps. Based upon these standard practices, the FEMA FIS for Reno County, Kansas, and Incorporated Areas (1990) and associated Flood Insurance Rate Maps (FIRMs) identify portions of the city as flood prone and provide estimates of the 100-year flood stages in order to provide guidance for home building and road elevations. For this study, available data were compiled in order to estimate flood boundary conditions for subsequent SWMP evaluations.

A floodway is often defined specifically by the FEMA standard: The channel of a stream, plus any adjacent floodplain areas that must be kept free of any encroachment so that the 100-year flood can be carried without increasing flood heights by more than 1.0 feet. Proper floodplain/floodway data are critical to guiding new development in the establishment of first-floor elevations, road crown elevations, lake control structure and tailwater elevations, allowable fill quantities/encroachments, and facility sizing.

2.6.3 Equivalent Conduits

For the EXTRAN model, equivalent conduits (through parallel and series equivalent pipes) were created in order to ensure model stability, account for local or transitional losses, and to simplify the total number of conduits in the model. This was accomplished through standard procedures based upon Manning's equation. Conduits were lengthened and/or combined as necessary, and Manning's roughness values were adjusted to maintain equal flow for an equal headloss. The following paragraphs provide additional details. SWMM 4.4 has a built-in option to automatically lengthen closed conduits to meet specified criteria and incorporate local losses.

Equivalent pipes are needed for one or more of the following reasons:

- Represent the significant local losses in the existing pipe (sometimes called minor losses)
- Lengthen a pipe for stability (wave celerity criterion)
- Produce an equivalent pipe to account for several existing pipes of equal size/geometry that are in parallel
- Produce an equivalent bridge
- Produce an equivalent pipe to account for several existing pipes that are in series

Local Losses

Local losses are associated with abrupt changes in the hydraulic grade line, which, when represented explicitly, cause numerical instabilities because the EXTRAN Saint-Venant solution is for "gradually-varied, unsteady flow". Therefore, local losses must be incorporated into the Manning's n of the conduit to satisfy this gradually-varied flow requirement. The guidelines in **Tables 2-6** and **2-7** were used when assigning local loss coefficients.

TABLE 2-6
ENTRANCE LOSS COEFFICIENTS
(FROM SFWMD, 1989)

Type of Structure and Design of Entrance	*Coefficient K_{ent}*
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radium = 1/12 D)	0.2
Mitered to conform to fill slope	0.7
End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side- or slope-tapered inlet	0.2

TABLE 2-7
EXIT AND IN-PIPE LOSS COEFFICIENTS

DESCRIPTION	K
Inlet to manhole	0.25
Manhole in straight section of closed conduit	0.1
Manhole at a 45 degree bend	0.25
Manhole at a 90 degree bend	0.5
Exit closed conduit to open channel or lake	0.3 - 0.7*

*Headloss at an abrupt enlargement is characterized by the equation (Vennard and Street, 1982):

$$h_L = k_L \frac{(v_1 v_2)^2}{2g}$$

where

h_L=head loss at enlargement in feet
k_L=approximately 1.0 (by experimentation)
v_1=velocity in upstream conduit, ft/sec
v_2=velocity in downstream conduit, ft/sec
g=acceleration of gravity = 32.174 ft/sec^2

The exit coefficient k_{exit}, is computed as

$$h_L = k_{exit} \frac{v_1^2}{2g} = \frac{(v_1 v_2)^2}{2g}$$

When the previous equation is rearranged, the following equation is derived:

$$k_{exit} = \frac{(v_1 v_2)^2}{v_1^2}$$

For lakes, v_2 is approximately 0, and the previous equation yields a value of 1.0 for k_{exit}.

Stability

Conduits:

EXTRAN model stability criteria are necessary checks to ensure that conditions of continuity are not violated for either conduits or junctions. The equation for conduits is normally used to set the simulation time steps as shown below:

$$\Delta t \leq \frac{L}{\sqrt{gD}} \qquad (circular \quad conduits)$$

where

Δt = Time step (seconds)
L = Conduit length (feet)

$$\Delta t \leq \frac{L}{\sqrt{g\frac{A}{T}}} \qquad (in \quad general)$$

where

Δt = Time step (seconds)
L = Conduit length (feet)
g = Acceleration of gravity (32.174 ft/sec^2)
D = Conduit depth (feet)
A = Area in flow (sq ft)
T = Top width or maximum width of flow surface (feet)

Junctions:

A second stability criterion applies the maximum allowable change in the water surface elevation over a single time step. This junction stability is not directly reported or calculated by EXTRAN; however, the following equation can be used after a simulation to test for junction stability:

$$\Delta t \leq \frac{CA_s\_H_{\max}}{\sum Q}$$

where

Δt = Time step (seconds)
C = Dimensionless constant (approximately 0.10)
A_s = Junction surface area (sq ft)
ΔH_{max} = Maximum change in head or elevation (feet) for any given time step
Q = Simulation of inflows and outflows (cu ft/sec)

Worst cases for Instability:

- Pipes: short, deep pipe with high inflow

- Junctions: small storage and/or surface area with high inflow or outflow

Equivalent parallel pipes, lengthened pipes, and local losses

Storm Sewer to Equivalent Pipe (local losses neglected). Assume equal head loss for equal flow. By Manning's equation,

$$\frac{1.49}{n_p} A_p R_p^{2/3} S_p^{1/2} = \frac{1.49}{n_e} A_e R_e^{2/3} S_e^{1/2}$$

$$n_e = \frac{n_p L_p^{1/2}}{L_e^{1/2}}$$

where

p = Actual pipe subscript
e = Equivalent pipe subscript
n = Manning's roughness coefficient
A = Conduit cross-sectional area (sq ft)
R = Hydraulic radius (feet)
S = Slope of the hydraulic grade line (feet/foot)
H = Head loss across the conduit (feet)
L = Conduit length (feet)

Culvert to Equivalent Pipe (local losses considered)
Assuming equal head loss for equal flow, Manning's equation yields

$$\left[\frac{29 n_e^2 L_e}{R_e^{4/3}}\right]\frac{v^2}{2g} = [k_{exit}]\frac{v^2}{2g}$$

$$n_e = \left[(k_{exit})\frac{R_e^{4/3}}{29 L_e}\right]^{1/2}$$

where

All variables are as previously defined
K_{exit} = Exit loss coefficient (dimensionless)
K_{ent} = Entrance loss coefficient (dimensionless)
V = Pipe velocity (ft/sec)
g = Acceleration of gravity (32.174 ft/sec^2)

This equation is most commonly used to adjust pipe lengths for stability, incorporate local losses, and/or make parallel pipe equivalents.

<u>It is recommended that local losses (due to expansions, contractions, bends, etc.) be included in equivalent culvert/pipe analyses</u>.

Equivalent Bridges

In some cases, bridges are modeled as their respective survey cross section (with roughness for the piers) unless they reach a full-flow condition. If a bridge reaches a full-flow condition, it is normally converted to an equivalent box culvert (or culverts with different shapes and inverts) and entered into the model using the guidelines for an equivalent box culvert.

The method for creating equivalent bridges with culverts involves a combination of graphical and numerical calculation techniques as shown:

- Plot the bridge cross section including piers and bridge low chord elevations
- Estimate a parallel set of box or other shaped culverts which appear to fit the approximate area-in-flow of the bridge at respective depths across the section

- Calculate:

$$\frac{AR^{2/3}}{n}$$

for the bridge section and for the equivalent section. Adjust the equivalent parallel culverts (width, inverts, and/or depths) until the terms most closely match with a reasonable graphical match as well.

Equivalent Series Pipes

Culverts to Equivalent Pipe - Assume total head loss across the series equals the sum of the head losses for each conduit and that flow is constant throughout the series.
Then,

$$\left[\frac{n_e}{1.49\ A_e R_e^{2/3}}\right]^2 L_e = \sum_{i=1}^{n} \left[[(\frac{n_i}{1.49\ A_i R_i^{2/3}})]^2 L_i\right]$$

there all variables are as previously defined and the subscript I refers to the "ith" elements in the series. This application is useful for creating equivalent pipes for multiple pipe sizes and geometries in series where there is no need for intermediate hydrograph loading.

2.6.4 Equivalent Storage

It is recommended that system storage alterations (from equivalent pipes or representations) be checked to ensure that the system storage is properly represented. The following storage conditions should be checked:

- Lengthened Pipes - check magnitude of volume added per unit length or with respect to system volumes in EXTRAN output. These effects are not normally significant for large storms (e.g., 10-, 25-, or 100-year) but may be significant for small storms (e.g., 1-month).

- Lengthened Open Channels - check magnitude of storage added. If storage is significant, check if adjacent channel may be shortened to equate storage (lost vs. added). Additionally, a storage element may be used to replace a short channel if the head loss across the channel is negligible.

- Proper Representation of Floodplains - when using stage-area junctions to account for floodplain storage, it is important to ensure that the stage-area relationship does not include the area composed of open channels (top width) since EXTRAN channels also account for storage as well as conveyance.

2.6.5 Boundary Conditions

Hydraulic boundary conditions are needed to simulate tailwater effects of the Arkansas River. For this study, a 10-year flood stage on the Arkansas River was used as a boundary condition. This assumes a relatively high stage on the Arkansas River occurs during the storm events in the Planning Area, but peak stages in the Planning Area do not occur simultaneously with peak stages on the Arkansas River (e.g., 100-year stage on the Arkansas River at the same time as 100-year stages are in Planning Area). Engineering guidelines suggest using a 10-year stage on a receiving stream for a boundary condition when the stream being evaluated has a tributary area 50 percent less than the receiving stream.

The 10-year stage on the Arkansas River at the Harsha diversion is 1531.5 ft-NGVD. Elevations are not available for the Cow Creek and GVI Channel confluences with the Arkansas River. A bank full condition was assumed as a boundary for the Cow Creek and GVI.

2.7 Water Quality Parameters

The quality of stormwater runoff is directly related to the land use and the extent of structural and non-structural BMPs associated with that land use. CDM developed numeric estimates of the stormwater loadings from each hydrologic unit in order to assess the source and magnitude of pollutant loads along with effectiveness of existing and future stormwater control in the City.

Annual pollutant loadings were estimated for each of the basins within metropolitan Hutchinson watershed. The WMM was used to develop estimates from land use, rainfall, and streamflow. The WMM is based upon a public domain version developed for Florida Department of Environmental Protection (FDEP) and refined for EPA's Rouge River National Wet Weather Demonstration Project. The capabilities of the public domain version are documented in a Compendium of Watershed-Scale Management Models for TMDL Development (EPA 841-R-92-002). A brief description of the model and the inputs follows.

The core calculations of the model are based on the observation that the concentration of pollutants in stormwater runoff is characteristic for each type of land use. That is, the runoff from medium density single family residential parcels contain similar concentrations of nitrogen and other pollutants. In contrast, commercial areas are characterized by different concentrations in the runoff. Most of the land use based concentrations were originally derived from the Nationwide Urban Runoff Program (NURP) conducted by EPA during the early 1980s (EPA, 1983). This program collected the runoff from over 2,000 storms from individual and mixed land use watersheds across the country and analyzed it for a wide spectrum of pollutants. Recently, the results of EPA's municipal NPDES stormwater permit program have been used to supplement the earlier NURP data.

2.7.1 Selection of Water Quality Loading Factors

Identification of Pollutants

The major sources of pollutants in a watershed are typically found in stormwater runoff from urban and agricultural areas, discharges from wastewater treatment plants (WWTPs) and industrial facilities, and contributions from failed septic tanks. Stormwater runoff pollution and septic tank loadings usually are referred to as "nonpoint source pollution" (NPS) or "nonpoint" because they are typically discharged into streams at dispersed points. A WWTP or industrial discharge is typically referred to as "point source pollution" because it releases pollution into streams at discrete points.

Urban nonpoint pollution has become a growing concern over the past 10 to 20 years as areas throughout the United States have compiled monitoring data on the significant increase in nonpoint pollution discharges that occur when an area becomes urbanized. For example, compared to undeveloped land uses like forest land, annual runoff pollution (pounds/acre/year) from urban development is as much as 10 to 20 times greater for fertilizer nutrients such as phosphorus, and as much as 10 to 50 times greater for toxic metals such as lead and copper. Nonpoint pollution contributed by cropland can also be a significant concern, particularly for existing undeveloped areas in a watershed. The SWMP targets the pollutants that are most frequently associated with stormwater including:

- Solids
  -Total Suspended Solids (TSS)
  -Total Dissolved Solids (TDS)

- Nutrients
  -Total Phosphorus (TP)
  -Dissolved Phosphorus (DP)
  -Total Kjeldahl Nitrogen (TKN)
  -Nitrate+Nitrite Nitrogen (NO_3+NO_2)

- Oxygen Demand
  -Biochemical Oxygen Demand (BOD)
  -Chemical Oxygen Demand (COD)

- Heavy Metals
  -Lead (Pb)
  -Copper (Cu)
  -Zinc (Zn)
  -Cadmium (Cd)

The municipal NPDES stormwater permitting process requires applicants to estimate the annual load of each of these pollutants. The pollutants and their potential effects on water quality and aquatic habitat are described below.

Solids: Suspended Solids (TSS) - Solids from nonpoint sources are the most common pollutant of surface waters. Many other toxic contaminants adsorb to sediment particles or solids suspended in the water column. Excessive sedimentation can lead to the destruction of habitat for fish and aquatic life. TSS is a measurement of the amount of sediment particles suspended in the water column. In developing areas, excessive sediment pollution is primarily associated with poor erosion and sediment controls at construction sites or unstable channels. Sediments also trap heavy metals and other toxicants adsorbed to sediment particles. These toxic pollutants can be later remobilized into the water column under suitable environmental conditions.

Nutrients: Nutrients (e.g., phosphorus and nitrogen) are essential for plant growth. Within a receiving water (e.g., river, estuary), high concentrations of nutrients, typically nitrogen in marine waters (EPA, 1983), can result in the overproduction of algae and other aquatic vegetation. Excessive levels of algae present in a receiving water is called an algal bloom. Algal blooms typically occur during the summer when sunlight and water temperatures are ideal for algal growth. Water quality problems associated with algal blooms range from simple nuisance or unaesthetic conditions, to noxious taste and odor problems, oxygen depletion in the water column, and fish kills. Collectively, the problems associated with excessive levels of nutrients in a receiving water are referred to as eutrophication impacts. Control of nutrients discharged to a receiving water can limit algal productivity and minimize the water quality problems associated with eutrophication.

Oxygen Demand: BOD is caused by the decomposition of organic material in stormwater which depletes dissolved oxygen (DO) levels in slower moving receiving waters such as lakes and estuaries. Low DO is often the cause of fish kills in streams and rivers. The degree of DO depletion is measured by the BOD test that expresses the amount of easily oxidized organic matter present in water. The COD test measures all the oxidizable matter present in urban runoff.

Heavy Metals: Heavy metals in abundance are toxic to humans and are subject to state and federal drinking water quality standards. Heavy metals are also toxic to aquatic life and may bioaccumulate in fish. Lead, copper, zinc, and cadmium are heavy metals that typically exhibit higher nonpoint pollutant loadings than other metals found in urban runoff. High quantities of these heavy metals in tributary streams in the watershed may also indicate problems with a wide range of other toxic chemicals, like synthetic organics, that have been identified in previous field monitoring studies of urban runoff pollution (EPA, 1983).

Selection of Stormwater Pollution Loading Factors

During a storm event, the concentration of pollutants in the runoff varies considerably over time. For example, the concentration of oily substances on roadways are highest during the first part of the storm, and then decline quickly when the bulk of the material is washed off. This is known as the "first-flush" phenomenon. However, the concentration in the first-flush runoff is not representative of the entire storm. In order to estimate the loading from a storm, the flow-weighted average concentration is needed. Known as the Event Mean Concentration (EMC), the flow-weighted concentration is derived as the average of total loading/total runoff for a series of storm events. In practice, the runoff is sampled periodically throughout the storm event. For each sampling interval, the concentration and the quantity of runoff are combined to get a loading for the interval. At the end of the storm, the results are coupled to develop the EMC (total mass/total runoff) which describes the average concentration for the storm. These results are combined with the results from many storms (e.g., 20 or more ideally) and statistically evaluated to arrive at a representative EMC for each land use. Results tend to be highly variable, even for the same sampling site. This is due to variable antecedent weather conditions which affect the amount of runoff, seasonal variations in land use (e.g., spring fertilization of lawns) and other factors. Consequently, it is desirable to obtain a good statistical representation of the EMC.

While some deviations exist, generally the results are transferrable throughout the country, especially for relative comparisons. This is possible because the characteristics of the land use tend to be similar. For example, the amount of roadway and amount of residential area maintained as lawns is similar for residential parcels of similar densities (homes per acre). However, local runoff quality should be used when the number of observations is sufficient to characterize the EMCs.

There have been a number of studies completed near Hutchinson. There were two Kansas City residential sites, one commercial site and one industrial site in the original NURP study. To the extent possible, these data were used to assign EMC values to local land uses. More recently, the City of Topeka completed sampling for six sites as part of the NPDES MS4 permitting process (192 sites; 603 storms). Other data sources evaluated include the complete NURP database, and a compilation of NPDES MS4 EMC's developed by CDM. The NPDES MS4 results are based on sites for which the identified land use constitutes 70% or greater of the contributing area.

Statistical Analysis of NPDES Land Use EMC Data: The raw data used to develop the MS4 EMC's were screened to identify outliers that were not included in the statistical analyses. EMCs reported below detection limits were assumed to be 50 percent of the detection limits for the statistical analyses.

When data are characterized by infrequent extreme observations, as often happens in water quality monitoring, it is typically appropriate to apply a lognormal distribution. Studies such as NURP (1983) and Federal Highway Administration (FHWA) (1990) have shown that water quality data are best represented by the lognormal distribution. The appropriate statistic to employ for comparisons between individual sites or groups of sites is the median value, because it is less influenced by the small number of large values typical of lognormally distributed data. However, for comparisons with other published data that usually report average values, and for annual mass load computations where large infrequent events can comprise a significant portion of the annual pollutant loads, the mean value is more appropriate.

An estimate of the arithmetic mean can be derived from the log-normal data (EPA, 1983. FHWA, 1990) as the following :

$$M = T*\sqrt{(1+CV^2)}$$

where

M= (Mean, Arithmetic) Estimated Arithmetic Mean of EMC based on log-normal distribution
T= (Median) x Geometric mean of transformed data, = exp(U)
U= (Mean, logarithmic) Mean of natural logarithm transformed data
CV = (Coefficient of variation, arithmetic) x Estimated Arithmetic CV based on log-normal

$$\text{distribution} = \sqrt{(\exp(W^2)-1)}$$

W= (Standard deviation, logarithmic) x Standard deviation of transformed data

Note that, in most cases, the arithmetic mean estimated from the lognormal transformation will not match the estimate produced by a straight average of the data. Both provide an estimate of the mean of the observed values, but the lognormal approach yields a better estimator for water quality monitoring data analyses. As the sample size increases, the two values converge.

As previously noted, EMCs tend to be highly variable. In order to evaluate the sensitivity of the WMM output in response to such highly variable input values, WMM has the option of specifying the uncertainty of the loading as a function of the variability contributing to the EMC. EMC data has been shown (FHWA, 1990) to be log-normally distributed. It can be shown that the percentile rank of the observed EMCs can be described by the following formula :

$$EMC_{(High,\ Low)} = e^{(U+Z+W)}$$

where
EMC = High or Low range, as desired and set by Z

Z = Standard normal deviate:
= 1.645 for 95% percentile
= 1.282 for 90% percentile
= -1.282 for 10% percentile
= -1.645 for 5 % percentile
(and other variables as previously defined.)

The practical application of this relationship is to estimate the annual loading using a 'high' estimate of the EMC. This is usually set to the 95th percentile. A similar model execution can be completed using a 'low' estimate (for example, 5th percentile) in order to bracket the probable true value of the EMC. The exact percentile(s) chosen can be set by the user in WMM. Fundamentally, such sensitivity analysis allows managers and decision-makers to answer questions like . . . Would I make the same management decisions if these events only occurred 5% of the time. If the answer is no, or if there is doubt, then a more in-depth study is probably warranted.

Agricultural Land Use Stormwater Data: Of particular concern for the Hutchinson evaluation was the impact of agriculture because it constitutes such a large fraction of the land use. Agricultural practices and impacts vary greatly with area, season and crop management practices. For the present evaluation, wheat field runoff studies completed by Dr. Andrew Sharpley (Sharpley et al, 1992) were used to develop phosphorus EMCs for a variety of crop management practices. The studies were carried out at sites in Oklahoma and Texas. Summary results are included in **Table 2-8** along with other EMC databases evaluated.

Urban Land Use Stormwater Data: Several databases were evaluated to derive urban land use EMCs. The older (circa 1970-1980's) NURP data was reviewed, and contrasted with the new MS4 (Municipal Separate Storm Sewer System) monitoring data collected under the EPA's NPDES Part 2 Stormwater Permit Application process. The NURP data was evaluated as a complete dataset, and as a subset of the data collected in Kansas City. As part of the permit application process, representative stormwater outfalls were monitored in cities and **Table 2-8** counties with populations greater than 100,000. These "representative" outfalls typically discharged stormwater from drainage areas with predominantly residential, commercial, or industrial land uses. Each outfall was monitored and sampled during a minimum of three storm events. CDM developed a database of MS4 results that included 192 sites.

Table 2-8 represents a summary of the databases considered for the Hutchinson stormwater quality evaluation. Based on a review of the data presented, the EMCs deemed most robust and representative of the Hutchinson watershed are given in **Table 2-9**.

2.7.2 Base Flow Discharges

In addition to estimating stormwater runoff loads, the WMM calculates loadings associated with base flow. Ideally, the gaged site should be located in, or near, the study area with a 20+ year period of record. In addition, since base flow decreases with increasing urbanization because of decreasing area for infiltration, the ideal gage site should reflect relatively pristine, undeveloped base flow conditions. Difficulty was encountered in locating a suitable gaged site from which to derive base flow estimates from stream-flow. Several long-term flow records were obtained from the USGS site (http://waterdata.usgs.gov/ nwis-w/KS/) and reviewed, but were rejected because of significant diversions, or reduced base flow due to local irrigation practices. For example, the Arkansas river at Hutchinson (USGS gage 07143330) produces less than 1 inch of streamflow over a 38,000 square mile watershed.

Discussion with USGS staff (B. Lacock, personal communication) indicated that there is no base flow remaining for this part of the country due to the large number of irrigation wells (7,000+) in the watershed. Based on this, the WMM base flow component was set to zero for the Hutchinson evaluation. In the absence of a base flow contribution, the base flow concentrations were set to zero.

2.7.3 Point Source Discharges

Pollutant loadings from point source dischargers such as regional WWTPs are usually estimated to determine the relative contributions of point versus nonpoint pollution loadings. However, no significant point source dischargers are known to discharge to waters within the City.

Table 2-8

EMC Values Reviewed for Hutchinson, KS

	BOD mg/L	COD mg/L	TSS mg/L	TKN mg/L	NO2+ NO3 mg/L	TDS mg/L	TP mg/L	DP mg/L	Pb mg/L	Cu mg/L	Zn mg/L	Cd mg/L
Nationwide Urban Runoff Program												
RESIDENTIAL	10.8	83	140	--	0.96	--	0.47	0.16	0.18	0.05	0.18	--
MIXED	8.8	75	102	--	0.67	--	0.33	0.07	0.19	0.04	0.20	--
COMMERCIAL	9.7	61	91	--	0.63	--	0.24	0.10	0.13	0.04	0.33	--
OPEN / NONURBAN	--	51	216	--	0.73	--	0.23	0.06	0.05	--	0.23	--
HIGHWAY	9.7	103	142	--	0.83	--	0.44	--	0.53	0.05	0.37	--
RAINFALL	3.3	17	7	--	0.60	--	0.03	0.01	0.00	0.00	0.11	--
Kansas City - NURP Program	BOD mg/L	COD mg/L	TSS mg/L	TKN mg/L	NO2+ NO3 mg/L	TDS mg/L	TP mg/L	DP mg/L	Pb mg/L	Cu mg/L	Zn mg/L	Cd mg/L
MEDIUM DENSITY RESIDENTIAL (Overton)	12	162	2,216	--	--	--	1.64	0.31	0.138	0.091	0.831	--
MEDIUM DENSITY RESIDENTIAL (IC-92nd)	28	176	156	4.187	--	--	1.30	0.24	--	--	--	--
MIXED (Noland)	--	106	280	--	--	--	0.56	0.17	0.164	0.048	0.814	--
COMMERCIAL (IC Metcalf)	8	55	80	1.175	--	--	0.25	0.12	--	0.041	0.465	--
INDUSTRIAL (Lenaxa)	14	58	102	1.385	--	--	0.60	0.35	--	0.036	2.721	--
Southeastern US	BOD mg/L	COD mg/L	TSS mg/L	TKN mg/L	NO2+ NO3 mg/L	TDS mg/L	TP mg/L	DP mg/L	Pb mg/L	Cu mg/L	Zn mg/L	Cd mg/L
FOREST, OPEN, PARK	1	--	11	0.94	0.31	100	0.05	0.004	--	--	--	--
AGRICULTURE, GOLF COURSE	4	--	55	1.74	0.58	100	0.34	0.23	--	--	--	--
LOW DENSITY RESIDENTIAL	15	71	27	1.34	0.63	286	0.44	0.33	0.002	0.009	0.051	0.002
MEDIUM DENSITY RESIDENTIAL	9	65	59	1.77	0.27	59	0.45	0.27	0.013	0.007	0.057	0.001
HIGH DENSITY RESIDENTIAL	8	53	42	1.03	0.67	141	0.20	0.09	0.011	0.022	0.065	0.001
INSTITUTIONAL	7	50	41	1.24	1.05	114	0.15	0.08	0.012	0.018	0.079	0.001
INDUSTRIAL	14	83	77	1.47	0.40	130	0.28	0.20	0.023	0.024	0.132	0.001
COMMERCIAL	8	53	42	1.03	0.67	141	0.20	0.09	0.011	0.022	0.065	0.001
WETLANDS	5	51	5	1.10	0.40	100	0.19	0.10	0.006	0.003	0.005	0.000
WATERCOURSES & WATERBODIES	3	22	5	1.10	0.20	100	0.17	0.09	0.006	0.003	0.005	0.000
MAJOR ROADWAYS	11	99	121	1.51	0.34	189	0.40	0.15	0.039	0.022	0.189	0.002
Phase 1 MS4 NPDES	BOD mg/L	COD mg/L	TSS mg/L	TKN mg/L	NO2+ NO3 mg/L	TDS mg/L	TP mg/L	DP mg/L	Pb mg/L	Cu mg/L	Zn mg/L	Cd mg/L
FOREST, OPEN, PARK	25	72	72	1.00	0.85	134.00	0.33	0.14	0.02	0.01	0.03	0.001
RESIDENTIAL	13	53	47	4.13	1.16	94.61	0.47	0.19	0.03	0.01	0.06	0.004
MULTIFAMILY	18	68	51	1.34	0.39	60.32	0.27	0.13	0.02	0.01	0.10	0.000
LIGHT INDUSTRIAL, COMMERCIAL	9	53	58	3.57	0.95	63.74	0.26	0.09	0.01	0.01	0.10	0.001
Agricultural Runoff - Oklahoma & Texas	BOD mg/L	COD mg/L	TSS mg/L	TKN mg/L	NO2+ NO3 mg/L	TDS mg/L	TP mg/L	DP mg/L	Pb mg/L	Cu mg/L	Zn mg/L	Cd mg/L
No Till Wheat	--	--	--	--	--	--	1.48	0.76	--	--	--	--
Conventional Till Wheat	--	--	--	--	--	--	5.27	0.30	--	--	--	--
Native Grass	--	--	--	--	--	--	0.22	0.13	--	--	--	--

Table 2-9
Event Mean Concentrations Modeled (mg/L)
Hutchinson, KS

	BOD, mg/L				COD, mg/L				TSS, mg/L			
	MEAN	CV	N=	Data	MEAN	CV	N=	Data	MEAN	CV	N=	Data
AGRICULTURE, GOLF COURSE	11.6	0.51	15	A	71	0.19	13	A	11.9	0.21	8	I
FOREST, OPEN, PARK	11.6	0.51	15	A	71	0.19	13	A	52	0.29	15	A
HEAVY INDUSTRIAL, ROADS	9.7	0.50		H	103	0.71		H	142	1.16		H
HIGH DENSITY RESIDENTIAL	17.8	0.40	14	C	68	0.19	14	C	17.8	0.40	14	C
LIGHT INDUSTRIAL, COMMERCIAL	11.0	0.62	21	D, E	57	0.73	36	D, E	91	1.47	40	D, E
LOW DENSITY RESIDENTIAL	25.4	1.68	14	L	72	0.61	12	L	72.3	1.49	15	L
MEDIUM DENSITY RESIDENTIAL	20.0	0.63	10	B	169	0.83	25	B	156	1.16	28	B
PASTURE & RANGELAND	11.6	0.51	15	A	71	0.19	13	A	52	0.29	15	A
WATERCOURSES & WATERBODIES	3.0	0.30		J	22	0.40		J	5	0.90		J
WETLANDS	5.0	0.30		J	51	0.40		J	5	0.90		J

	TDS, mg/L				TP, mg/L				DP, mg/L			
	MEAN	CV	N=	Data	MEAN	CV	N=	Data	MEAN	CV	N=	Data
AGRICULTURE, GOLF COURSE	114	0.14	15	A	3.38	2.37	261	F	0.53	2.37	261	F
FOREST, OPEN, PARK	114	0.14	15	A	0.22	0.50	155	M	0.13	0.38	155	M
HEAVY INDUSTRIAL, ROADS	60	0.35	13	C	0.44	1.10		H	0.44	1.10	23	N
HIGH DENSITY RESIDENTIAL	60	0.35	13	C	0.27	0.83	14	C	0.13	0.57	14	C
LIGHT INDUSTRIAL, COMMERCIAL	60	0.35	13	C	0.42	0.92	36	D, E	0.24	1.36	37	D, E
LOW DENSITY RESIDENTIAL	134	0.71	15	L	0.33	0.81	15	L	0.14	1.14	15	L
MEDIUM DENSITY RESIDENTIAL	95	0.24	173	G	1.47	1.11	18	B	0.28	0.52	18	B
PASTURE & RANGELAND	114	0.14	15	A	0.22	0.50	155	M	0.13	0.38	155	M
WATERCOURSES & WATERBODIES	100	0.90		J	0.17	0.70		J	0.09	0.70		J
WETLANDS	100	0.90		J	0.19	0.70		J	0.10	0.70		J

	TKN, mg/L				NO2+NO3-N, mg/L				Pb, mg/L			
	MEAN	CV	N=	Data	MEAN	CV	N=	Data	MEAN	CV	N=	Data
AGRICULTURE, GOLF COURSE	2.44	0.34	8	I	0.10	0.50		I	0.0047	0.29	13	A
FOREST, OPEN, PARK	0.99	4.70	13	A	0.73	1.22	13	A	0.0047	0.29	13	A
HEAVY INDUSTRIAL, ROADS	1.78	0.67		H	0.66	0.62	15	H	0.0200	0.18	14	C
HIGH DENSITY RESIDENTIAL	1.34	0.71	14	C	0.39	0.71	14	C	0.0200	0.18	14	C
LIGHT INDUSTRIAL, COMMERCIAL	1.28	0.73	29	D, E	0.95	1.52	112	K	0.0200	0.18	14	C
LOW DENSITY RESIDENTIAL	1.00	0.44	13	L	0.85	2.50	13	L	0.0200	2.82	13	L
MEDIUM DENSITY RESIDENTIAL	4.187	0.94	8	B	1.16	2.07	143	G	0.0280	1.54	142	G
PASTURE & RANGELAND	0.99	4.70	13	A	0.73	1.22	13	A	0.0047	0.29	13	A
WATERCOURSES & WATERBODIES	1.1	0.40		J	0.20	0.50		J	0.0060	0.70		J
WETLANDS	1.1	0.40		J	0.40	0.50		J	0.0060	0.70		J

	Cu, mg/L				Zn, mg/L				Cd, mg/L			
	MEAN	CV	N=	Data	MEAN	CV	N=	Data	MEAN	CV	N=	Data
AGRICULTURE, GOLF COURSE	0.004	0.20	13	A	0.025	0.23	13	A	0.0005	0.17	13	A
FOREST, OPEN, PARK	0.004	0.20	13	A	0.025	0.23	13	A	0.0005	0.17	13	A
HEAVY INDUSTRIAL, ROADS	0.05	0.87		H	0.370	1.37		H	0.0020	0.15		J
HIGH DENSITY RESIDENTIAL	0.01	0.15	14	C	0.100	0.28	14	C	0.0004	0.10	14	C
LIGHT INDUSTRIAL, COMMERCIAL	0.038	0.29	11	D, E	1.590	2.04	13	D, E	0.0010	0.33	134	K
LOW DENSITY RESIDENTIAL	0.007	1.50	13	L	0.033	1.09	13	L	0.0010	2.20	13	L
MEDIUM DENSITY RESIDENTIAL	0.091	0.50	12	B	0.831	0.39	11	B	0.0040	2.65	154	G
PASTURE & RANGELAND	0.004	0.20	13	A	0.025	0.23	13	A	0.0005	0.17	13	A
WATERCOURSES & WATERBODIES	0.003	0.80		J	0.005	1.10		J	0	0.00		J
WETLANDS	0.003	0.80		J	0.005	1.10		J	0	0.00		J

A= NDPDES (Open)
B= Kansas City NURP (2 Residential Sites)
C=NPDES MS4 (MultiFamily)
D= Kansas City NURP (Commercial Site)
E= Kansas City NURP (Industrial Site)
F= Sharpley et al (Till, No Till Wheat Sites)
G= NPDES MS4 (Residential Sites)
H= NURP (Highway)
I= SBNEP(Golf)
J= Southeastern US
K=NPDES MS4 (Light Industrial and Commercial Sites
L= NPDES MS4 (Forest, Open and Park Sites)
M= Sharpley et a. (Native Grass Sites)
N= Federal Highway Administration (Highway Sites)

2.7.4 Failed Septic Tank Loadings

Within the WMM framework, provisions have been made to incorporate the impacts of failed septic tanks. Estimates are derived by multiplying the loading rate by a factor to simulate the introduction of untreated, or partially treated septic tank effluent into the receiving waters. Failure rates can often be estimated from local health department records of tank repair and/or replacement. This option was not exercised in the present application for the City of Hutchinson but is available for future evaluations.

2.7.5 Best Management Practice (BMP) Removal Efficiencies

The design and applicability of Best Management Practices (BMPs) are discussed in detail in **Appendix C**, but are briefly reviewed here in the context of the impact on loading. Common forms of stormwater treatment include structural facilities, such as treatment swales, wet detention ponds and dry retention areas. Known as a form of Best Management Practice (BMP), these structures provide Table 2-9 different pollutant removal efficiencies. The effectiveness of a given BMP depends on the type and size of facility and type of pollutant. For example, if a particular pollutant exists mostly in the dissolved form, then a BMP which relies on settling of solid particles to achieve pollutant reduction will be less effective.

In the case of a dry retention facility, a properly designed structure will fully "treat" approximately 90 percent of the average annual runoff by diverting the runoff from storms under 1 inch and allowing this volume to infiltrate into the ground. Thus, a 90 percent removal efficiency for all parameters is used for this form of stormwater treatment. Swales provide areas for settling of particulate matter (and attached pollutants), and thus are more efficient at removing pollutants which tend to be associated with solids. Swales are not designed to capture a significant portion of the runoff, but simply to slow the movement of stormwater to enhance the settling. Wet detention ponds are also designed to delay the movement of stormwater. Settling within a wet detention pond is enhanced when the water velocity slows after entering the pond, and by the friction afforded by the emergent vegetation. The vegetation and in-column biota also remove nutrients and other pollutants through biological uptake. Ponds generally are designed with a two to four week residence time during the wet season to facilitate the uptake.

Table 2-10 lists five common forms of structural stormwater BMPs, along with the load removal efficiencies which are typically assigned within the WMM model. Currently, there are no structural BMPs located within the City.

2.7.6 Delivery Ratio

Following storm events, when the stream and tributary flows return to quiescent conditions, some of the pollutants associated with solids will settle out, resulting in a reduction in load delivered further downstream. Often (e.g., in the case of potable water reservoirs) it is desirable to determine how much of the runoff load actually reaches a receiving waterbody. Within WMMs, a "delivery ratio" is set from 0-1.0 to account for these settling losses. Generally, turbulent flow will persist (Rechow, et al. , 1988) for approximately 1. 5 - 2.0 times the actual storm event duration. For most of the U.S., the typical storm event duration is 4-8 hours. Thus, for a period of 6-16 hours following, turbulent conditions will persist, and settling losses will be minimal.

Table 2-10
Stormwater BMPs for the City of Hutchinson

Parameter, mg/L	*Retention* [1]	*Wet Detention* [1]	*Swale* [1]	*Baffle Box* [2]	*Dry Detention* [1]
BOD_5	90 mg/L	30 mg/L	30 mg/L	0 mg/L	25 mg/L
COD	90 mg/L	30 mg/L	30 mg/L	0 mg/L	25 mg/L
TSS	90 mg/L	90 mg/L	80 mg/L	85 mg/L	85 mg/L
TDS	90 mg/L	40 mg/L	10 mg/L	0 mg/L	0 mg/L
Total - P	90 mg/L	50 mg/L	40 mg/L	35 mg/L	25 mg/L
Dissolved P	90 mg/L	70 mg/L	10 mg/L	0 mg/L	0 mg/L
TKN	90 mg/L	30 mg/L	40 mg/L	20 mg/L	15 mg/L
$NO_2 + NO_3$ - N	90 mg/L	30 mg/L	40 mg/L	40 mg/L	0 mg/L
Lead	90 mg/L	80 mg/L	75 mg/L	75 mg/L	75 mg/L
Copper	90 mg/L	70 mg/L	50 mg/L	50 mg/L	55 mg/L
Zinc	90 mg/L	50 mg/L	50 mg/L	35 mg/L	45 mg/L
Cadmium	90 mg/L	80 mg/L	65 mg/L	60 mg/L	75 mg/L

(1) Watershed Management Model Verions 3.30 User's Manual. CDM, 1994.
(2) Based on 85 % removal of the suspended fraction.

Except for very large watersheds, travel times are usually short, and settling is not an issue. Furthermore, if the intent of the Master Plan is to compare and identify sub-basins which contribute an abnormally high pollutant load, then a delivery ratio of 1.0 is appropriate. Thus, for the present application of the WMM, the individual sub-basin delivery ratios were set to 1.0.

2.7.7 Loading Calculations

The estimation of stormwater pollutant loading is accomplished by summing the runoff from both pervious and impervious area for each land use and then multiplying the result by the appropriate EMC. Thus, the annual loading from each basin is the sum of loadings from all land uses within that basin. Results are presented in Section 3.

2.8 Calibration and Verification

Calibration and verification of stormwater modeling results to actual historic events where possible is necessary in order to "tune" the models to specific conditions in a study area such as the City. High water marks and eyewitness accounts of flooding were used where possible to qualitatively verify the water quantity models because stream monitoring was not available.

Runoff Parameters

Depending on the initial verification results, one or more of the runoff parameters were adjusted to more accurately represent the sub-basin runoff response to the design rainfall events. The first parameters adjusted were typically the infiltration parameters (from the default of AMC II). Generally, the only other runoff parameter that may have been adjusted was the sub-basin width term. Reducing the sub-basin width reduces the sub-basin peak flow, slows the overall sub-basin response, and in some cases increases the total infiltration volume by allowing infiltration to occur for a longer period of time.

Hydraulic Parameters

After adjusting for rainfall and runoff parameters, hydraulic parameters might be adjusted if variations between actual and simulated stages are noted. Hydraulic parameters such as Manning's n values, tailwater effects, and floodplain storage were adjusted based on observed flooding. Manning's n estimates were revised to reflect actual out-of-bank conditions, siltation, and debris blockage.

Base flows were simulated from the Harsha diversion gates through Cow Creek for the water quantity verification events. No other base flows were used in the models.

2.9 Alternatives Evaluations

This section describes the alternatives evaluations that were conducted in order to produce a ranked list of recommendations for stormwater management improvements.

The following factors were considered in developing alternatives:

1. Technical feasibility and reliability - the project or option should be feasible and reliable based on current technology while solving or relieving as many of the known problem(s) as possible (maximize public safety by minimizing risk).

2. Socio-political acceptability - the project or option should be acceptable to the public and the regulatory agencies.

3. Economical reasonability - the project or option should give a reasonable degree of public protection for the public funds which are expended.

4. Environmental consistency - the project or option should be consistent with known environmental goals and facts.

5. Financial ability - the project or option should have a reasonable chance of being funded without causing undue financial hardship.

Based upon these factors, the following considerations were used in developing the alternatives:

1. Only the most technically feasible and reliable options were considered (e.g., some technically possible options that would be difficult to implement were excluded).

2. Potential public reaction and support were considered and regulatory agency guidelines were incorporated into all options.

3. Options were developed based on obtaining improved levels of service for both water quantity and water quality, with cost.

4. All options were developed with the intent of improving the environmental health of the area(particularly in terms of water quality and wetlands benefits).

5. Financing options and ability to pay were considered for each option.

Alternatives for solving flooding problems and improving water quality conditions will involve the use of both structural and non-structural stormwater management approaches. This section provides details on the structural approaches.

2.9.1 Implementation Considerations

A critical step in the implementation of any alternative solution is the careful consideration of practical constraints and necessary decisions. The following paragraphs highlight and discuss these constraints and decisions.

Constraints

The constraints for a given area are identified and factored into the alternative analysis. In developing retrofit BMPs, there generally is not adequate open land.

Decisions

Water quality controls should be considered in retrofit projects in order to achieve one of the major goals of this program--stormwater control to meet future NPDES permit requirements.

Existing regulations do not have firm criteria for retrofitting large-scale urban areas in a practical, yet environmentally sensitive manner. This program recommends approaches based on the need to solve severe flooding and water quality degradation in certain areas with limited options and available space for facilities. The outlined Level of Service (LOS) approach for retrofits is consistent with the goals of the state water policy and EPA NPDES stormwater permitting guidelines by attempting to restore and/or improve adversely impacted wetlands and degraded water quality.

The LOS decision will drive the size and cost of facilities. Technically, much can be accomplished, but costs begin to rise exponentially for limited returns. Participation by the public and the regulatory agencies is critical to the implementation process. The public must decide on the LOS they desire and are willing to pay for. In addition, trade-offs of flood protection and water quality enhancement for park alternatives must be considered. The regulatory agencies and the public need to consider the net positive effects of the alternative solutions.

2.9.2 Definition of Alternatives

Five alternatives have been developed for the study area. A Level 1 maintenance condition was used for the 5-, 10-, 25-, and 100-year design storms. This Level 1 maintenance generally involves removal of silt and other obstructions from culverts and channels.

Alternative 1 is no action. This alternative was considered in the ultimate decision on implementation in order to fully understand the problems, the solutions, and the true benefits.

Alternative 2 involves upsizing the existing PSWMS storm sewers, channels, and culverts. The improvements would replace existing conveyance systems.

Alternative 3 adds new storm sewers parallel to existing PSWMS storm sewers, and increases existing channel and culvert capacities.

Alternative 4 incorporates local detention facilities throughout the City. The detention facilities would generally be small in size and strategically located near or at problem areas.

Alternative 5 incorporates large storm sewers and regional detention facilities located in strategic areas to relieve excess flows to the existing stormwater system.

Many local areas exist in the planning area that currently are not served by local storm sewer systems. Local storm sewers need to be added to the improvements in addition to the PSWMS improvements.

Section 3
Results

This Section presents the results of the stormwater analysis. Discussed are the water quantity and water quality modeling results.

3.1 Levels of Service

Stormwater management has become a complex national issue in the last decade. In the past, ditching and draining to convey stormwater away from development, coupled with filling of floodplains and wetlands, was the accepted practice. Over the years, flood damages along with adverse impacts to water quality, fisheries, scenic areas, recharge areas, and wildlife habitats have forced a change in the accepted approaches to manage stormwater.

Hutchinson is similar in characteristics to other communities regarding stormwater service. Many of the City's older stormwater management systems provide inadequate flood protection for streets and provide little or no treatment of the runoff prior to release. This is due mainly to the "piecemeal approach" to stormwater management and the aging condition of the existing infrastructure.

Level of Service (LOS) is a measure of benefit or protection provided by stormwater systems. Proper LOS decisions for water quantity (flooding) and water quality protection are essential for the City. LOS decisions set the goals for a Capital Improvement Program (CIP) that establishes the intent of public involvement. LOS recommendations in this plan have been based on CDM's evaluations of Hutchinson and experience with similar programs. They have been formulated to protect or enhance public safety and to provide benefits for the goals of the program.

Water Quantity LOS

The LOS for water quantity (flood control) retrofit is an essential decision for the City because it will directly affect the size and cost of facilities. Stated simply, the improvements are developed to protect public safety by keeping major roads passable and protecting buildings from flooding. **Figure 3-1** shows examples of various water quantity LOS. For example, Class D provides for flood protection of first-floor elevations (FFE), and less than 0.75 feet over the arterial roads, while Class C provides control of flood waters to less than 0.5 feet over the arterial road crowns. **Table 3-1** provides a list of water quantity LOS goals used in the alternatives evaluations.

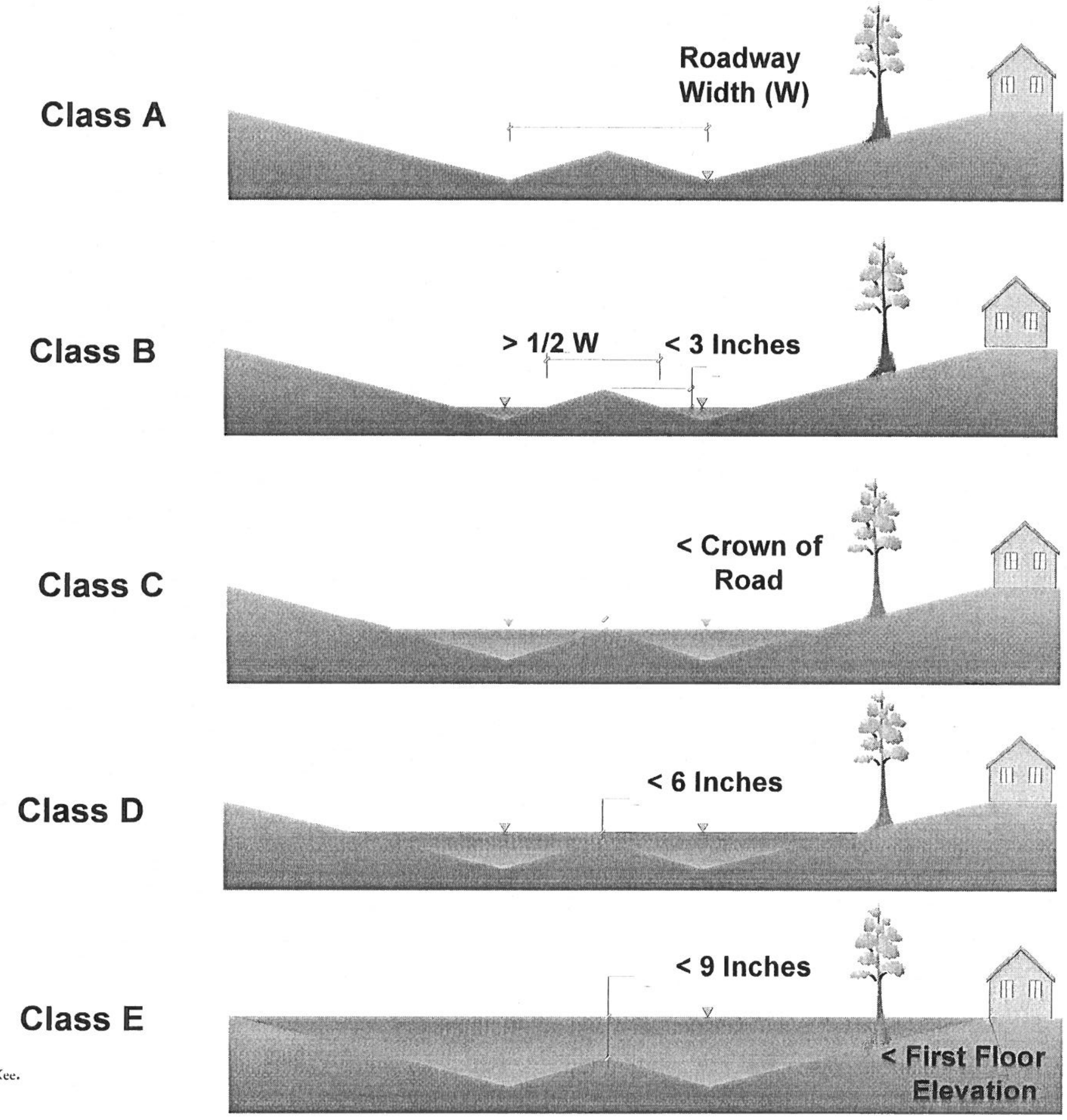

Figure 3-1
Water Quantity
Levels of Service
Hutchinson,
Kansas

CDM Camp Dresser & McKee.
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Table 3-1
Water Quantity Levels of Service
Flood Protection Goals and Classes [1]

	10-Year		25-Year		100-Year	
Structure/ Facility	10-Year	Class	25-Year	Class	100-Year	Class
Houses/ Buildings	<FFE[2]	E	<FFE	E	<FFE	E
Arterial Roads[3]	½ W[4]	B	Crown	C	<0.5ft	C
Other Roads[5]	<0.5 ft	D	<0.75 ft	E	<1 ft	NA

(1) All storm durations are 24 hours.
(2) Peak flood stages less than the FFE based on available data.
(3) Roads with four or more travel lanes, or roads that are the only access to a respective area/development.
(4) Flood inundation limited to each side of the road such that half of the roadway width (W) or one travel land width is not flooded.
(5) Other roads that are not critical for evacuation, but that will be used to estimate encroachment of FFEs.

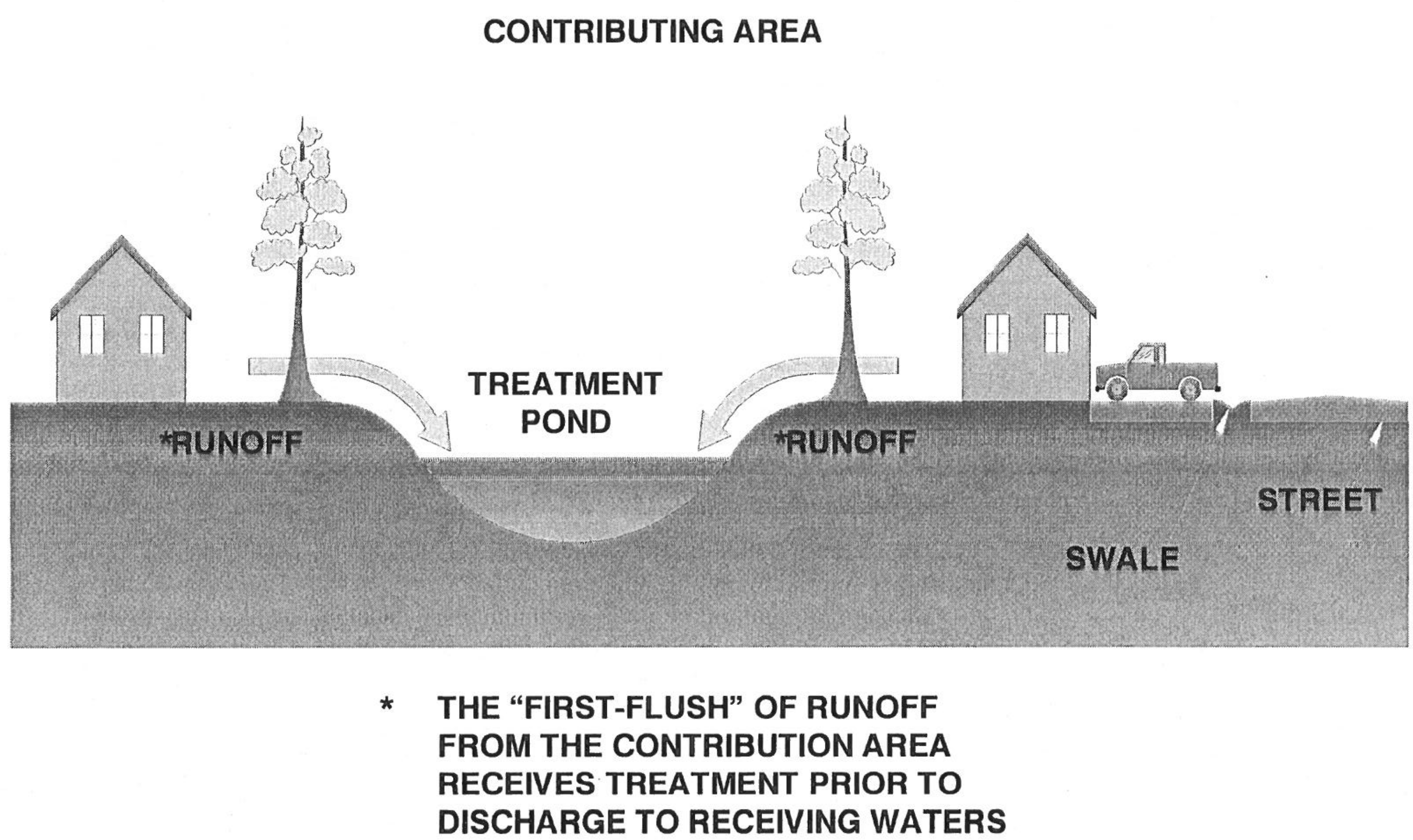
As defined by the scope of services, CDM evaluated five alternative solutions, including a "no action" alternative. For urban areas, a diminishing return for public expenditures occurs sooner than for new developments due to severe space constraints, and low-lying first-floor and road elevations. It is also important to note that storm events greater than the 100-year may exceed LOS goals.

Water Quality LOS

Water quality LOS are generally based on a "first flush" abatement of pollutants for new developments (see **Figure 3-2**). Retrofit water quality LOS are often limited due to technical and financial constraints. In general, water quality retrofits are considered if flooding solutions are implemented or if a clear cause-and-effect relationship of water quality degradation or impaired use can be attributed to a source. Potential federal NPDES regulations may require water quality treatment within a framework of basin-specific goals or rules. For these SWMP solution evaluations, technical and financial constraints were considered in the recommendations for water quality retrofit LOS. **CDM recommends that the City consider water quality benefits in design features for new developments and in retrofit projects.**

3.2 Water Quantity Analysis Results

CDM modeled and evaluated the City of Hutchinson PSWMSs under present and future land use conditions for the 5-, 10-, 25-, and 100-year design storm events. These storm events have the probability of occurring once every 5-, 10-, 25-, and 100-years. The model evaluated TP40 24-hour design rainfall depths of 3.5, 4.5, 5.5, and 7.5" for the 5-, 10-, 25-, and 100-year storm events, respectively. The evaluation produced flows and water surface elevations for the PSWMSs. CDM



CDM Camp Dresser & McKee.
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Figure 3-2
First Flush Abatement of Pollutants
Hutchinson, Kansas

determined the capacities of the PSWMS components based on the resulting water surface elevations for the design storm events. CDM also summarized historical reported ponding and flooding problems.

CDM prepared a questionnaire asking the residents and businesses in the City of Hutchinson to identify historical stormwater problems they may have observed. 2,012 responses (1,940 residences, 68 businesses, and 4 churches) were received by the City identifying 155 problem areas. The reported problems were evaluated and the location and severity summarized on **Figure 3-3**. The reported problems typically are frequent and/or excessive street and yard ponding in low, flat areas. As shown in **Table 3-2**, Cow Creek has by far the most reported problem areas with 96, followed by the ESD with 49. Together, these two systems account for 94% of the reported problems.

Table 3-2
Reported Problem Areas by PSWMS

PSWMS	*No. of Reported Problem Areas*
Arkansas River	0
Sand Hills Diversion	2
Cow Creek	96
East Side Drain	49
GVI	8
Total	**155**

The City has insufficient capacity in its Cow Creek, ESD, and GVI PSWMSs, based on the level of service criteria presented in **Section 3.1**. The modeling results are presented in **Appendix A** and **Figure 3-2**. Surface ponding depths are summarized in **Appendix A** for the evaluated design storm events and **Figure 3-4** shows the capacities of the PSWMS components as a thematic plot. The insufficient capacities can be attributed to undersized storm sewers with poor surface drainage, lack of storm sewers to localized areas, and limited outlets for the storm sewers. Several areas have adequate storm sewer capacity, but lack sufficient inlet capacity to allow water to enter the system with minimal ponding on the streets. The modeling results confirmed the reported problem areas. The results of the analysis are discussed below for each PSWMS.

3.2.1 Sand Hills Diversion

Two problem areas were reported in the Sand Hills Diversion Watershed. The reported problems are the result of a lack of a SSWMS, not due to insufficient capacity of the PSWMS.

The components of the SHD PSWMS meet the desired LOS. The SHD PSWMS has a 100-year capacity. This is based on the modeling assumption that water does not overtop 43rd Avenue and ponds in the area north of 43rd Avenue for the 100-year event. City Staff observed the area north of 43rd Avenue during extreme storm events and flood waters did not overtop 43rd Avenue.

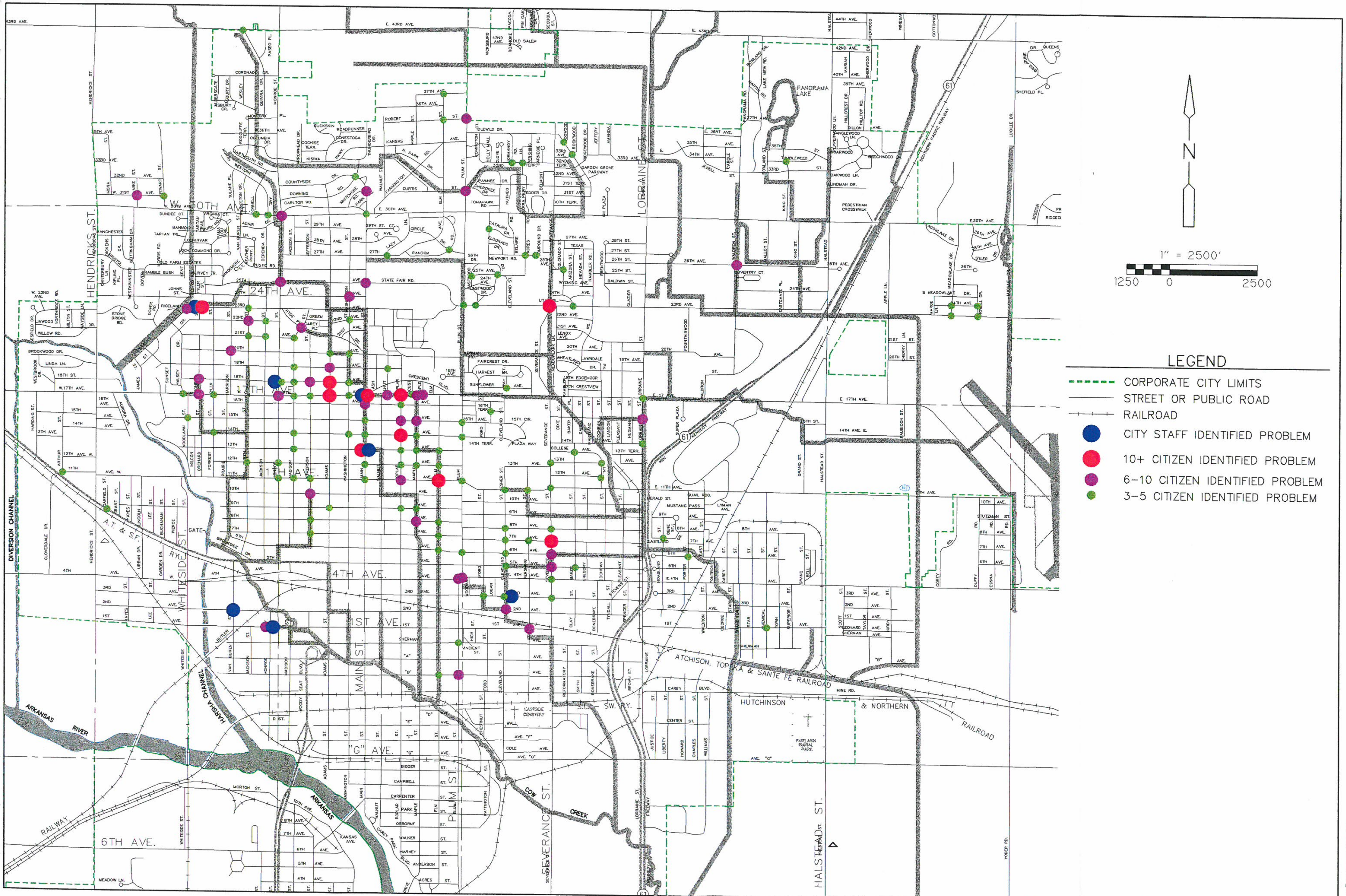

Figure No. 3-3
PROBLEM AREAS
STORMWATER MASTER PLAN
HUTCHINSON, KANSAS

3.2.2 Cow Creek

There were 96 problem areas reported in the Cow Creek Watershed. Some of the reported problems areas are served by storm sewers, while other reported problem areas are not served by a storm sewer system. There were no problems reported along the Cow Creek Channel.

The capacity of the Cow Creek PSWMS ranges from less than a 5-year event (more than 3-inches of ponding occurs for the 5-year design rainfall storm event) to more than a 100-year event, depending on the location. Cow Creek has less than a 5-year level of protection downstream of Severance and at Plum Street, and has a 100-year level of protection at Main Street and upstream of 2nd Avenue as shown on **Figure 3-4**. Approximately 80 percent of the storm sewers in the Cow Creek PSWMS have far less than a 5-year level of protection, confirming the reported problem areas. Also, there is up to two feet of sediment in the channel upstream of 2nd Avenue potentially reducing the capacity of storm sewers that outfall to the area. This would be expected because larger flows are diverted by the Harsha Channel, significantly reducing velocities in Cow Creek upstream of 2nd Avenue.

The components of the PSWMS that do not meet the desired LOS are:

- Cow Creek channel from the City limits to Elm Street
- Severance Street storm sewer system from SL-SW Railroad to 5th Avenue
- Elm Street storm sewer system from 6th Avenue to 23rd Avenue
- Maple Street storm sewer system from 7th Avenue to 22nd Avenue
- Washington Street storm sewer system from Cow Creek to 5th Avenue
- Sherman Avenue storm sewer system from Cow Creek to Monroe Street
- 5th Avenue storm sewer system from Cow Creek to Monroe Street
- Prairie Street storm sewer system from Cow Creek to 19th Avenue

PSWMS components not meeting the desired LOS are shown on **Figure 3-5**.

3.2.3 East Side Drain

There were 49 problem areas reported in the East Side Drain (ESD) Watershed. Several of the reported problems are along the channel, with most of the reported problems served by storm sewers or not served by a stormwater system at all.

The ESD ranges in capacity from a 5-year event at O'Daniels Street, the Kennedy Freeway, and the Fair Grounds, to a 100-year event at G Avenue and Elm Street. The primary storm sewers serving the ESD PSWMS have less than a 5-year level of protection, confirming the reported problems in the area.

The PSWMS components not meeting the desired LOS are:

- ESD channel from 1st Avenue to 9th Avenue
- ESD channel from Maryland Street to Baker Place
- ESD channel from 23rd Avenue to 27th Avenue
- ESD channel from Nutmeg Street To Plum Street
- ESD channel from Kisiwa Parkway to Coronado Drive
- State Fair channel from State Fair Road to 17th Avenue
- 6th Avenue storm sewer system from Cleveland Street to ESD channel

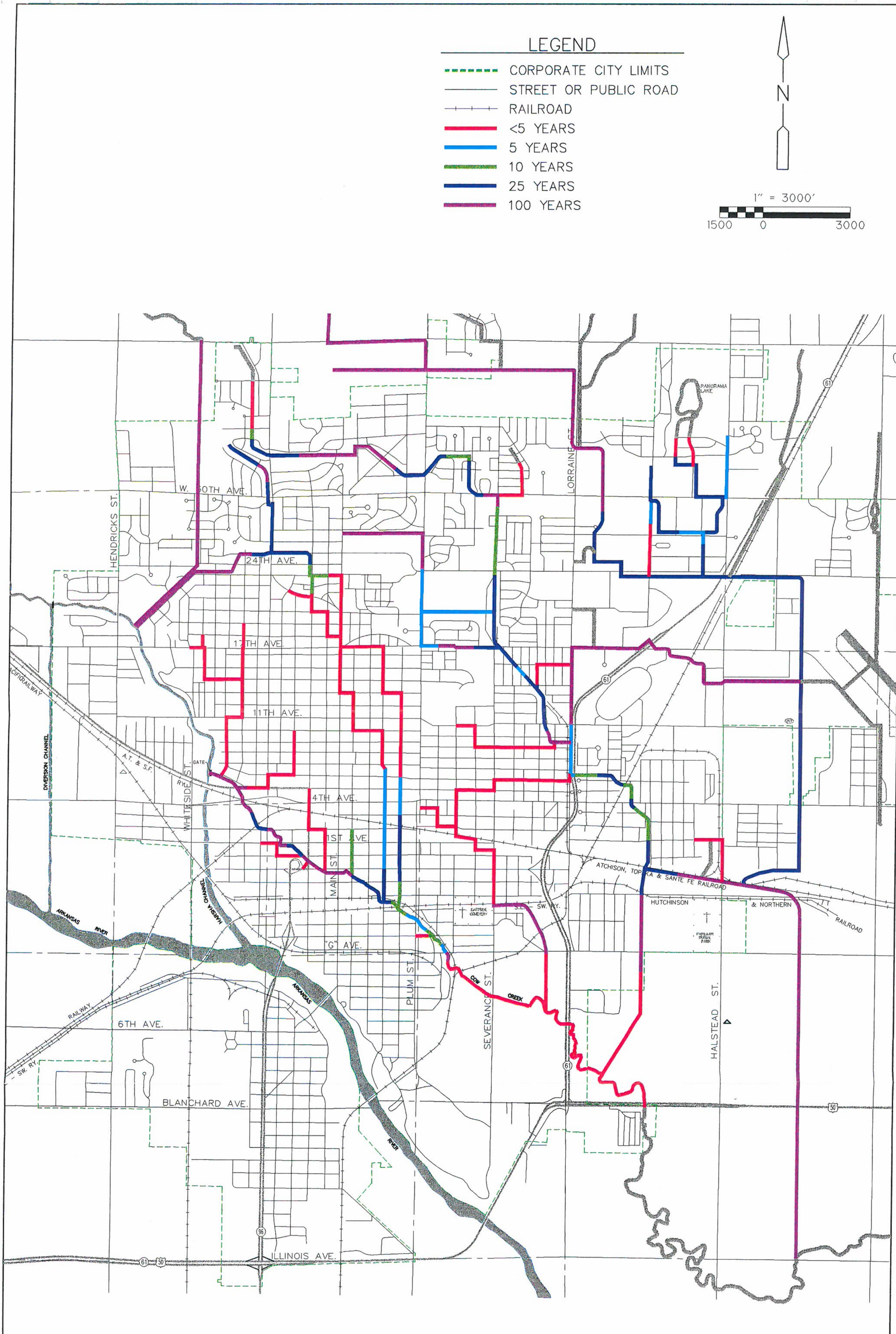

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Figure No. 3-4
PSWMS CAPACITIES
STORMWATER MASTER PLANS
HUTCHINSON, KANSAS

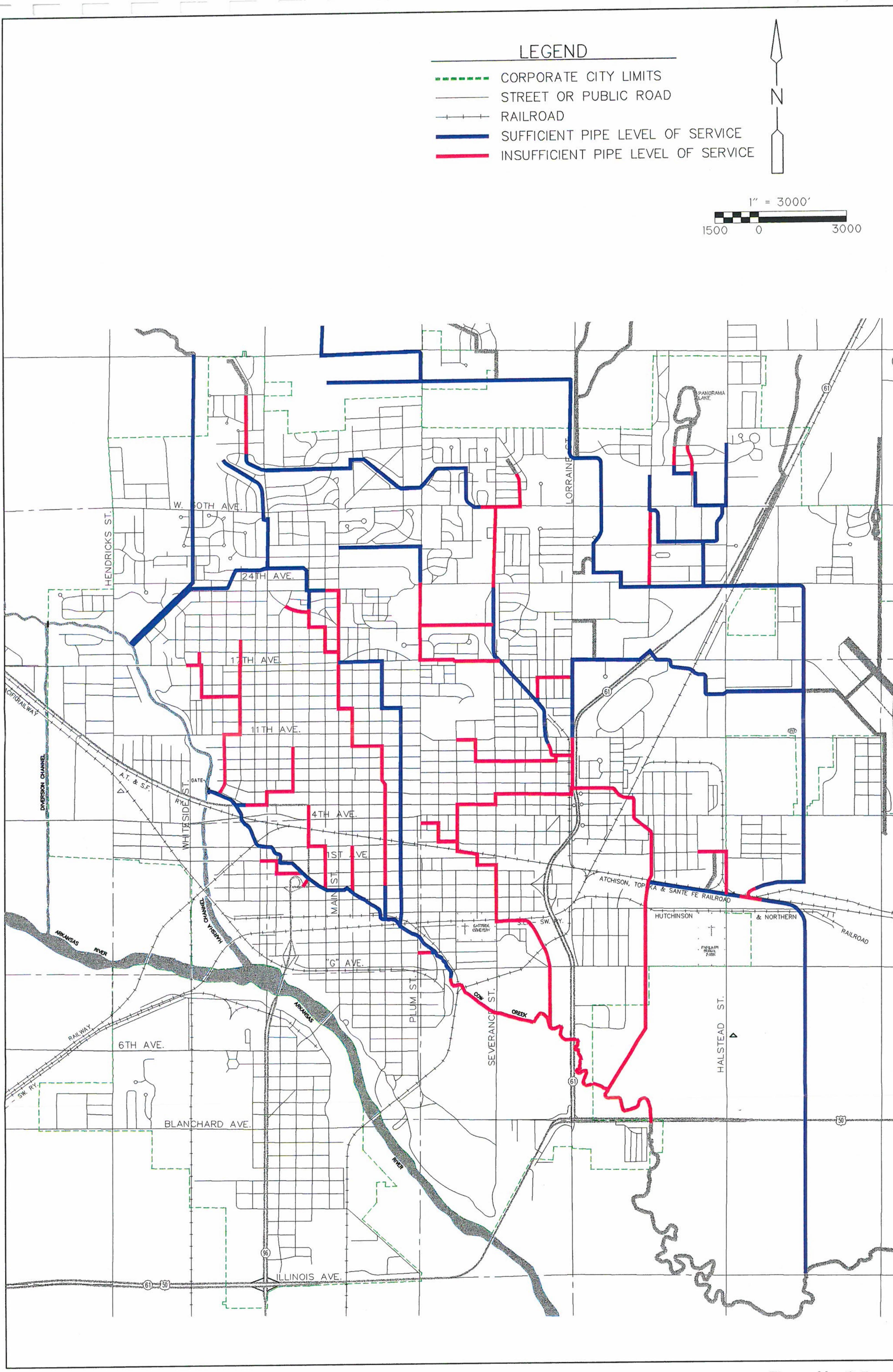

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Figure No. 3-5
PSWMS WITH INSUFFICIENT LEVEL OF SERVICE
STORMWATER MASTER PLANS
HUTCHINSON, KANSAS

- 9th Avenue storm sewer system from Sesher Street to ESD channel
- Cochran Street storm sewer system from 16th Avenue to ESD channel
- 30th Avenue storm sewer system from 32nd Avenue to ESD channel

3.2.4 Grand View Industrial

There were eight problem areas reported in the GVI Watershed. The reported problem areas are served by storm sewers. No problems were reported along the GVI channel.

The GVI channel has a minimum of a 25-year capacity near the AT & SF Railroad, and the capacity increases to a 100-year capacity from 30th to 43rd Avenue. Flows from the unincorporated area north of 43rd Avenue are limited to the GVI channel by several 30-inch storm sewers underneath 43rd Avenue.

The components of the PSWMS that do not meet the desired LOS are:

- AT & SF culvert crossing
- Waldron Street storm sewer system
- Roland Street from 33rd Avenue to 35th Avenue
- King Street from 33rd Avenue to 35th Avenue
- Halsted Street storm sewer system from 1st Avenue to GVI channel

3.3 Water Quality

The watershed was characterized by land uses listed in **Table 3-3.** The WMM loading results by subbasin are included as **Appendix B-2**. The results were normalized by area and ranked as shown in **Appendix B-3**. (Normalizing by contributing area results in a generation rate that can be compared among the subbasins.) The five top-ranked subbasins for each parameter are presented in **Table 3-4.** Subbasins from the Cow Creek Watershed appear highly ranked the most often (49 of 61 top ranked generation rates), followed by Grand View Industries (7), East Side Drain (4) and Sand Hills Diversion(1). Thus, incorporation of BMPs to reduce stormwater loads should be an important consideration for improvements contemplated for the Cow Creek watershed.

Table 3-3 **Land Use Areas**		
Land Use	*Total Area (acres)*	*Percent of Total Study Area*
Forest, Open, Park	588	3%
Pasture	-	0%
Agriculture	14,664	64%
Low Density	2,723	12%
Medium Density	3,878	17%
High Density	-	0%
Institutional	371	2%
Commercial	290	1%
Industrial	410	2%
Watercourses, Waterbodies	-	0%
Total	**22,923**	**100%**

Table 3-4
Hutchinson, KS - Top Ranked Unit Loadings (lbs/acre/yr)

Name	Tributary Area (acres)	Storm Water (lbs/yr)	lb/ac/yr	rank	Name	Tributary Area (acres)	Storm Water (lbs/yr)	lb/ac/yr	rank
BOD					COD				
COW160	44.1	2,406	54.6	1	GVI130	176.5	59,209	335.5	1
COW220	31.3	1,707	54.5	2	COW250	39.5	12,979	328.6	2
COW210	67.3	3,450	51.3	3	COW295	41.6	13,669	328.6	3
COW200	23.6	1,170	49.6	4	COW185	62.6	20,569	328.6	4
COW170	46	2,168	47.1	5	COW285	90.6	29,769	328.6	5
TSS					TDS				
COW160	44.1	19,863	450.4	1	COW160	44.1	13,063	296.2	1
COW220	31.3	14,092	450.2	2	COW220	31.3	9,267	296.1	2
GVI130	176.5	75,295	426.6	3	COW210	67.3	18,357	272.8	3
COW210	67.3	28,231	419.5	4	COW200	23.6	6,155	260.8	4
COW200	23.6	9,527	403.7	5	COW170	46	11,196	243.4	5
Dissolved P					Total P				
GVI130	176.5	270	1.5	1	ESD205	29	100	3.4	1
GVI330	66.4	81	1.2	2	COW330	91.2	314	3.4	2
COW220	31.3	37	1.2	3	ESD250	164.5	566	3.4	3
COW160	44.1	52	1.2	4	GVI250	194.2	668	3.4	4
COW210	67.3	70	1.0	5	SHD050	286.1	984	3.4	5
NO2+NO3-N					TKN				
COW160	44.1	206	4.7	1	COW048	39.1	319	8.2	1
COW220	31.3	146	4.7	2	COW080	53.6	437	8.2	2
COW210	67.3	282	4.2	3	COW085	49.8	406	8.2	3
COW200	23.6	93	3.9	4	COW250	39.5	322	8.2	4
COW170	46	165	3.6	5	COW295	41.6	339	8.1	5
Copper					Zinc				
COW210	67.3	13	0.193	1	COW160	44.1	339	7.7	1
COW220	31.3	6	0.192	2	COW220	31.3	240	7.7	2
ESD065	48.9	9	0.184	3	COW210	67.3	431	6.4	3
COW180	32.9	6	0.182	4	COW200	23.6	136	5.8	4
COW160	44.1	8	0.181	5	COW170	46	221	4.8	5
Cadmium					Lead				
COW040	45.7	0.33	0.00722	1	COW220	31.3	30	1.0	1
ESD165	65.1	0.47	0.00722	2	COW160	44.1	42	1.0	2
GVI230	82	0.59	0.00720	3	COW210	67.3	51	0.8	3
COW010	110	0.79	0.00718	4	COW200	23.6	16	0.7	4
COW030	76.9	0.55	0.00715	5	COW170	46	24	0.5	5
GVI240	76.9	0.55	0.00715	5					

Section 4
Alternative Evaluation

This section discusses the Alternative evaluation. CDM evaluated five Alternatives that meet the City's goals, including a no action Alternative. The water quantity goals are to develop cost effective and implementable solutions to identified flooding problems. The water quality goals are to implement best management practices where practicable to improve water quality and provide proactive solutions to the future NODES permit requirements. The Alternatives incorporate retrofit detention, conveyance, and a combination of conveyance and detention improvements to the PSWMS. The Alternatives are:

Alternative 1	No action. This Alternative was considered as the baseline in order to fully understand the problems, the solutions, and the true benefits.
Alternative 2	Replace PSWMS storm sewers identified that have insufficient capacity, and increase conveyance capacities of channels and culverts identified to have insufficient capacity.
Alternative 3	Add parallel storm sewers to existing PSWMS storm sewers identified as having insufficient capacity, and increase conveyance capacities of channels and culverts identified as having insufficient capacity.
Alternative 4	Incorporate local detention facilities throughout the City. The detention facilities would generally be small in size and strategically located near or at identified problem areas.
Alternative 5	Incorporate large relief storm sewers and regional detention facilities located in strategic areas to relieve excess flows to the existing stormwater system.

The Alternatives were developed to enable a phased prioritization of improvements in each planning area. CDM developed the improvement Alternatives to provide the City with a desired level of service based on the design criteria and constraints presented in **Section 2**.

The improvements for the five Alternatives are described below. The improvements are identified for each watershed, which are the Sand Hills Diversion, Cow Creek, East Side Drain, and Grand View Industrial watersheds. No problems were reported in the Arkansas River watershed and therefore no improvements were identified in the watershed. Components of each Alternative are presented in **Table 4-1.**

Many of the reported problem areas are served by the secondary stormwater system, or are not served by a system at all. Improvements to the PSWMS identified in the Alternatives Evaluation will help conditions in some of these areas. However, most of these problems will not be corrected to the desired level of service by the improvements to the PSWMS. These problems are typically isolated conveyance problems that can be improved by increasing the capacity of the existing secondary system serving the problem area, or constructing a new secondary system to problem areas not currently served by a stormwater system. CDM conducted an analysis of typical isolated problems served by the secondary system. Typically, the reported problems could be remedied with 24- to 36-inch storm sewers. CDM prepared cost estimates for improvements to the secondary system based on these typical improvements. The identified PSWMS improvements with the secondary improvements will address all the reported problem areas. Secondary system improvements should not be implemented until the PSWMS has been improved to the desired level of service.

Table 4-1
Alternative Comparison
City of Hutchinson Stormwater Master Plan

Item	*Alternatives*				
	1	2	3	4	5
PSWMS Storm Sewer Improvements Length (ft.)	0	55,750	55,750	0	27,370
Secondary Storm Sewer Improvements Length (ft.)	0	61,325	61,325	61,325	58,125
Total Storm Sewer Improvements Length (ft.)	0	117,075	117,075	61,325	85,495
Inlet Improvements[1]	0	2	2	2	2
Channel Improvement Length (ft.)	0	24,600	24,600	0	24,600
Bridge Expansion (ft.)	0	1,040	1,040	0	1,040
No. of Detention Basins	0	0	0	26	1
Total Detention Volume (AF)	0	0	0	285	150
No. of Problems Addressed by PSWMS Improvements	0	49	49	49	63
No. of Problems Addressed by Secondary System Improvements	0	106	106	106	92
Total Number of Problems Addressed by Improvements	0	155	155	155	155
PSWMS Improvements Cost Estimate (millions $)	$0.0	$39.8	$33.8	$43.7	$27.4
Secondary System Improvements Cost Estimate (millions $)	$0.0	$7.2	$5.9	$7.2	$6.6
Total Estimated Cost (millions $)	$0.0	$47.0	$39.7	$50.9	$34.0

Notes:
1. Inlet improvements that are separate from the storm sewer improvements.
2. Cost estimates do not include system maintenance cost.

4.1 Alternative 1

Alternative 1 is no action. This Alternative was considered in order to fully understand the problems, the solutions, and the true benefits.

The City currently experiences significant flooding and ponding. There were 155 flooding or ponding problem areas reported by City Residents. The analysis of the stormwater system confirmed the reported problems and identified significant lengths and reaches of deficient system components. CDM estimates 42 percent of the City's PSWMS does not meet the desired level of service. **Figure 3-5** shows the segments of the PSWMS that are less than the desired level of service. No problems were associated with maintenance problems. All the identified problems will continue to exist without capital improvements. CDM estimates that maintenance of the existing system costs $320,000. Cost Estimates are presented in **Appendix D**.

4.2 Alternative 2

Alternative 2 replaces PSWMS storm sewers identified as having insufficient capacity, and increases conveyance capacities of channels and culverts identified as having insufficient capacity. **Figure 4-1** shows the improvements to the existing storm system. Detention basins are not incorporated as part of the improvements.

Alternative 2 replaces 55,750 feet of existing PSWMS storm sewers, improves 24,600 feet of open channels, and expands 15 culvert crossings adding 1,040 feet of new culverts. **Table 4-2** summarizes the Alternative 2 improvements. The new storm sewers range in size from 10 feet wide by 4 feet high concrete box culverts (CBCs) to 24-inch diameter pipes. The channel improvements consist of excavating an overbank area to provide the necessary conveyance. Culvert expansions consist of adding barrels parallel to the existing culverts. The new culverts would range in size from 48- to 84-inch diameter reinforced concrete pipes (RCPs).

The improvements to the PSWMS will directly address 49 of the 155 reported problems in the watershed, and likely improve conditions at an additional 24 reported problem areas served by the secondary system. The estimated cost to improve the PSWMS is $40 million. The cost to improve the secondary system is $7 million. The total cost for both the PSWMS and secondary system is $47 million. The cost estimates are presented in **Appendix D**.

4.2.1 Sand Hills Diversion

Two problem areas were reported in the Sand Hills Diversion watershed. The areas are on West 31st Avenue near the intersections of Mike and Stewart Streets. The problems are not a result of a deficient PSWMS, but due to a lack of a secondary storm sewer system. CDM recommends adding 2,000 feet of 24- to 36-inch diameter storm sewer pipe, as shown on **Figure 4-1**. The estimated cost is $200,000.

4.2.2 Cow Creek

Improvements to the Cow Creek PSWMS include storm sewer replacement, channel improvements, and culvert expansions. 46,850 feet of storm sewers would be replaced, 11,800 feet of open channel would be improved, and 2 culvert crossings would be expanded adding 160 feet of culverts. The improvements will directly address 36 of the 96 reported problems in the watershed. The estimated cost for the PSWMS is $32 million. The estimated cost with the secondary system improvements is $35 million.

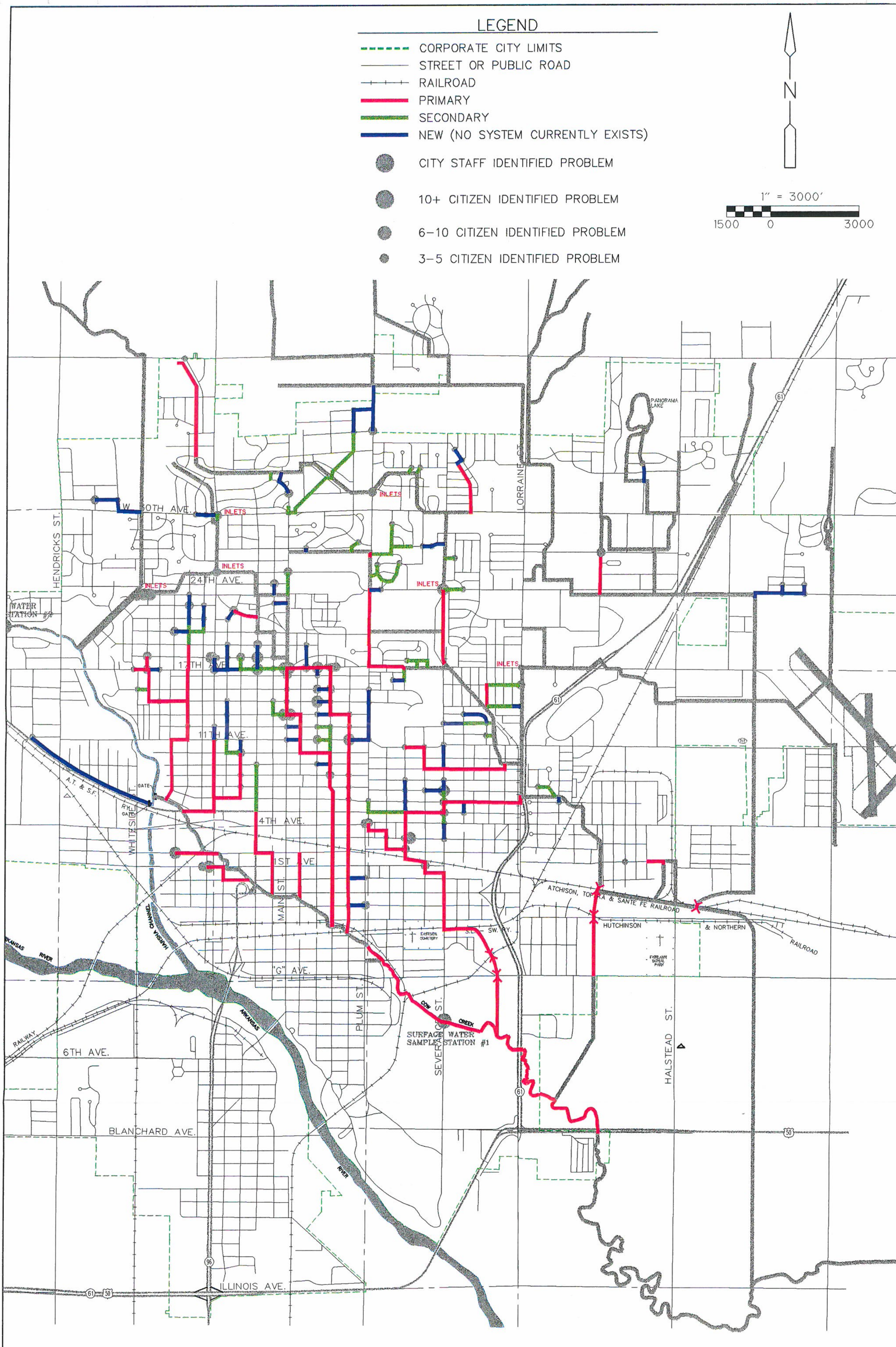

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Figure No. 4-1
ALTERNATE NO. 2 - ENLARGE EXISTING STORM SYSTEM
STORMWATER MASTER PLAN
HUTCHINSON, KANSAS

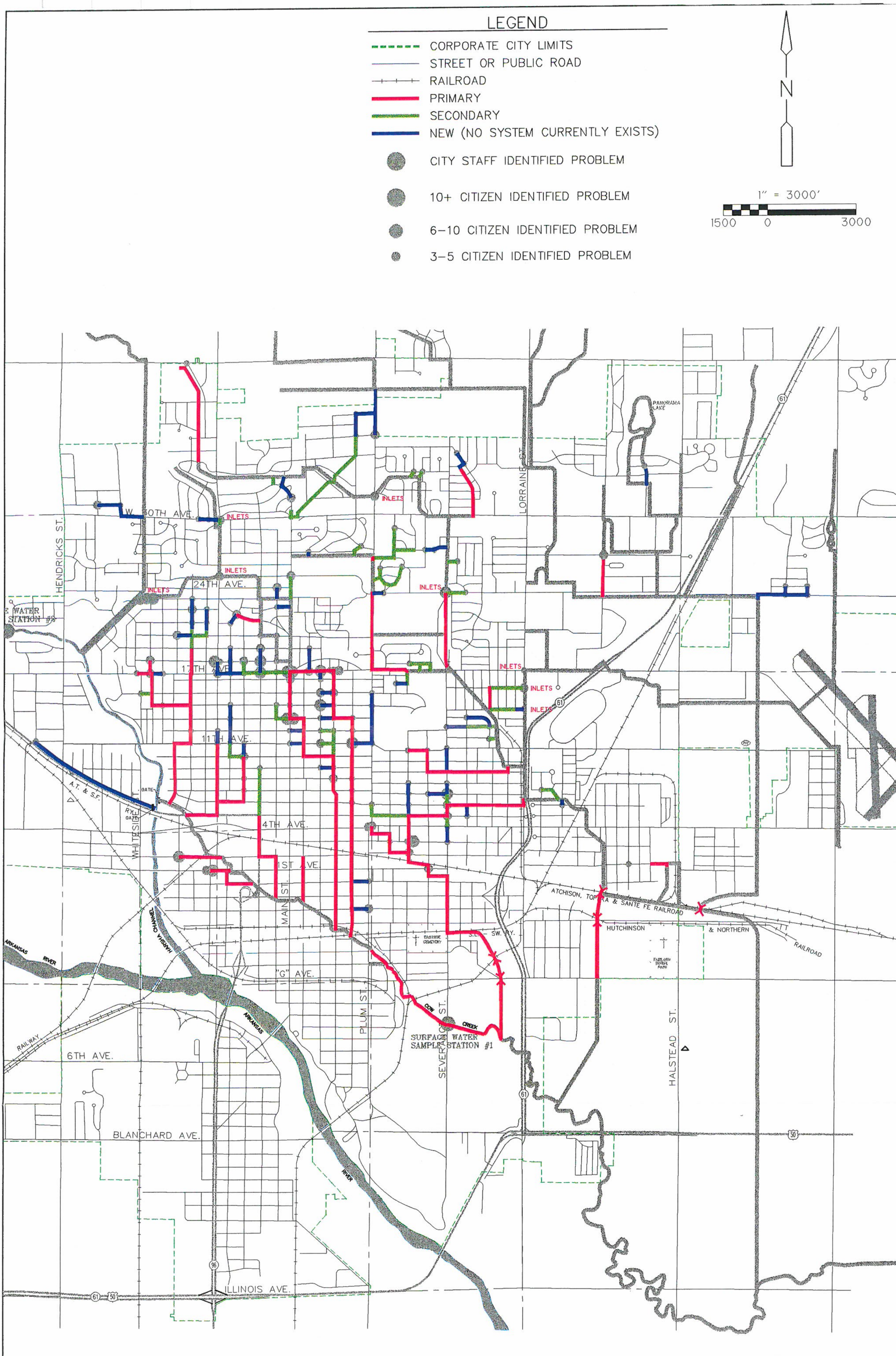

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Figure No. 4-2
ALTERNATE NO. 3 - PARALLEL CONVEYANCES
STORMWATER MASTER PLAN
HUTCHINSON, KANSAS

Table 4-2
Alternative 2 Characteristics
City of Hutchinson Stormwater Master Plan

Item	Watershed				Total
	SHD	*CC*	*ESD*	*GVI*	
PSWMS Storm Sewer Improvements Length (ft.)	0	46,850	6,800	2,100	55,750
Secondary Storm Sewer Improvements Length (ft.)	2,000	26,950	26,775	5,600	61,325
Total Storm Sewer Improvements Length (ft.)	2,000	73,800	33,575	7,700	117,075
Inlet Improvements[1]	2	0	0	0	2
Channel Improvement Length (ft.)	0	11,800	12,800	0	24,600
Bridge Expansion (ft.)	0	160	640	240	1,040
No. of Detention Basins	0	0	0	0	0
Total Detention Volume (AF)	0	0	0	0	0
No. of Problems Addressed by PSWMS Improvements	2	36	9	2	49
No. of Problems Addressed by Secondary System Improvements	0	60	40	6	106
Total Number of Problems Addressed by Improvements	2	96	49	8	155
PSWMS Improvements Cost Estimate (millions $)	0	$31.9	$6.3	$1.6	$39.8
Secondary System Improvements Cost Estimate (millions $)	$0.2	$3.1	$3.4	$0.5	$7.2
Total Estimated Cost (millions $)	$0.2	$35.0	$9.8	$2.0	$47.0

Notes:
1. Inlet improvements that are separate from the storm sewer improvements.

PSWMS storm sewers to be replaced are:

- 8,650 feet of the Van Buren Street Storm Sewer System from Cow Creek to 19th Avenue
- 6,050 feet of the Monroe Street Storm Sewer System from Cow Creek to 11th Avenue
- 1,400 feet of the 2nd Avenue Storm Sewer System from Cow Creek to Van Buren Street
- 1,950 feet of the Sherman Avenue Storm Sewer System from Cow Creek to Monroe Street
- 3,500 feet of the Washington Street Storm Sewer System from Cow Creek to 5th Avenue
- 1,600 feet of the Walnut Street Storm Sewer System from Cow Creek to 2nd Avenue
- 800 feet of storm sewer on Hyde Park Drive from Adams to Madison Streets
- 10,300 feet of the Maple Street Storm Sewer System from Cow Creek to 17th Avenue
- 11,100 feet of the Elm Street Storm Sewer System from Cow Creek to 17th Avenue
- 6,000 feet of the Severance Street Storm Sewer System from SLSW Railroad to 4th Avenue

Channel Improvements are:

- 7,000 feet of Cow Creek channel from Ken Kennedy Freeway to Plum Street
- 4,800 feet of Tributary channel from Cow Creek to Severance Street

Bridge Expansions are:

- G Avenue crossing over channel tributary to Cow Creek
- Southern Pacific Railroad crossing over channel tributary to Cow Creek

4.2.3 East Side Drain

Improvements to the East Side Drain PSWMS include storm sewer replacement, channel improvements, and culvert expansions. 6,800 feet of storm sewers would be replaced, 12,800 feet of open channel would be improved, and 12 culvert crossings would be expanded adding 640 feet of culverts. The improvements to the PSWMS will directly address 9 of the 49 reported problems in the watershed. The estimated cost for the PSWMS is $6.3 million. The estimated cost with the secondary system improvements is $10 million.

PSWMS storm sewer replacements are:

- Replace 5,700 feet of the 6th Avenue Storm Sewer System from the ESD Channel to Cleveland Street
- Replace 4,300 feet of the 9th Avenue storm sewer system from the ESD channel to Cleveland Street
- Replace 800 feet of the storm sewer on Cochran Street from the ESD channel to 16th Avenue

Channel improvements are:

- 3,500 feet from Columbia Drive to 43rd Avenue
- 3,000 feet from G Avenue to AT&SF Railroad
- 4,000 feet along Plum Street from 17th Avenue to 23rd Avenue
- 2,500 feet along Severance Street from 18th Avenue to 23rd Avenue
- 1,800 feet along Garden Grove Parkway from 30th Avenue to 33rd Avenue

Culvert crossing expansions are:

- G Avenue
- Carey Blvd
- 30th Avenue
- 30th Terrace
- 31st Avenue
- 31st Terrace
- 32nd Avenue
- 32nd Terrace
- Kisiwa Parkway
- 36th Avenue
- Monterey Place
- Coronado Drive

4.2.4 Grand View Industrial

Improvements to the Grand View Industrial PSWMS include storm sewer replacement and culvert expansions. 2,100 feet of storm sewers would be replaced, and one culvert crossing would be expanded adding 240 feet of culvert. The improvements to the PSWMS will directly address two of the eight reported problems in the watershed. The estimated cost for the PSWMS is $1.6 million. The estimated cost with the secondary system improvements is $2 million.

PSWMS storm sewer replacements are:

- Replace 1,400 feet of the storm sewer on Waldron Street from the GVI Channel to 26th Avenue
- Replace 700 feet of the storm sewer on 1st Avenue from the open channel to Superior Street

Culvert crossing expansions are:

- AT&SF Railroad

4.3 Alternative 3

Alternative 3 adds parallel storm sewers to existing PSWMS storm sewers identified as having insufficient capacity, and increases conveyance capacities of channels and culverts identified as having insufficient capacity. **Figure 4-2** shows the Alternative 3 improvements to the existing storm system. Detention basins are not incorporated as part of the improvements for this Alternative.

Alternative 3 adds 55,800 feet of storm sewers parallel to existing PSWMS storm sewers, improves 24,600 feet of open channels, and expands 15 culvert crossings adding 1,040 feet of new culverts. **Table 4-3** summarizes the Alternative 3 improvements. The new storm sewers range in size from 7 feet wide by 3 feet high concrete box culverts (CBCs) to 24-inch diameter pipes. The channel improvements consist of excavating an overbank area to provide the necessary conveyance. Culvert expansions consist of adding additional barrels to the existing culverts. The new culverts would range in size from 48- to 84-inch diameter reinforced concrete pipes (RCPs).

The improvements to the PSWMS will directly address 49 of the 155 reported problems in the watershed, and likely improve conditions at an additional 24 reported problem areas served by the secondary system. The estimated cost to improve the PSWMS is $34 million. Alternative 3

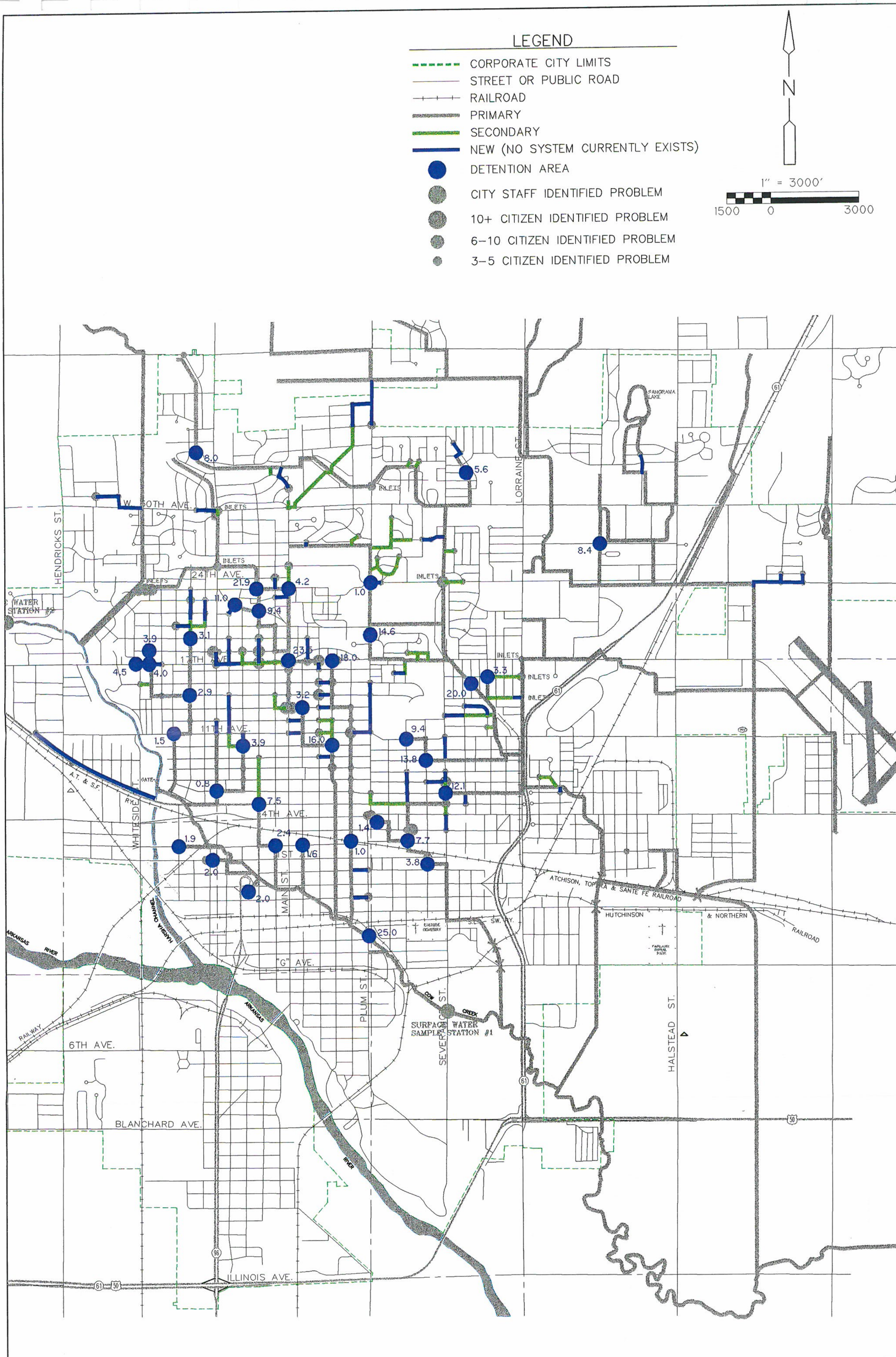

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Figure No. 4-3
ALTERNATE NO. 4 - LOCAL DETENTION
STORMWATER MASTER PLAN
HUTCHINSON, KANSAS

Table 4-3
Alternative 3 Characteristics
City of Hutchinson Stormwater Master Plan

Item	Watershed				Total
	SHD	CC	ESD	GVI	
PSWMS Storm Sewer Improvements Length (ft.)	0	46,850	6,800	2,100	55,750
Secondary Storm Sewer Improvements Length (ft.)	2,000	26,950	26,775	5,600	61,325
Total Storm Sewer Improvements Length (ft.)	2,000	73,800	33,575	7,700	117,075
Inlet Improvements[1]	2	0	0	0	2
Channel Improvement Length (ft.)	0	11,800	12,800	0	24,600
Bridge Expansion (ft.)	0	160	640	240	1,040
No. of Detention Basins	0	0	0	0	0
Total Detention Volume (AF)	0	0	0	0	0
No. of Problems Addressed by PSWMS Improvements	2	36	9	2	49
No. of Problems Addressed by Secondary System Improvements	0	60	40	6	106
Total Number of Problems Addressed by Improvements	2	96	49	8	155
PSWMS Improvements Cost Estimate (millions $)	$0.0	$26.7	$5.8	$1.3	$33.8
Secondary System Improvements Cost Estimate (millions $)	$0.2	$3.1	$2.2	$0.5	$5.9
Total Estimated Cost (millions $)	$0.2	$29.8	$8.0	$1.7	$39.7

Notes:
1. Inlet improvements that are separate from the storm sewer improvements.

addresses the same problem areas as Alternative 2. Capital costs are less for Alternative 3 because it implements smaller, parallel storm sewers, taking advantage of the capacity of the existing sewers. The total cost to improve the PSWMS and secondary system is $40 million. The improvements are described below for each of the four watersheds requiring improvements.

4.3.1 Sand Hills Diversion

Two problem areas were reported in the Sand Hills Diversion watershed. The areas are on West 31st Avenue near the intersections of Mike and Stewart Streets. The problems are not a result of a deficient PSWMS, but due to a lack of secondary storm sewer system. CDM recommends adding 2,000 feet of 24- to 36-inch diameter storm sewer pipe, as shown on **Figure 4-2.** The estimated cost is $200,000.

4.3.2 Cow Creek

Improvements to the Cow Creek PSWMS includes adding parallel storm sewers, channel improvements, and culvert expansions. 46,850 feet of new storm sewers would be constructed, 11,800 feet of open channel would be improved, and 2 culvert crossings would be expanded adding 160 feet of new culverts. The improvements will directly address 36 of the 96 reported problems in the watershed. The estimated cost for the PSWMS is $27 million. The estimated cost with the secondary system improvements is $30 million.

PSWMS storm sewers to be supplemented with parallel storm sewers are:

- 8,650 feet of the Van Buren Street Storm Sewer System from Cow Creek to 19th Avenue
- 6,050 feet of the Monroe Street Storm Sewer System from Cow Creek to 11th Avenue
- 1,400 feet of the 2nd Avenue Storm Sewer System from Cow Creek to Van Buren Street
- 1,950 feet of the Sherman Avenue Storm Sewer System from Cow Creek to Monroe Street
- 3,500 feet of the Washington Street Storm Sewer System from Cow Creek to 5th Avenue
- 1,600 feet of the Walnut Street Storm Sewer System from Cow Creek to 2nd Avenue
- 800 feet of storm sewer on Hyde Park Drive from Adams to Madison Streets
- 10,300 feet of the Maple Street Storm Sewer System from Cow Creek to 17th Avenue
- 11,100 feet of the Elm Street Storm Sewer System from Cow Creek to 17th Avenue
- 6,000 feet of the Severance Street Storm Sewer System from SLSW Railroad to 4th Avenue

Channel Improvements are:

- 7000 feet of Cow Creek channel from Ken Kennedy Freeway to Plum Street
- 4,800 feet of Tributary channel from Cow Creek to Severance Street

Bridge Expansions are:

- G Avenue crossing over channel tributary to Cow Creek
- Southern Pacific Railroad crossing over channel tributary to Cow Creek

4.3.3 East Side Drain

Improvements to the East Side Drain PSWMS include adding parallel storm sewers, channel improvements, and culvert expansions. 6,800 feet of new storm sewers would be constructed, 12,800 feet of open channel would be improved, and 12 culvert crossings would be expanded adding 640 feet of new culverts. The improvements to the PSWMS will directly address 9 of the 49 reported problems in the watershed. The estimated cost for the PSWMS is $5.8 million. The estimated cost with the secondary system improvements is $8 million.

PSWMS storm sewers to be supplemented with parallel storm sewers are:

- Replace 5,700 feet of the 6th Avenue Storm Sewer System from the ESD Channel to Cleveland Street
- Replace 4,300 feet of the 9th Avenue storm sewer system from the ESD channel to Cleveland Street
- Replace 800 feet of the storm sewer on Cochran Street from the ESD channel to 16th Avenue

Channel improvements are:

- 3,500 feet from Columbia Drive to 43rd Avenue
- 3,000 feet from G Avenue to AT&SF Railroad
- 4000 feet along Plum Street from 17th Avenue to 23rd Avenue
- 2,500 feet along Severance Street from 17th Avenue to 23rd Avenue
- 1,800 feet along Garden Grove Parkway from 30th Avenue to 33rd Avenue

Culvert crossing expansions are:

- G Avenue
- Carey Blvd
- 30th Avenue
- 30th Terrace
- 31st Avenue
- 31st Terrace
- 32nd Avenue
- 32nd Terrace
- Kisiwa Parkway
- 36th Avenue
- Monterey Place
- Coronado Drive

4.3.4 Grand View Industrial

Improvements to the Grand View Industrial PSWMS include storm sewer replacement and culvert expansions. 2,100 feet of new storm sewers would be constructed, and 1 culvert crossing would be expanded adding 240 feet of new culvert. The improvements to the PSWMS will directly address 2 of the 8 reported problems in the watershed. The estimated cost for the PSWMS is $1.3 million. The estimated cost with the secondary system improvements is $1.7 million.

PSWMS storm sewers to be supplemented with parallel storm sewers are:

- Replace 1,400 feet of the storm sewer on Waldron Street from the GVI Channel to 26th Avenue
- Replace 700 feet of the storm sewer on 1st Avenue from the open channel to Superior Street

Culvert crossing expansions are:

- AT&SF Railroad

4.4 Alternative 4

Alternative 4 incorporates local detention facilities throughout the City. The detention facilities would generally be small in size and strategically located near or at problem areas.

Figure 4-3 shows the 26 local detention basins that would be constructed to provide a total of 285 acre-feet of storage. The basins would have an average storage volume of 11 acre-feet (AF). 50% of the basins would have ponds in the bottom and configured to provide treatment to improve water quality. There would be no significant PSWMS storm sewer improvements with this Alternative, other than routing flows into and out of the detention basins. **Table 4-4** summarizes the Alternative 4 improvements.

The improvements to the PSWMS will directly address 49 reported problems and likely improve conditions at reported problem areas on the existing secondary system. The estimated cost to improve the PSWMS is $44 million. The total cost to improve the PSWMS and secondary system is $51 million. The improvements are described below for each of the four watersheds requiring improvements.

4.4.1 Sand Hills Diversion

Two problem areas were reported in the Sand Hills Diversion watershed. The areas are on West 31st Avenue near the intersections of Mike and Stewart Streets. The problems are not a result of a deficient PSWMS, but do to a lack of secondary storm sewer system. CDM recommends adding 2,000 feet of 24- to 36-inch diameter storm sewer pipe. No detention basins are planned in this watershed. The estimated cost is $200,000.

4.4.2 Cow Creek

In the Cow Creek watershed, 17 detention basins would be constructed. The basins would provide a total of 188 AF of storage volume. There would be no improvements to the PSWMS storm sewers, no channel improvements, and no culvert expansions. The improvements will directly address 36 of the 96 reported problems in the watershed. The estimated cost for the PSWMS is $29 million. The estimated cost with the secondary system improvements is $32 million.

4.4.3 East Side Drain

Eight detention basins would be constructed in the East Side Drain watershed. The basins would provide a total of 88 ac-ft of storage volume. There would be no improvements to the PSWMS storm sewers, no channel improvements, and no culvert expansions. The improvements will directly address 9 of the 49 reported problems in the watershed. The estimated cost for the PSWMS is $14 million. The estimated cost with the secondary system improvements is $17 million.

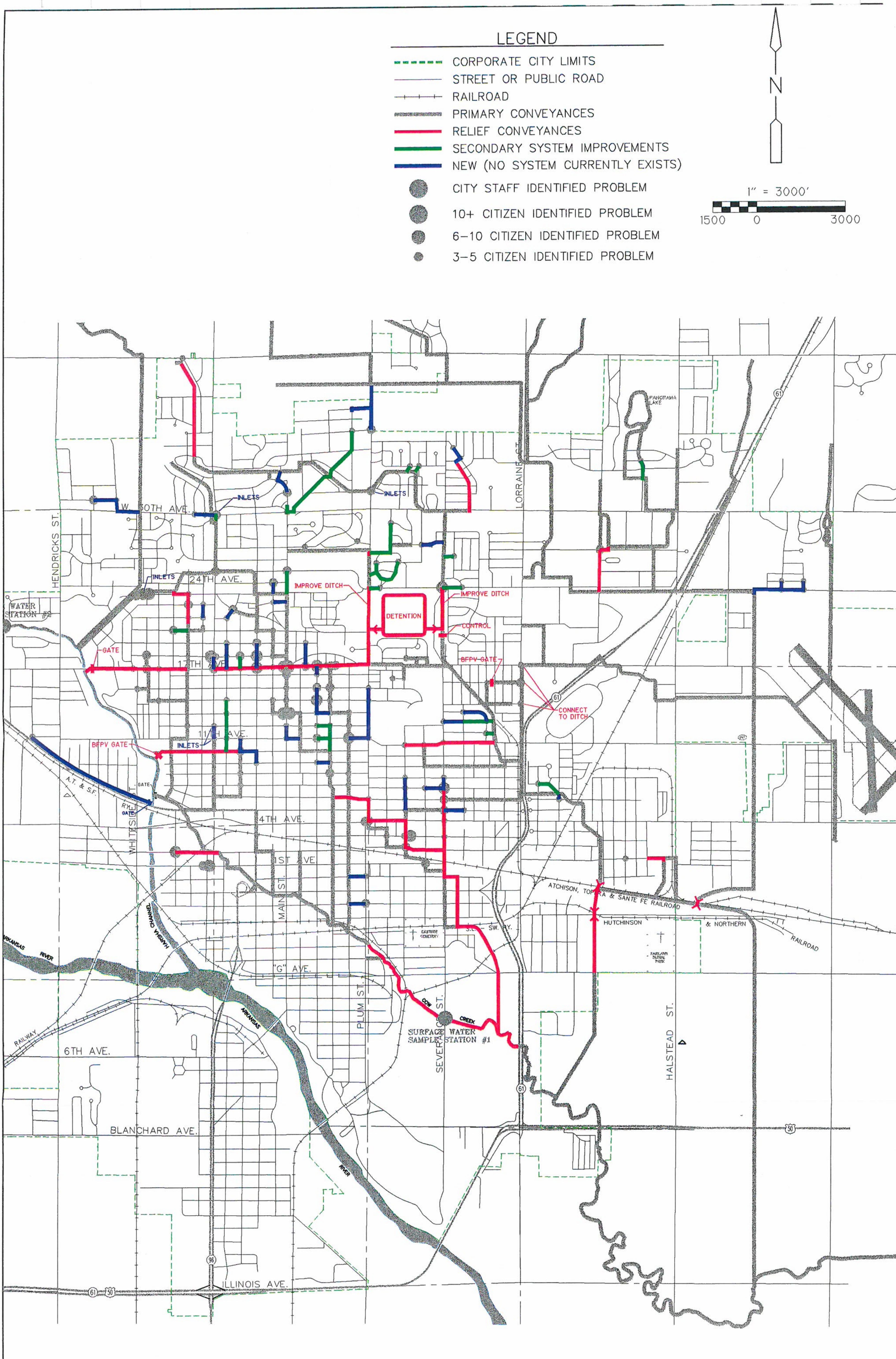

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Figure No. 4-4
ALTERNATE NO. 5 - RELIEF CONVEYANCES & REGIONAL DETENTION
STORMWATER MASTER PLAN
HUTCHINSON, KANSAS

Table 4-4
Alternative 4 Characteristics
City of Hutchinson Stormwater Master Plan

Item	*Watershed*				*Total*
	SHD	*CC*	*ESD*	*GVI*	
PSWMS Storm Sewer Improvements Length (ft.)	0	0	0	0	0
Secondary Storm Sewer Improvements Length (ft.)	2,000	26,950	26,775	5,600	61,325
Total Storm Sewer Improvements Length (ft.)	2,000	26,950	26,775	5,600	61,325
Inlet Improvements[1]	2	0	0	0	2
Channel Improvement Length (ft.)	0	0	0	0	0
Bridge Expansion (ft.)	0	0	0	0	0
No. of Detention Basins	0	17	8	1	26
Total Detention Volume (AF)	0	188	88	9	285
No. of Problems Addressed by PSWMS Improvements	2	36	9	2	49
No. of Problems Addressed by Secondary System Improvements	0	60	40	6	106
Total Number of Problems Addressed by Improvements	2	96	49	8	155
PSWMS Improvements Cost Estimate (millions $)	$0.0	$28.7	$13.6	$1.5	$43.8
Secondary System Improvements Cost Estimate (millions $)	$0.2	$3.1	$3.4	$0.5	$7.2
Total Estimated Cost (millions $)	$0.2	$31.8	$17.0	$2.0	$51.0

Notes:
1. Inlet improvements that are separate from the storm sewer improvements.

4.4.4 Grand View Industrial

One detention basin would be constructed in the GVI watershed. The basins would provide a total of 188 AF of storage volume. There would be no improvements to the PSWMS storm sewers, no channel improvements, and no culvert expansions. The improvements will directly address two of the eight reported problems in the watershed. The estimated cost for the PSWMS is $1.5 million. The estimated cost with the secondary system improvements is $2 million.

4.5 Alternative 5

Alternative 5 incorporates large relief storm sewers and regional detention facilities located in strategic areas to relieve excess flows to the existing stormwater system. **Figure 4-4** shows the Alternative 5 improvements to the existing storm system.

Alternative 5 adds 27,400 feet of new storm sewers, improves 24,600 feet of open channels, and expands 15 culvert crossings adding 1,040 feet of new culverts. **Table 4-5** summarizes the Alternative 5 improvements. The new storm sewers range in size from 10 feet wide by 4 feet high concrete box culverts (CBCs) to 24-inch diameter pipes. The channel improvements consist of excavating an overbank area to provide the necessary conveyance. Culvert expansions consist of adding additional barrels to the existing culverts. The new culverts would range in size from 48- to 84-inch diameter reinforced concrete pipes (RCPs).

The improvements to the PSWMS will directly address 63 of the 155 reported problems in the watershed, and likely improve conditions at an additional 20 reported problem areas served by the secondary system. The estimated cost to improve the PSWMS is $27 million. The total cost to improve the PSWMS and secondary system is $34 million. The improvements are described below for each of the four watersheds requiring improvements.

4.5.1 Sand Hills Diversion

Two problem areas were reported in the Sand Hills Diversion watershed. The areas are on West 31st Avenue near the intersections of Mike and Stewart Streets. The problems are not a result of a deficient PSWMS, but due to a lack of a secondary storm sewer system. CDM recommends adding 2,000 feet of 24- to 36-inch diameter storm sewer pipe, as shown on **Figure 4-4**. The estimated cost is $200,000.

4.5.2 Cow Creek

Improvements to the Cow Creek PSWMS include new storm sewers, channel improvements, and culvert expansions. 23,700 feet of storm sewers would be replaced, 11,800 feet of open channel would be improved, and two culvert crossings would be expanded adding 160 feet of culverts. The improvements will directly address 44 of the 96 reported problems in the watershed. The estimated cost for the PSWMS is $16 million. The estimated cost with the secondary system improvements is $19 million. The improvements are shown on **Figure 4-4**.

Relief storm sewers are:

- 3,450 feet of 8 feet wide by 4 feet high CBC on 17th Avenue from Harsha Channel to Van Buren Street. A gate would constructed at the outfall.
- 6,600 feet of 10 feet wide by 4 feet high CBC on 17th Avenue from Plum Street to Monroe Street. The relief storm sewer would outfall to a new 150 AF detention facility.

Table 4-5
Alternative 5 Characteristics
City of Hutchinson Stormwater Master Plan

Item	*Watershed*				*Total*
	SHD	*CC*	*ESD*	*GVI*	
PSWMS Storm Sewer Improvements Length (ft.)	0	23,650	3,220	500	27,370
Secondary Storm Sewer Improvements Length (ft.)	2,000	25,750	24,775	5,600	58,125
Total Storm Sewer Improvements Length (ft.)	2,000	49,400	27,995	6,100	85,495
Inlet Improvements[1]	2	0	0	0	2
Channel Improvement Length (ft.)	0	11,800	12,800	0	24,600
Bridge Expansion (ft.)	0	160	640	240	1,040
No. of Detention Basins	0	0	1	0	1
Total Detention Volume (AF)	0	0	150	0	150
No. of Problems Addressed by PSWMS Improvements	2	44	15	2	63
No. of Problems Addressed by Secondary System Improvements	0	52	34	6	92
Total Number of Problems Addressed by Improvements	2	96	49	8	155
PSWMS Improvements Cost Estimate (millions $)	$0.0	$16.3	$10.4	$0.6	$27.4
Secondary System Improvements Cost Estimate (millions $)	$0.2	$2.9	$3.1	$0.5	$6.6
Total Estimated Cost (millions $)	$0.2	$19.2	$13.6	$1.1	$34.0

Notes:
1. Inlet improvements that are separate from the storm sewer improvements.

- 1,400 feet of 8 feet wide by 3 feet high CBC on Van Buren Street from 21st to 23rd Avenues. The relief storm sewer would connect to the existing storm sewer on 23rd Avenue.
- 2,900 feet of ten feet wide by 4 feet high to 5 feet wide by 2.5 feet high CBC on 10th Avenue from the Harsha Channel to Jefferson Street. The relief sewer would have a gated outfall.
- 1,100 feet of 5 feet wide by 3 feet high CBC on 2nd Avenue from Cow Creek to Van Buren Street.
- 700 feet of 5 feet wide by 3 feet high CBC on 1st Avenue from Cow Creek to Monroe Street.
- 8,400 feet of 10 feet wide by 4 feet high CBC from the intersection of the SLSW Railroad and Reformatory Road to the intersection of 6th Avenue and Maple Street.
- 2,050 feet of 6 feet wide by 3 feet wide CBC on Severance Street from 7th Avenue to 2nd Avenue.

Channel Improvements are:

- 7,000 feet of Cow Creek channel from Ken Kennedy Freeway to Plum Street
- 4,800 feet of Tributary channel from Cow Creek to Severance Street

Bridge Expansions are:

- G Avenue crossing over channel tributary to Cow Creek
- Souther Pacific Railroad crossing over channel tributary to Cow Creek

4.5.3 East Side Drain

Improvements to the East Side Drain PSWMS include relief storm sewers, channel improvements, culvert expansions, and a detention basin. 3,220 feet of relief storm sewers would be constructed, 12,800 feet of open channel would be improved, and 12 culvert crossings would be expanded adding 640 feet of culverts. The improvements to the PSWMS will directly address 15 of the 49 reported problems in the watershed. The estimated cost for the PSWMS is $10.4 million. The estimated cost with the secondary system improvements is $13.6 million.

Relief storm sewers are:

- 3,100 feet of 8 feet wide by 3 feet high CBC on 11th Avenue from the ESD to Cleveland Street
- 100 feet of 36-inch diameter RCP under Lorraine Street on 16th Avenue

Channel improvements are:

- 3,500 feet from Columbia Drive to 43rd Avenue
- 3,000 feet from G Avenue to AT&SF Railroad
- 4,000 feet along Plum Street from 17th Avenue to 23rd Avenue
- 2,500 feet along Severance Street from 17th Avenue to 23rd Avenue
- 1,800 feet along Garden Grove Parkway from 30th Avenue to 33rd Avenue

Culvert crossing expansions are:

- G Avenue
- Carey Blvd
- 30th Avenue
- 30th Terrace

- 31st Avenue
- 31st Terrace
- 32nd Avenue
- 32nd Terrace
- Kisiwa Parkway
- 36th Avenue
- Monterey Place
- Coronado Drive

4.5.4 Grand View Industrial

Improvements to the Grand View Industrial PSWMS include relief storm sewers and culvert expansions. 500 feet of relief storm sewers would be constructed, and one culvert crossing would be expanded adding 240 feet of culvert. The improvements to the PSWMS will directly address 2 of the 8 reported problems in the watershed. The estimated cost for the PSWMS is $600,000. The estimated cost with the secondary system improvements is $1.1 million.

Relief storm sewers are:

- 400 feet of storm sewer on 26th Avenue from the GVI Channel to Waldron Street
- Replace 700 feet of the storm sewer on 1st Avenue from the open channel to Superior Street

Culvert crossing expansions are:

- AT&SF Railroad

Section 5
Recommendations

This section describes the recommendations for the City's SWMP. Discussed are the recommended structural improvement Alternative, operation & maintenance, non-structural water quality controls, and the monitoring system.

5.1 Capital Improvements Program - Structural Controls

CDM considered six major factors in formulating the improvement Alternatives and recommendations. The six factors are:

1. Technical feasibility and reliability
2. Environmental consistency
3. Socio-political acceptability
4. Economic reasonability
5. Financial ability
6. Maintainability

5.1.1 Technical Feasibility and Reliability

CDM formulated the Alternatives to be feasible and reliable from a technical standpoint. The Alternatives solve flooding and ponding problems to the desired level of service, and provide cost-effective water quality controls where practicable. Detention and conveyance improvements operate by gravity.

5.1.2 Environmental Consistency

CDM formulated the Alternatives 4 and 5 to allow implementation of best management practices to improve stormwater quality, proactively meet the future NPDES Phase II requirements, and minimize wetland impacts.

5.1.3 Socio-Political Acceptability

Public information and involvement will be an important aspect of the implementation of the improvements. The improvements will also need to be permitted by local, state, and federal agencies. The alternatives address the general concerns of the public, which are flooding, ponding, water quality, and cost. The improvements also have been formulated to meet permitting agency requirements.

5.1.4 Economic Reasonability

The recommended alternative provides the most cost-effective water quantity and quality controls while meeting the design criteria and constraints.

5.1.5 Financial Ability

The recommended alternative provides a phased approach to implement the improvements within the available funding.

5.1.6 Recommended Alternative

CDM recommends Alternative 5 in conjunction with local detention facilities discussed in Alterative 4 configured with both water quality and quantity controls. This combination provides a cost-effective solution to solve flooding and ponding, and implements water quality controls. The total estimated cost of the recommended improvement plan is $34 million, with the PSWMS improvements estimated to cost $27.4 million, and the secondary system improvements cost estimated at $6.6 million. The cost estimates and implementation schedule are presented in Table 5-1. The PSWMS improvements would be implemented in five phases over a 55-year period, with an average annual expenditure of about $500,000. The schedule is based on the City's planned available funding for stormwater improvements. Figure 5-1 shows the recommended improvements and problems addressed by phase.

Table 5-1
Implementation Schedule for Recommended PSWMS Improvements

Phase	Description	Date (Yr)	Cost ($ Million)			Problems Solved		
			PSWMS	Secondary	Total	PSWMS	Secondary	Total
I	150 AF detention facility	2000-2013	6.8	0.2	7.0	2	2	4
II	East 17th Avenue relief storm sewer	2014-2022	4.3	1.5	5.8	21	21	42
III	Cow Creek Tributary channel improvements and relief storm sewers	2023-2032	5.2	1.1	6.3	17	19	36
IV	Relief storm sewers on west 17th Ave., Van Buren St., 10th Ave., 2nd Ave., and 1st Ave.	2033-2044	6.2	0.8	7.0	15	18	33
V	ESD and GVI channel improvements and relief storm sewers, and Cow Creek Channel Improvements	2045-2055	4.9	3.0	7.9	8	32	40
	Total	55	27.4	6.6	34.0	63	92	155

Secondary system improvements would be implemented in conjunction with the PSWMS improvements, potentially adding another $120,000 a year in expenditures. The secondary improvments (see Table 5-2) have been broken down into 51 separate projects and are listed below for each implementation phase. All of the secondary improvements may not be needed to adequately address all of the reported problems. The PSWMS improvements may be all that is needed in some cases to adequately address reported problems near the PSWMS. CDM recommends that the City evaluate the impacts of the PSWMS on surrounding reported problem areas during final design and include the secondary system improvements found necessary to address the nearby problem areas. The City should monitor the improvements to verify that the reported problems have been adequately addressed.

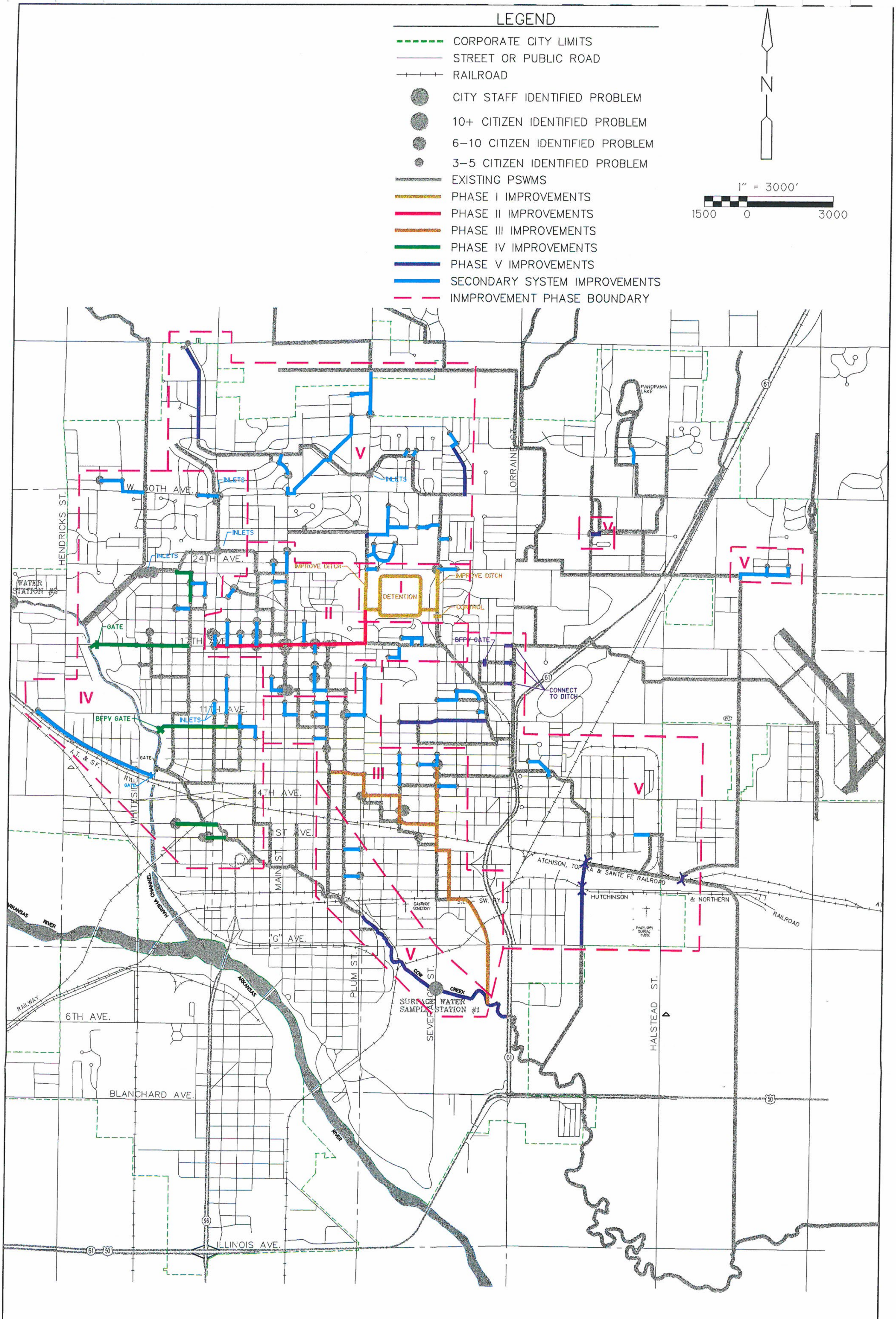

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Figure No. 5-1
RECOMMENDED IMPROVEMENT PLAN
STORMWATER MASTER PLAN
HUTCHINSON, KANSAS

Table 5-2
Secondary System Improvements
Stormwater Master Plan
City of Hutchinson, Kansas

Project N	Phase	Location	Length	Phase Length	Estimated Cost	Total Phase Cost
1	I	23rd Ave. from Eastwood Drive to Plum St.	406		$56,840	
2	I	23rd Ave. from Colorado St. to Severance St.	754	1,160	$105,560	$162,400
3	II	Washington Street from 24th Ave. to 23rd Ave.	406		$56,840	
4	II	Main Street from 25th Ave. to 23rd Ave	812		$113,680	
5	II	22nd Ave. from Washington St. to Main St.	522		$73,080	
6	II	Madison St. from 21st Ave. to Hyde Pl.	464		$64,960	
7	II	Monroe St. from 18th Ave. to 17th Ave.	464		$64,960	
8	II	Madison St. from 19th Ave. to 17th Ave.	986		$138,040	
9	II	Jefferson St. from 18th Ave. to 17th Ave.	464		$64,960	
10	II	Adams St. from 19th Ave. to 17th Ave.	928		$129,920	
11	II	Walnut St. from 19th Ave. to 17th Ave.	928		$129,920	
12	II	Poplar St. from 16th Ave. to 17th Ave.	290		$40,600	
13	II	16th Terrace and Cleveland Street from Ford St. to 17th Ave.	1,044		$146,160	
14	II	Sunflower Ave. from Way St. to Faircrest Dr., then to 17th Ave.	1,044		$146,160	
15	II	Poplar St. and 13th Ave. from 15th Ave. to Maple St.	1,450		$203,000	
16	II	Washington St. and 13th Ave. from 14th Ave. to Main St.	1,044	10,846	$146,160	$1,518,440
17	III	Main St. and 11th Ave. from 12th Ave. to Walnut St.	1,044		$125,280	
18	III	12th Ave., 11th Ave., and Maple St. from Poplar St. to 10th Ave.	1,972		$236,640	
19	III	Plum St. and 11th Ave. from 15th Ave. to Elm St.	2,088		$250,560	
20	III	9th Ave. from Poplar St. to Maple St.	522		$62,640	
21	III	Cleveland St. from 8th Ave. to 5th Ave.	1,276		$153,120	
22	III	Severance St. from 8th Ave. to 7th Ave., and 7th Ave. from Pershing St. to Severance St.	1,218		$146,160	
23	III	5th Ave. from Baker St. to Severance St.	812	8,932	$97,440	$1,071,840
24	IV	31st Ave., Stewart St., and 30th Ave. from Mike St. to 100 ft. east of Tartan Trl.	2,204		$176,320	
25	IV	30th Ave. from Cornell Dr. to Carlton. Rd.	928		$74,240	
26	IV	Jackson St. and 22nd Ave. from 20th Ave. to Van Buren St.	1,160		$92,800	
27	IV	20th Ave. from Harrison St. to Van Buren St.	522		$41,760	
28	IV	Monroe St. from 12th Ave. to 11th Ave.	522		$41,760	
29	IV	Madison St. from 14th Ave. to 10th Ave.	1,392		$111,360	
30	IV	Jefferson St. from 11th Ave. to 10th Ave.	522		$41,760	
31	IV	Adams St. and 10th Ave. from 9th Ave. to Jefferson St.	1,044		$83,520	
32	IV	Nickerson Blvd. From Arthur St. to the Harsha Canal	5,800	14,094	$145,000	$808,520
33	V	Main St. and Downing Rd. from Whitemore Rd. to ESD Channel	1,044		$140,940	
34	V	Farmington Road from 30th Ave. to ESD Channel	2,320		$313,200	
35	V	Farmington Rd. from Kansas Ave. to ESD Channel	2,204		$297,540	
36	V	Plum St. from Robert St. to Harsha Channel, and 37th Ave. from Elm St. to Plum St.	2,552		$344,520	
37	V	32nd Terr. To ESD Channel between Normandy Rd. and Pershing.	464		$62,640	
38	V	Idlewild Dr. from Dogwood Dr. to ESD channel	696		$93,960	
39	V	From the intersection of Lazy Ln. and 27th Ave. to ESD Channel	232		$31,320	
40	V	Random Rd. from Circle Dr. to ESD Channel	464		$62,640	
41	V	26th Dr. from Catalina Dr. to Plum St.	1,972		$266,220	
42	V	Compound Dr. from Acres Rd. to Severance	928		$125,280	
43	V	25th Ave. from Colorado St. to Severance	406		$54,810	
44	V	Eastwood Drive from 25th Ave. to ESD Channel	1,972		$266,220	
45	V	13th Ave. from Severance to Baker St., and Baker St. from College Ave. to 13th St.	1,160		$156,600	
46	V	Eastland Dr. from Hoagland St. to ESD Channel, and Porter St. from 6th Ave. to ESD Ch	1,044		$140,940	
47	V	Sherman Ave. from Plum St. to Elm St.	696		$93,960	
48	V	B Ave. from Plum St. to Elm St.	696		$93,960	
49	V	1st Ave. from Chemical St. to ESD Channel	928		$125,280	
50	V	23rd Ave. from Howell Dr. to Harsha Channel	2,204		$297,540	
51	V	King St. from Tumbleweed Dr. Harsha Channel	696	22,678	$93,960	$3,061,530
		Total	57,710	57,710	$6,622,730	$6,622,730

Each Phase would be implemented over a several-year period. Each phase can be implemented over several years following a typical order of right-of-way acquisition, preliminary design, utility coordination, permitting, and final design.

5.1.6.1 Phase I

The Phase I primary system improvement is the 150 AF detention facility bounded by Plum Street on the west, 23rd Avenue on the north, Severance Street on the east, and Faircrest Drive on the south. Construction of the detention facility includes the inlet and outlet structures and the channel improvements along Plum Street and Severance Street necessary to convey flows into the basin. The Phase I improvements would directly address 4 reported problem areas. The detention facility must be constructed first to provide an outlet for the 17th Street relief sewer and to control flows on the ESD.

The secondary system improvements are separated into two projects. They are:

- 400 feet of storm sewer on 23rd Avenue from Eastwood Drive to Plum Street
- 750 feet of storm sewer on 23rd Avenue from Colorado Street to Severance Street

Phase I will be implemented over a 14-year period with a total present worth cost of $6.8 million for the PSWMS, and $200,000 for the secondary system. The City should begin implementation of the improvements by first obtaining the necessary right of way through property acquisition.

5.1.6.2 Phase II

Phase II primary system improvements consists of 6,600 feet of 10 feet by 4 feet to 8 feet by 3 feet relief storm sewer on 17th Street from Plum Street to Monroe Street and will outfall into the 150 AF detention facility.

The secondary system improvements are separated into 14 projects. They are:

- 400 feet of storm sewer on Washington Street from 24th Avenue to 23rd Avenue
- 800 feet of storm sewer on Main Street from 25th Avenue to 23rd Ave
- 530 feet of storm sewer on 22nd Avenue from Washington Street to Main Street
- 460 feet of storm sewer on Madison Street from 21st Avenue to Hyde Pl.
- 460 feet of storm sewer on Monroe Street from 18th Avenue to 17th Avenue
- 1,000 feet of storm sewer on Madison Street from 19th Avenue to 17th Avenue
- 460 feet of storm sewer on Jefferson Street from 18th Avenue to 17th Avenue
- 930 feet of storm sewer on Adams Street from 19th Avenue to 17th Avenue
- 930 feet of storm sewer on Walnut Street from 19th Avenue to 17th Avenue
- 300 feet of storm sewer on Poplar Street from 16th Avenue to 17th Avenue
- 1,050 feet of storm sewer on 16th Terrace and Cleveland Street from Ford Street to 17th Avenue
- 1,050 feet of storm sewer on Sunflower Avenue from Way Street to Faircrest Dr., then to 17th Avenue
- 1,500 feet of storm sewer on Poplar Street and 13th Avenue from 15th Avenue to Maple Street
- 1,050 feet of storm sewer on Washington Street and 13th Avenue from 14th Avenue to Main Street

The primary relief storm sewer on 17th Avenue would be implemented over 9 years at a present worth cost of $4.3 million. The secondary system improvements would cost an additional $1.5 million. Phase II would address 42 reported problem areas.

5.1.6.3 Phase III

Phase III Primary system improvements consist of relief storm sewers and channel improvements on the Cow Creek Tributary. The improvements are:

- 8,400 feet of 10-feet wide by 4-feet high CBC from the intersection of the SLSW Railroad and Reformatory Road to the intersection of 6th Avenue and Maple Street

- 2,050 feet of 6-feet wide by 3-feet high CBC on Severance Street from 7th Avenue to 2nd Avenue

- 4,800 feet of Tributary channel improvements from Cow Creek to Severance Street, including two bridge expansions

The secondary system improvements are separated into seven projects. They are:

- 1,050 feet of storm sewer on Main Street and 11th Avenue from 12th Avenue to Walnut Street
- 1,975 feet of storm sewer on 12th Avenue, 11th Avenue, and Maple Street from Poplar Street to 10th Avenue
- 2,100 feet of storm sewer on Plum Street and 11th Avenue from 15th Avenue to Elm Street
- 520 feet of storm sewer on 9th Avenue from Poplar Street to Maple Street
- 1,275 feet of storm sewer on Cleveland Street from 8th Avenue to 5th Avenue
- 1,200 feet of storm sewer on Severance Street from 8th Avenue to 7th Avenue, and 7th Avenue from Pershing Street to Severance Street
- 800 feet of storm sewer on 5th Avenue from Baker Street to Severance Street

Phase III PSWMS improvements would be implemented over an 11-year period at a cost of $5.2 million, with secondary improvements at a cost of $1.1 million. Thirty-six reported problem areas would be addressed.

5.1.6.4 Phase IV

Phase IV implements five primary system relief storm sewers along the west side of the City. They are:

- 3,450 feet of 8-feet wide by 4-feet high CBC on 17th Avenue from Harsha Channel to Van Buren Street. A gate would constructed at the outfall.

- 1,400 feet of 8-feet wide by 3-feet high CBC on Van Buren Street from 21st to 23rd Avenues. The relief storm sewer would connect to the existing storm sewer on 23rd Avenue.

- 2,900 feet of 10-feet wide by 4-feet high to 5-feet wide by 2.5-feet high CBC on 10th Avenue from the Harsha Channel to Jefferson Street. The relief sewer would have a gated outfall.

- 1,100 feet of 5-feet wide by 3-feet high CBC on 2nd Avenue from Cow Creek to Van Buren Street.

- 700 feet of 5-feet wide by 3-feet high CBC on 1st Avenue from Cow Creek to Monroe Street.

The secondary system improvements are separated into nine projects. They are:

- 2,200 feet of storm seweron 31st Avenue, Stewart Street, and 30th Avenue from Mike Street to 100 ft. east of Tartan Trl.
- 925 feet of storm sewer on 30th Avenue from Cornell Dr. to Carlton. Road
- 1,150 feet of storm sewer on Jackson Street and 22nd Avenue from 20th Avenue to Van Buren Street
- 525 feet of storm sewer on 20th Avenue from Harrison Street to Van Buren Street
- 525 feet of storm sewer on Monroe Street from 12th Avenue to 11th Avenue
- 1,400 feet of storm sewer on Madison Street from 14th Avenue to 10th Avenue
- 525 feet of storm sewer on Jefferson Street from 11th Avenue to 10th Avenue
- 1,050 feet of storm sewer on Adams Street and 10th Avenue from 9th Avenue to Jefferson Street
- 5,800 feet of ditch along the north side of Nickerson Blvd. From Arthur Street to the Harsha Canal

Phase IV PSWMS improvements would be implemented over 13 years at an estimated total present worth cost of $6.2 million. Secondary system improvements would cost an additional $800,000. Thirty-three reported problem areas would be addressed by the phase IV improvements.

5.1.6.5 Phase V

Phase V primary system improvements consists of relief storm sewers and channel improvements on the ESD and GVI stormwater systems and Cow Creek channel improvements. The improvements are:

- 7,000 feet of Cow Creek channel improvements from Ken Kennedy Freeway to Plum Street, including bridge expansions

- 3,100 feet of 8-feet wide by 3-feet high CBC on 11th Avenue from the ESD to Cleveland Street

- 100 feet of 36-inch diameter RCP under Lorraine Street on 16th Avenue

- 3,500 feet of channel improvements on the ESD from Columbia Drive to 43rd Avenue

- 3,000 feet of channel improvements on the ESD from G Avenue to AT&SF Railroad

- 1,800 feet of channel improvements on the ESD along Garden Grove Parkway from 30th Avenue to 33rd Avenue

- 400 feet of relief storm sewer on 26th Avenue from the GVI Channel to Waldron Street

- Replace 700 feet of the storm sewer on 1st Avenue from the open channel to Superior Street

The secondary system improvements are separated into 19 projects. They are:

- 1,050 feet of storm sewer on Main Street and Downing Road from Whitemore Road to ESD Channel
- 2,300 feet of storm sewer on Farmington Road from 30th Avenue to ESD Channel

- 2,200 feet of storm sewer on Farmington Road from Kansas Avenue to ESD Channel
- 2,550 feet of storm sewer on Plum Street from Robert Street to Harsha Channel, and 37th Avenue from Elm Street to Plum Street
- 450 feet of storm sewer on 32nd Terr. To ESD Channel between Normandy Road and Pershing.
- 700 feet of storm sewer on Idlewild Dr. from Dogwood Dr. to ESD channel
- 250 feet of storm sewer from the intersection of Lazy Ln. and 27th Avenue to ESD Channel
- 460 feet of storm sewer on Random Road from Circle Dr. to ESD Channel
- 1,975 feet of storm sewer on 26th Dr. from Catalina Dr. to Plum Street
- 930 feet of storm sewer on Compound Dr. from Acres Road to Severance
- 400 feet of storm sewer on 25th Avenue from Colorado Street to Severance
- 1,975 feet of storm sewer on Eastwood Drive from 25th Avenue to ESD Channel
- 1,150 feet of storm sewer on 13th Avenue from Severance to Baker Street, and Baker Street from College Avenue to 13th Street
- 1,050feet of storm sewer on Eastland Dr. from Hoagland Street to ESD Channel, and Porter Street from 6th Avenue to ESD Channel
- 700 feet of storm sewer on Sherman Avenue from Plum Street to Elm Street
- 700 feet of storm sewer on B Avenue from Plum Street to Elm Street
- 950 feet of storm sewer on 1st Avenue from Chemical Street to ESD Channel
- 2,200 feet of storm sewer on 23rd Avenue from Howell Dr. to Harsha Channel
- 700 feet of storm sewer on King Street from Tumbleweed Dr. Harsha Channel

Phase V PSWMS improvements would be implemented over a 10-year period at an estimated cost of $4.9 million. The secondary system improvements would cost an estimated $3.0 million. The Phase V improvements would address 40 reported problem areas.

5.2 Operation & Maintenance

Operation and maintenance are critical elements of a watershed management plan. Control measures that are not maintainable provide short-lived, expensive solutions. Stormwater management systems that are not adequately maintained cannot be relied upon to provide the desired levels of service. The recommended improvements were developed with consideration for maintenance issues. Annual operation and maintenance costs are summarized in Table 5-3 and shown for each planning area. The costs are for maintenance of the existing system in conjunction with the recommended improvements.

5.3 Nonstructural Controls

CDM considered nonstructural controls to aid in the control of storm water quantity and quality. Nonstructural controls are ordinances, regulations, and source controls that depend on participation by municipalities and residents to minimize the water quantity and quality impacts associated with development.

CDM recommends that nonstructural controls be incorporated in the planning areas. They are:

- Public Information Program
- Fertilizer Application Control
- Pesticide and Herbicide Control
- Solid Waste Management and Control of Illegal Dumping
- DCIA minimization
- Water conservation landscaping
- Illicit connections identification and removal
- Erosion and sediment control and construction sites
- Stormwater management ordinance requirements
- Stormwater management system maintenance

The effectiveness of nonstructural controls is dependent on practices set forth through ordinances, public participation, and awareness.

5.4 Monitoring

A comprehensive monitoring program is used to accurately define the hydrologic and hydraulic characteristics of a watershed. A monitoring system should collect data on rainfall and stormwater flows, stages, and quality. CDM recommends that the City of Hutchinson augment its existing monitoring program in order to provide additional data necessary to evaluate the stormwater quantity and quality of the planning areas. The monitoring program should address the following:

- Identification of rainfall and flow/stage data at key points of interest to calibrate and verify model analysis tools

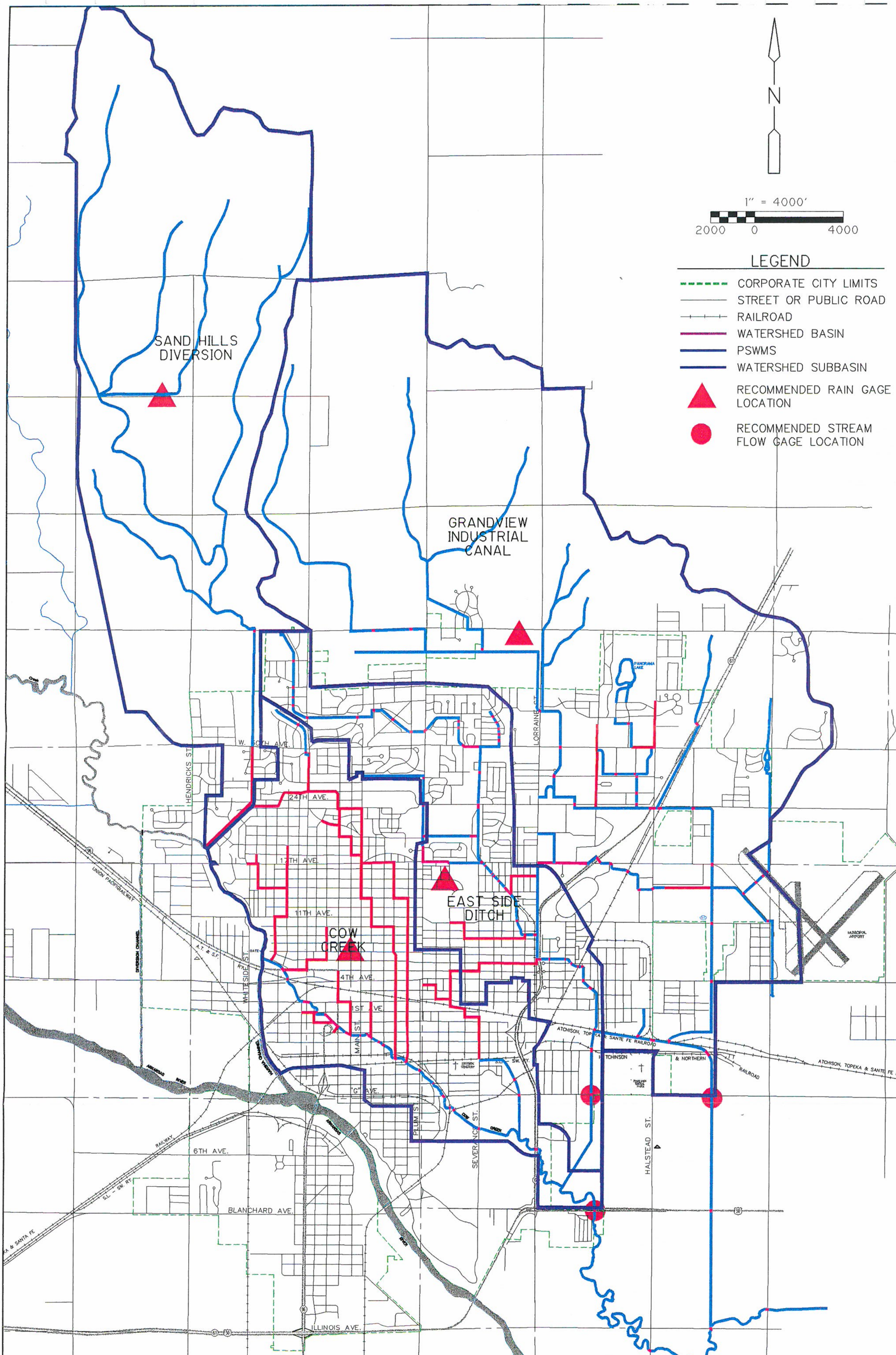
- Current status of water quality including ambient data, dry weather flow from stormwater outfalls, and wet weather runoff as EMC values for land use types

- Trends in water quality due to land use changes and BMP implementation

- Regulatory assistance with state and federal permitting

5.4.1 Recommended Rainfall Monitoring Program

Figure 5-2 shows the recommended monitoring locations. CDM recommends installing a minimum of three continuously recording rain gages. State and federal agencies should be contacted to inquire whether they may be willing to participate in the monitoring and maintenance of the gages. Ideally, a gage should be located in the center of the Cow Creek watershed, ESD watershed, and GVI watershed. Factors controlling the location of the gages are easy access, security against vandalism, and little potential for the gage to be moved in the future. Typical locations include



CDM Camp Dresser & McKee Inc.

consulting
engineering
construction
operations

Figure No. 5-2
RECOMMENDED MONITORING LOCATIONS
STORMWATER MASTER PLAN
HUTCHINSON, KANSAS

public facilities such as City Hall, fire stations, police stations, public works offices, and maintenance facilities. The gages should record rainfall in maximum time intervals of 15 minutes. Ideally, the gages should record rainfall in 5-minute intervals.

5.4.2 Recommended Flow and Stage Monitoring Program

CDM recommends installing three continuously recording flow and stage gages. A gage should be installed on Cow Creek, ESD, and GVI. The gages should be located near where the streams cross the City limits. This will provide measurements of flows from the watersheds in the City of Hutchinson.

5.4.3 Recommended Water Quality Monitoring Program

CDM recommends monitoring water quality at three locations. Water quality should be monitored on Cow Creek, ESD, and GVI near the City limits. This will provide data on the quality of water from the City of Hutchinson.

Section 6
Drainage Policies and Implementation Requirements

6.1 Existing Drainage Policies

As part of the stormwater master planning process, Camp Dresser & McKee (CDM) has conducted a review of the existing ordinances and regulations addressing stormwater, floodplain management, and erosion control. The City of Hutchinson provided CDM with a copy of sections 4.10, 4.11, and 4.12 of the 1991 Subdivision Regulations, which address stormwater and floodplain management. This section discusses the current regulations and provides recommendations to address management and expansion of the stormwater system. For organizational purposes, this has been organized in accordance with the City's Subdivision Regulations to address: Grading, Sedimentation Control, Fill and Refuse; Stormwater Management Program; and Floodways and Floodplains.

6.1.1 Grading, Sedimentation Control, Fill and Refuse

Grading, Sedimentation Control, Fill and Refuse is addressed in Section 4.10 of the subdivision regulations. This section of the regulations require the developer to adhere to four general conditions, these are:

- reasonable efforts to preserve topsoil
- prohibits the burial of top soil
- prevention of blowing topsoil beyond development limits
- vegetative ground cover required before and after construction

These conditions are good in concept, however they do not provide any criteria to determine compliance or the effectiveness of the controls.

Regulations for the control of sediment and erosion are generally based on management practices rather than numerical limits. These practices known as BMPs or Best Management Practices, can consist of many activities or combinations, such as installation of silt fence, sedimentation ponds, vegetative strips, gravel berms or weirs, gravel entrance/exit paths, soil tackifiers, and/or perimeter berms. Each BMP has been developed for specific conditions, which make the selection of BMPs site specific, therefore it would not be recommended for the City to identify a single type of BMP and require it's use on all construction projects. Therefore, a list of appropriate BMPs based on local conditions and proposed landuses is recommended.

However, there are ways in an ordinance or regulation to require implementation of adequate erosion and sediment control practices. The following is a list of suggestions which the City may want to consider.

1. Require the development and submittal of a Sediment and Erosion Control Plan. Several communities have this requirement. The plan is submitted and reviewed as a part of the construction approval process. The plan generally consists of a plan sheet showing the

location of the BMPs, along with a written section describing the materials and design. These plans generally include the identification of nearby features which could be adversely affected by an increase in sediment load, such as sensitive streams or ponds. The basic goal of the plan is to make the developer/contractor aware of the potential for sediment and erosion problems.

2. Develop criteria which can be measured to identify when sediment and erosion control devices are not working properly. This could be in the form of a limit of increase in turbidity in an adjacent stream or pond (i.e. less then 29 Nephelometric Turbidity Units [NTU] above background), or limited distance on road surfaces where sediment is allowed to buildup (i.e. no more than 100 feet beyond the construction project boundaries on public roads).

3. Require the construction site operators to be certified in erosion and sediment control practices. This may be the most difficult, since the certification process has not been established nationwide. Therefore, the City would have to be responsible for ensuring the program was available locally.

4. Make the developer/contractor responsible for clean-up of any sediment or erosion from the project site. This is generally implemented through a requirement for the developer / contractor to provide a bond to cover the cost of clean up of sediment deposits on public areas such as roads, storm sewers, or drainage canals. The issuance of a bond provides incentive for the developer / contractor to clean up these deposits upon completion of the project.

6.1.2 Stormwater Management Program

The stormwater management program section of the regulation has the greatest potential to impact the success of the stormwater master planning project. Uncontrolled stormwater discharges from new developments can negate major capital improvement programs, by increasing the peak flow rates above the design capacity of the structures. Unless the city places strict control on what can and cannot be developed, it would be cost prohibitive to design improvements capable of addressing all potential development scenarios.

Under the current stormwater management program regulations, new developments are required to meet the following conditions:

- As far as practical, no subdivision shall increase the quantity and rate of stormwater emanating from the subdivision.
- All systems must prevent undue ponding, unless included in design.
- All systems must comply with design criteria and performance standards adopted by City or County.
- Prohibits stormwater from sanitary sewer system.
- Requires use of Rational Method and submittal of design calculations.
- Must be designed to avoid substantial damage to properties upstream of the development.

- The appropriate Engineer must review and approve plans.
- Allows filling low areas to a level above the base flood, provided it is not in FEMA Flood Zone A.

These requirements address most of the major issues associated with stormwater management. However, similar to the erosion control regulations, they do not have any measurable means to determine compliance. To address this issue, the city may want to consider the following modifications or enhancements to the stormwater management regulations:

1. Establish design criteria identifying a single storm event, such as the 24 hour / 25 year storm event, or multiple events, 2, 10, 25, and 100 year / 24 hour events. The design storm(s) would be the basis of determining the level of service for stormwater system internal to the development, as well as provide a basis for determining any increase in stormwater discharge. The language should be expanded to state that the post development discharge rate and/or volume shall not be greater than the pre-development discharge rate and/or volume for the critical design storm.

2. Define substantial damage to upstream properties. Consider changing this portion of the regulation to read "no increase in flood stage or velocity upstream or downstream of the project."

3. Modify the requirement for use of the Rational Method to read "rational method or appropriate stormwater model, as approved by the Director." This will allow the use of more sophisticated methods on more complex projects. Based on this, the City should develop a list of accepted models.

4. Define the minimum height of the first finished or habitable floor above the 100 year flood elevation. A common minimum is 2 feet above the flood elevation. This would apply to all habitable structures.

6.1.3 Floodways and Floodplains

The floodways and floodplains regulations appear to address the major issues associated with minimizing encroachment which would adversely affect the flood flow and storage capacity. The major points addressed include:

- Restriction of development within the floodplain to structures which will not block or impact the flood characteristics of the areas.
- Restricts the placement of fill or debris within the floodplain.
- Prohibits the approval of projects by the development review committee which will adversely affect the floodplain or floodway.

One item which is commonly found in floodways and floodplain regulations and ordinances are requirements for developers to provide the information necessary prepare the certificate of no-rise which is required by FEMA to maintain the City's rating under the National Flood Insurance Program. Information generally required for this program includes updated channel cross-sections showing the encroachment into the floodplain or floodway and a updated HEC-2 model of the channel reach showing that the project is in compliance of the No-Rise Certification.

In addition, the City may want to consider adding a provision to this section requiring compensating storage for any fill within the floodplain. The purpose of this provision is to minimize the loss of the flood storage capacity of the floodplain.

6.2 NPDES Permitting

In 1991, the U.S. Environmental Protection Agency issued rules regulating the discharge of stormwater from medium and large municipalities, industrial facilities, and construction activities (greater than 5 acres). At the present time, EPA is revising these regulations to include small municipalities and construction sites between 1 and 5 acres. It is anticipated that revised NPDES Stormwater regulations will be promulgated in October 1999. Based on the draft phase II regulations, it is unclear if the City of Hutchinson will be required to apply. The small communities have been broken into two groups, those associated with urban areas, and those not associated with urban areas. At this point, EPA will allow the states to decide on the issue of regulating small communities which are not associated with urban areas. Should it be decided that these communities be regulated under the program, then the City of Hutchinson will be required to prepare and submit a permit application.

Regardless of regulation as a small community, some of the legal authority requirements of the NPDES program could be beneficial to the city in addressing future water quality concerns related to stormwater discharges. In anticipation of the new EPA regulations and in compliance with the existing requirements, the city may want to consider modifying their existing regulations or developing a new ordinance to address the following issues:

Construction Projects - Regardless of the decision on regulation of small communities, the City of Hutchinson and all citizens are required to be in compliance with the NPDES regulations for construction activities. Since construction activities are covered by a General Nationwide Permit, the city does not have to address the construction permit requirements unless a city construction project has greater than 5 acres of impacted area (1 acre under the proposed rules). However, the City may want to notify developers and contractors that some projects may be required to comply with NPDES Construction Activity permits. This notice not only serves to assist local developers, but can also help protect the city from any liability associated with EPA enforcement actions on construction sites.

Control of Pollutants - Under Phase I of the NPDES permitting program, EPA required the regulated municipalities to implement an ordinance which provided certain legal authority to the city to control the discharge of pollutants to the publicly owned stormwater system. EPA required the following legal authority:

- Control through ordinance, permit, contract, order or similar means, the contribution of pollutants to the municipal storm sewer by storm water discharges associated with industrial activity and the quality of storm water discharged from industrial activity

- Prohibit through ordinance, order, or similar means, illicit discharges to the municipal separate storm sewer

- Control through ordinance, order, or similar means, the discharge to the municipal separate storm sewer of spills, dumping, or disposal of materials other than storm water

- Require the compliance with conditions in ordinances, permits, contracts, or orders

- Carry out all inspection, surveillance and monitoring procedures necessary to determine compliance and noncompliance with permit conditions, including the prohibition on illicit discharges to the municipal separate storm sewer

Even if not required by EPA, implementing the legal authority discussed above would provide the City with the ability to control discharges to the storm sewer system. This will allow the City to better address situations where private entities are discharging pollutants to the storm sewer system and thereby, protect the quality of surface waters in Hutchinson.

6.3 Recommendations

CDM has reviewed the City's stormwater regulations to identify ways which could make them more effective and preserve the City's investment in the capital improvements identified in the stormwater master plan. At this point, it is recommended that the City present these recommendations to the City's legal department and Stormwater Management Advisory Committee for discussion. Based on the review by the legal department and the Stormwater Management Advisory Committee, the City should implement agreed upon revisions.

Appendix A
Hydrologic and Hydraulic Data

Table No. A-1
Runoff Parameters
Area, Ground Slope, and Width Calculations
Hutchinson Stormwater Master Plan

			Overland Flow Path No. 1				Overland Flow Path No. 2				Overland Flow Path No. 3				Results				
			Ground Elevations (ft)				Ground Elevations (ft)				Ground Elevations (ft)								
No.	Subbasin	Area (acres)	Maximum	Minimum	Flow Length (ft)	Weight Fraction	Maximum	Minimum	Flow Length (ft)	Weight Fraction	Maximum	Minimum	Flow Length (ft)	Weight Fraction	Slope (ft/ft)	Flow Length (ft)	Weight Check	Area (ft2)	Width (ft)
1	SHD010	598.3	1720.0	1680.0	4,400	1.00	1.0	0.0	3,400	0.00	1.0	0.0	1	0.00	0.0091	4,400	1.00	26,060,641	7,665
2	SHD020	393.6	1680.0	1600.0	5,000	1.00	1.0	0.0	3,000	0.00	1.0	0.0	1	0.00	0.0160	5,000	1.00	17,143,038	5,714
3	SHD030	220.6	1640.0	1560.0	4,200	1.00	1.0	0.0	2,300	0.00	1.0	0.0	1	0.00	0.0190	4,200	1.00	9,610,207	4,178
4	SHD040	257.2	1700.0	1650.0	3,900	1.00	1.0	0.0	3,100	0.00	1.0	0.0	1	0.00	0.0128	3,900	1.00	11,201,454	3,613
5	SHD050	286.1	1650.0	1560.0	4,900	1.00	1.0	0.0	1,900	0.00	1.0	0.0	1	0.00	0.0184	4,900	1.00	12,462,080	6,559
6	SHD060	442.2	1700.0	1660.0	5,500	1.00	1.0	0.0	3,200	0.00	1.0	0.0	1	0.00	0.0073	5,500	1.00	19,261,361	6,019
7	SHD070	312.4	1660.0	1560.0	6,000	1.00	1.0	0.0	1,500	0.00	1.0	0.0	1	0.00	0.0167	6,000	1.00	13,609,015	9,073
8	SHD080	455.5	1560.0	1550.0	5,400	1.00	1.0	0.0	2,000	0.00	1.0	0.0	1	0.00	0.0019	5,400	1.00	19,839,838	9,920
9	SHD090	104.4	1550.0	1540.0	3,000	1.00	1.0	0.0	600	0.00	1.0	0.0	1	0.00	0.0033	3,000	1.00	4,546,793	7,578
10	SHD100	402.8	1680.0	1600.0	1,600	1.00	1.0	0.0	2,800	0.00	1.0	0.0	1	0.00	0.0500	1,600	1.00	17,545,968	6,266
11	SHD110	361.5	1660.0	1570.0	5,100	1.00	1.0	0.0	1,900	0.00	1.0	0.0	1	0.00	0.0176	5,100	1.00	15,748,247	8,289
12	SHD120	466.9	1590.0	1550.0	6,000	1.00	1.0	0.0	1,700	0.00	1.0	0.0	1	0.00	0.0067	6,000	1.00	20,335,986	11,962
13	SHD130	506.2	1560.0	1550.0	3,300	1.00	1.0	0.0	2,200	0.00	1.0	0.0	1	0.00	0.0030	3,300	1.00	22,051,379	10,023
14	SHD140	284.7	1550.0	1540.0	600	1.00	1.0	0.0	2,100	0.00	1.0	0.0	1	0.00	0.0167	600	1.00	12,400,225	5,905
15	SHD150	800.9	1555.0	1550.0	2,600	1.00	1.0	0.0	5,000	0.00	1.0	0.0	1	0.00	0.0019	2,600	1.00	34,885,462	6,977
16	SHD160	197.3	1542.0	1540.0	2,850	1.00	1.0	0.0	1,400	0.00	1.0	0.0	1	0.00	0.0007	2,850	1.00	8,592,210	6,137
17	ESD010	182.5	1545.0	1543.0	2,500	1.00	1.0	0.0	1,300	0.00	1.0	0.0	1	0.00	0.0008	2,500	1.00	7,951,442	6,116
18	ESD020	119.7	1542.0	1540.0	1,200	1.00	1.0	0.0	1,300	0.00	1.0	0.0	1	0.00	0.0017	1,200	1.00	5,213,261	4,010
19	ESD030	42.2	1542.0	1540.0	1,000	1.00	1.0	0.0	1,000	0.00	1.0	0.0	1	0.00	0.0020	1,000	1.00	1,839,539	1,840
20	ESD040	150.4	1542.0	1536.0	2,000	1.00	1.0	0.0	1,100	0.00	1.0	0.0	1	0.00	0.0030	2,000	1.00	6,551,424	5,956
21	ESD050	144.7	1536.0	1534.0	2,500	1.00	1.0	0.0	1,300	0.00	1.0	0.0	1	0.00	0.0008	2,500	1.00	6,303,132	4,849
22	ESD060	57.5	1526.0	1524.0	1,500	1.00	1.0	0.0	600	0.00	1.0	0.0	1	0.00	0.0013	1,500	1.00	2,504,700	4,175
23	ESD065	48.9	1524.0	1523.0	1,000	1.00	1.0	0.0	900	0.00	1.0	0.0	1	0.00	0.0010	1,000	1.00	2,130,084	2,367
24	ESD070	42.0	1534.0	1532.0	1,000	1.00	1.0	0.0	1,400	0.00	1.0	0.0	1	0.00	0.0020	1,000	1.00	1,829,520	1,307
25	ESD080	89.9	1534.0	1533.0	2,400	1.00	1.0	0.0	1,500	0.00	1.0	0.0	1	0.00	0.0004	2,400	1.00	3,916,044	2,611
26	ESD090	73.4	1534.0	1532.0	1,200	1.00	1.0	0.0	1,600	0.00	1.0	0.0	1	0.00	0.0017	1,200	1.00	3,198,175	1,999
27	ESD100	52.8	1532.0	1530.0	1,300	1.00	1.0	0.0	1,500	0.00	1.0	0.0	1	0.00	0.0015	1,300	1.00	2,299,097	1,533
28	ESD110	69.6	1542.0	1536.0	1,400	1.00	1.0	0.0	1,300	0.00	1.0	0.0	1	0.00	0.0043	1,400	1.00	3,032,647	2,333
29	ESD120	131.1	1538.0	1537.0	700	1.00	1.0	0.0	1,300	0.00	1.0	0.0	1	0.00	0.0014	700	1.00	5,708,974	4,392
30	ESD130	195.6	1538.0	1534.0	2,100	1.00	1.0	0.0	2,500	0.00	1.0	0.0	1	0.00	0.0019	2,100	1.00	8,519,900	3,408
31	ESD140	120.4	1534.0	1532.0	1,100	1.00	1.0	0.0	1,100	0.00	1.0	0.0	1	0.00	0.0018	1,100	1.00	5,244,188	4,767
32	ESD150	74.1	1532.0	1530.0	1,600	1.00	1.0	0.0	1,500	0.00	1.0	0.0	1	0.00	0.0013	1,600	1.00	3,229,103	2,153
33	ESD160	47.1	1532.0	1530.0	1,000	1.00	1.0	0.0	1,400	0.00	1.0	0.0	1	0.00	0.0020	1,000	1.00	2,051,676	1,465
34	ESD165	65.1	1530.0	1528.0	1,400	1.00	1.0	0.0	1,000	0.00	1.0	0.0	1	0.00	0.0014	1,400	1.00	2,835,756	2,836
35	ESD170	106.7	1530.0	1528.0	1,200	1.00	1.0	0.0	2,000	0.00	1.0	0.0	1	0.00	0.0017	1,200	1.00	4,646,110	2,323
36	ESD180	128.3	1532.0	1528.0	3,300	1.00	1.0	0.0	1,000	0.00	1.0	0.0	1	0.00	0.0012	3,300	1.00	5,588,748	5,589
37	ESD185	102.8	1532.0	1531.0	1,250	1.00	1.0	0.0	1,500	0.00	1.0	0.0	1	0.00	0.0008	1,250	1.00	4,477,968	2,985
38	ESD190	149.2	1528.0	1526.0	1,200	1.00	1.0	0.0	900	0.00	1.0	0.0	1	0.00	0.0017	1,200	1.00	6,499,588	7,222
39	ESD200	153.0	1528.0	1526.0	1,550	1.00	1.0	0.0	1,300	0.00	1.0	0.0	1	0.00	0.0013	1,550	1.00	6,664,680	5,127
40	ESD205	29.0	1530.0	1528.0	500	1.00	1.0	0.0	900	0.00	1.0	0.0	1	0.00	0.0040	500	1.00	1,263,240	1,404
41	ESD210	103.7	1526.0	1524.0	1,100	1.00	1.0	0.0	1,600	0.00	1.0	0.0	1	0.00	0.0018	1,100	1.00	4,515,865	2,822
42	ESD220	126.2	1524.0	1522.0	1,500	1.00	1.0	0.0	2,200	0.00	1.0	0.0	1	0.00	0.0013	1,500	1.00	5,497,272	2,499
43	ESD230	116.5	1524.0	1522.0	1,350	1.00	1.0	0.0	2,300	0.00	1.0	0.0	1	0.00	0.0015	1,350	1.00	5,073,869	2,206
44	ESD240	49.7	1522.0	1521.5	500	1.00	1.0	0.0	2,300	0.00	1.0	0.0	1	0.00	0.0010	500	1.00	2,164,932	941
45	ESD250	164.5	1522.0	1521.0	1,250	1.00	1.0	0.0	2,300	0.00	1.0	0.0	1	0.00	0.0008	1,250	1.00	7,166,056	3,116
46	COW010	110.0	1542.0	1540.0	700	1.00	1.0	0.0	1,900	0.00	1.0	0.0	1	0.00	0.0029	700	1.00	4,789,422	2,521
47	COW020	72.9	1542.0	1540.0	1,500	1.00	1.0	0.0	1,200	0.00	1.0	0.0	1	0.00	0.0013	1,500	1.00	3,177,266	2,648
48	COW030	76.9	1542.0	1538.0	2700.0	1.00	1.0	0.0	1,000	0.00	1.0	0.0	1	0.00	0.0015	2,700	1.00	3,348,022	3,348
49	COW035	17.0	1539.0	1538.0	700	1.00	1.0	0.0	1,500	0.00	1.0	0.0	1	0.00	0.0014	700	1.00	738,778	493
50	COW040	45.7	1538.0	1537.0	1,050	1.00	1.0	0.0	700	0.00	1.0	0.0	1	0.00	0.0010	1,050	1.00	1,990,692	2,844

Huthydr1.xls Widths,slopes,Areas
6/1/00

Table No. A-1
Runoff Parameters
Area, Ground Slope, and Width Calculations
Hutchinson Stormwater Master Plan

			Overland Flow Path No. 1				Overland Flow Path No. 2				Overland Flow Path No. 3				Results				
			Ground Elevations (ft)				Ground Elevations (ft)				Ground Elevations (ft)								
No.	Subbasin	Area (acres)	Maximum	Minimum	Flow Length (ft)	Weight Fraction	Maximum	Minimum	Flow Length (ft)	Weight Fraction	Maximum	Minimum	Flow Length (ft)	Weight Fraction	Slope (ft/ft)	Flow Length (ft)	Weight Check	Area (ft2)	Width (ft)
51	COW042	35.8	1542.0	1540.0	400	1.00	1.0	0.0	1,500	0.00	1.0	0.0	1	0.00	0.0050	400	1.00	1,559,448	1,040
52	COW044	88.4	1540.0	1538.0	1,250	1.00	1.0	0.0	1,000	0.00	1.0	0.0	1	0.00	0.0016	1,250	1.00	3,850,704	3,851
53	COW046	81.1	1538.0	1536.0	1,250	1.00	1.0	0.0	900	0.00	1.0	0.0	1	0.00	0.0016	1,250	1.00	3,532,716	3,925
54	COW048	39.1	1538.0	1536.0	300	1.00	1.0	0.0	700	0.00	1.0	0.0	1	0.00	0.0067	300	1.00	1,703,196	2,433
55	COW050	109.2	1536.0	1534.0	1,300	1.00	1.0	0.0	1,100	0.00	1.0	0.0	1	0.00	0.0015	1,300	1.00	4,758,494	4,326
56	COW060	83.7	1542.0	1540.0	1,500	1.00	1.0	0.0	1,700	0.00	1.0	0.0	1	0.00	0.0013	1,500	1.00	3,647,714	2,146
57	COW070	44.8	1540.0	1538.0	600	1.00	1.0	0.0	500	0.00	1.0	0.0	1	0.00	0.0033	600	1.00	1,952,795	3,906
58	COW080	53.6	1540.0	1538.0	750	1.00	1.0	0.0	700	0.00	1.0	0.0	1	0.00	0.0027	750	1.00	2,334,816	3,335
59	COW085	49.8	1542.0	1541.0	300	1.00	1.0	0.0	1,000	0.00	1.0	0.0	1	0.00	0.0033	300	1.00	2,169,288	2,169
60	COW090	103.2	1540.0	1539.0	1,350	1.00	1.0	0.0	2,000	0.00	1.0	0.0	1	0.00	0.0007	1,350	1.00	4,494,956	2,247
61	COW100	74.0	1538.0	1536.0	1,800	1.00	1.0	0.0	1,200	0.00	1.0	0.0	1	0.00	0.0011	1,800	1.00	3,223,876	2,687
62	COW110	112.6	1536.0	1532.0	1,300	1.00	1.0	0.0	1,200	0.00	1.0	0.0	1	0.00	0.0031	1,300	1.00	4,903,114	4,086
63	COW120	57.1	1536.0	1528.0	1,300	1.00	1.0	0.0	1,100	0.00	1.0	0.0	1	0.00	0.0062	1,300	1.00	2,485,098	2,259
64	COW130	19.3	1534.0	1533.0	1,400	1.00	1.0	0.0	900	0.00	1.0	0.0	1	0.00	0.0007	1,400	1.00	842,015	936
65	COW140	63.9	1536.0	1534.0	1,750	1.00	1.0	0.0	1,600	0.00	1.0	0.0	1	0.00	0.0011	1,750	1.00	2,783,484	1,740
66	COW145	79.2	1538.0	1532.0	2,400	1.00	1.0	0.0	1,500	0.00	1.0	0.0	1	0.00	0.0025	2,400	1.00	3,449,952	2,300
67	COW150	121.3	1538.0	1530.0	600	1.00	1.0	0.0	1,200	0.00	1.0	0.0	1	0.00	0.0133	600	1.00	5,285,570	4,405
68	COW160	44.1	1530.0	1528.0	1,900	1.00	1.0	0.0	500	0.00	1.0	0.0	1	0.00	0.0011	1,900	1.00	1,922,303	3,845
69	COW170	46.0	1532.0	1530.0	600	1.00	1.0	0.0	800	0.00	1.0	0.0	1	0.00	0.0033	600	1.00	2,004,631	2,506
70	COW180	32.9	1532.0	1530.0	1,300	1.00	1.0	0.0	900	0.00	1.0	0.0	1	0.00	0.0015	1,300	1.00	1,433,124	1,592
71	COW185	62.6	1532.0	1530.0	1,400	1.00	1.0	0.0	1,400	0.00	1.0	0.0	1	0.00	0.0014	1,400	1.00	2,726,856	1,948
72	COW190	153.5	1532.0	1530.0	1,550	1.00	1.0	0.0	1,400	0.00	1.0	0.0	1	0.00	0.0013	1,550	1.00	6,686,460	4,776
73	COW200	23.6	1530.0	1529.0	450	1.00	1.0	0.0	1,400	0.00	1.0	0.0	1	0.00	0.0022	450	1.00	1,028,016	734
74	COW210	67.4	1530.0	1528.0	900	1.00	1.0	0.0	1,300	0.00	1.0	0.0	1	0.00	0.0022	900	1.00	2,934,637	2,257
75	COW220	31.3	1530.0	1529.0	1,100	1.00	1.0	0.0	1,300	0.00	1.0	0.0	1	0.00	0.0009	1,100	1.00	1,363,864	1,049
76	COW230	66.4	1536.0	1528.0	2,100	1.00	1.0	0.0	2,300	0.00	1.0	0.0	1	0.00	0.0038	2,100	1.00	2,893,255	1,258
77	COW240	105.8	1534.0	1530.0	2,800	1.00	1.0	0.0	1,200	0.00	1.0	0.0	1	0.00	0.0014	2,800	1.00	4,608,648	3,841
78	COW250	39.5	1530.0	1528.0	2,900	1.00	1.0	0.0	800	0.00	1.0	0.0	1	0.00	0.0007	2,900	1.00	1,720,620	2,151
79	COW260	92.3	1530.0	1526.0	2,400	1.00	1.0	0.0	1,100	0.00	1.0	0.0	1	0.00	0.0017	2,400	1.00	4,022,330	3,657
80	COW270	169.5	1528.0	1524.0	2,400	1.00	1.0	0.0	1,800	0.00	1.0	0.0	1	0.00	0.0017	2,400	1.00	7,382,984	4,102
81	COW280	132.5	1532.0	1530.0	1,800	1.00	1.0	0.0	2,500	0.00	1.0	0.0	1	0.00	0.0011	1,800	1.00	5,771,264	2,309
82	COW285	90.6	1532.0	1530.0	600	1.00	1.0	0.0	1,500	0.00	1.0	0.0	1	0.00	0.0033	600	1.00	3,947,407	2,632
83	COW290	79.7	1530.0	1526.0	2,350	1.00	1.0	0.0	900	0.00	1.0	0.0	1	0.00	0.0017	2,350	1.00	3,471,732	3,857
84	COW295	41.6	1532.0	1530.0	600	1.00	1.0	0.0	600	0.00	1.0	0.0	1	0.00	0.0033	600	1.00	1,812,096	3,020
85	COW300	200.0	1528.0	1526.0	1,300	1.00	1.0	0.0	3,000	0.00	1.0	0.0	1	0.00	0.0015	1,300	1.00	8,710,693	2,904
86	COW310	52.4	1526.0	1524.0	1,700	1.00	1.0	0.0	1,600	0.00	1.0	0.0	1	0.00	0.0012	1,700	1.00	2,283,851	1,427
87	COW320	119.6	1526.0	1524.0	1,700	1.00	1.0	0.0	1,200	0.00	1.0	0.0	1	0.00	0.0012	1,700	1.00	5,207,598	4,340
88	COW330	91.2	1526.0	1524.0	1,700	1.00	1.0	0.0	900	0.00	1.0	0.0	1	0.00	0.0012	1,700	1.00	3,973,108	4,415
89	COW340	179.7	1526.0	1524.0	1,700	1.00	1.0	0.0	1,200	0.00	1.0	0.0	1	0.00	0.0012	1,700	1.00	7,827,732	6,523
90	COW350	63.0	1526.0	1524.0	1,700	1.00	1.0	0.0	1,400	0.00	1.0	0.0	1	0.00	0.0012	1,700	1.00	2,743,409	1,960
91	GVI010	639.1	1650.0	1600.0	3,400	1.00	1.0	0.0	4,000	0.00	1.0	0.0	1	0.00	0.0147	3,400	1.00	27,839,196	6,960
92	GVI020	391.4	1575.0	1551.0	3,400	1.00	1.0	0.0	2,500	0.00	1.0	0.0	1	0.00	0.0071	3,400	1.00	17,049,384	6,820
93	GVI030	647.6	1550.0	1545.0	2,500	1.00	1.0	0.0	2,600	0.00	1.0	0.0	1	0.00	0.0020	2,500	1.00	28,209,456	10,850
94	GVI040	418.5	1545.0	1540.0	2,600	1.00	1.0	0.0	1,200	0.00	1.0	0.0	1	0.00	0.0019	2,600	1.00	18,229,860	15,192
95	GVI050	653.3	1650.0	1634.0	2,400	1.00	1.0	0.0	3,000	0.00	1.0	0.0	1	0.00	0.0067	2,400	1.00	28,457,748	9,486
96	GVI060	643.3	1625.0	1550.0	5,700	1.00	1.0	0.0	4,000	0.00	1.0	0.0	1	0.00	0.0132	5,700	1.00	28,022,148	7,006
97	GVI070	839.8	1625.0	1575.0	3,500	1.00	1.0	0.0	3,500	0.00	1.0	0.0	1	0.00	0.0143	3,500	1.00	36,581,688	10,452
98	GVI080	499.9	1600.0	1535.0	4,650	1.00	1.0	0.0	4,000	0.00	1.0	0.0	1	0.00	0.0140	4,650	1.00	21,775,644	5,444
99	GVI090	201.4	1555.0	1540.0	2,000	1.00	1.0	0.0	2,100	0.00	1.0	0.0	1	0.00	0.0075	2,000	1.00	8,772,984	4,178
100	GVI100	558.7	1625.0	1550.0	4,700	1.00	1.0	0.0	2,000	0.00	1.0	0.0	1	0.00	0.0160	4,700	1.00	24,336,972	12,168
101	GVI110	313.8	1625.0	1566.0	4,000	1.00	1.0	0.0	1,500	0.00	1.0	0.0	1	0.00	0.0148	4,000	1.00	13,669,128	9,113

Table No. A-1
Runoff Parameters
Area, Ground Slope, and Width Calculations
Hutchinson Stormwater Master Plan

			Overland Flow Path No. 1				Overland Flow Path No. 2				Overland Flow Path No. 3				Results				
			Ground Elevations (ft)				Ground Elevations (ft)				Ground Elevations (ft)								
No.	Subbasin	Area (acres)	Maximum	Minimum	Flow Length (ft)	Weight Fraction	Maximum	Minimum	Flow Length (ft)	Weight Fraction	Maximum	Minimum	Flow Length (ft)	Weight Fraction	Slope (ft/ft)	Flow Length (ft)	Weight Check	Area (ft2)	Width (ft)
102	GVI120	217.1	1625.0	1550.0	4,400	1.00	1.0	0.0	1,300	0.00	1.0	0.0	1	0.00	0.0170	4,400	1.00	9,456,876	7,275
103	GVI130	176.5	1600.0	1535.0	3,400	1.00	1.0	0.0	1,400	0.00	1.0	0.0	1	0.00	0.0191	3,400	1.00	7,688,340	5,492
104	GVI140	321.0	1600.0	1530.0	5,000	1.00	1.0	0.0	1,000	0.00	1.0	0.0	1	0.00	0.0140	5,000	1.00	13,982,760	13,983
105	GVI150	257.6	1605.0	1530.0	5,000	1.00	1.0	0.0	5,000	0.00	1.0	0.0	1	0.00	0.0150	5,000	1.00	11,221,056	2,244
106	GVI160	240.5	1525.0	1500.0	4,100	1.00	1.0	0.0	3,200	0.00	1.0	0.0	1	0.00	0.0061	4,100	1.00	10,476,180	3,274
107	GVI170	471.2	1550.0	1500.0	2,700	1.00	1.0	0.0	2,800	0.00	1.0	0.0	1	0.00	0.0185	2,700	1.00	20,525,472	7,331
108	GVI180	246.2	1524.0	1522.0	2,000	1.00	1.0	0.0	800	0.00	1.0	0.0	1	0.00	0.0010	2,000	1.00	10,724,472	13,406
109	GVI185	206.6	1522.0	1520.0	800	1.00	1.0	0.0	2,100	0.00	1.0	0.0	1	0.00	0.0025	800	1.00	8,999,496	4,285
110	GVI190	155.3	1532.0	1531.0	3,000	1.00	1.0	0.0	1,600	0.00	1.0	0.0	1	0.00	0.0003	3,000	1.00	6,764,868	4,228
111	GVI200	130.6	1532.0	1531.0	1,000	1.00	1.0	0.0	1,700	0.00	1.0	0.0	1	0.00	0.0010	1,000	1.00	5,688,936	3,346
112	GVI210	136.1	1532.0	1530.0	1,500	1.00	1.0	0.0	1,900	0.00	1.0	0.0	1	0.00	0.0013	1,500	1.00	5,928,516	3,120
113	GVI220	78.6	1532.0	1530.0	700	1.00	1.0	0.0	1,500	0.00	1.0	0.0	1	0.00	0.0029	700	1.00	3,423,816	2,283
114	GVI230	82.0	1532.0	1530.0	900	1.00	1.0	0.0	900	0.00	1.0	0.0	1	0.00	0.0022	900	1.00	3,571,920	3,969
115	GVI240	76.9	1530.0	1528.0	2,000	1.00	1.0	0.0	1,400	0.00	1.0	0.0	1	0.00	0.0010	2,000	1.00	3,349,764	2,393
116	GVI250	194.2	1532.0	1530.0	5,000	1.00	1.0	0.0	1,400	0.00	1.0	0.0	1	0.00	0.0004	5,000	1.00	8,459,352	6,042
117	GVI260	66.9	1532.0	1530.0	1,900	1.00	1.0	0.0	1,200	0.00	1.0	0.0	1	0.00	0.0011	1,900	1.00	2,914,164	2,428
118	GVI270	84.2	1530.0	1526.0	1,500	1.00	1.0	0.0	2,300	0.00	1.0	0.0	1	0.00	0.0027	1,500	1.00	3,667,752	1,595
119	GVI280	245.0	1526.0	1522.0	7,500	1.00	1.0	0.0	2,900	0.00	1.0	0.0	1	0.00	0.0005	7,500	1.00	10,672,200	3,680
120	GVI290	379.7	1528.0	1522.0	4,300	1.00	1.0	0.0	5,200	0.00	1.0	0.0	1	0.00	0.0014	4,300	1.00	16,539,732	3,181
121	GVI300	178.3	1526.0	1522.0	4,400	1.00	1.0	0.0	1,000	0.00	1.0	0.0	1	0.00	0.0009	4,400	1.00	7,766,748	7,767
122	GVI310	235.9	1526.0	1522.0	5,300	1.00	1.0	0.0	2,800	0.00	1.0	0.0	1	0.00	0.0008	5,300	1.00	10,275,804	3,670
123	GVI320	173.6	1522.0	1520.0	1,700	1.00	1.0	0.0	2,400	0.00	1.0	0.0	1	0.00	0.0012	1,700	1.00	7,562,016	3,151
124	GVI330	66.4	1522.0	1520.0	1,600	1.00	1.0	0.0	600	0.00	1.0	0.0	1	0.00	0.0013	1,600	1.00	2,892,384	4,821
125	GVI340	145.2	1520.0	1518.0	650	1.00	1.0	0.0	2,300	0.00	1.0	0.0	1	0.00	0.0031	650	1.00	6,324,912	2,750

Area:	22,923 acres	35.82 sq. miles
Max	839.8 acres	
Min	17.0 acres	
Ave	183.4 acres	
SHD	6,090 acres	9.52 sq. miles
ESD	2,937 acres	4.59 sq. miles
COW	3,524 acres	5.51 sq. miles
GVI	10,372 acres	16.21 sq. miles

Table No. A-2
Runoff Parameters
Land Use Data
Hutchinson Stormwater Master Plan

	Forest, Open, Park	Pasture	Agriculture	Residential Low Density	Residential Medium Density	Residential High Density	Institutional	Commercial	Industrial	Watercourses, Waterbodies
IMPERVIOUS n	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.024
PERVIOUS n	0.400	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.060
IMPERVIOUS Ia	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
PERVIOUS Ia	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.10
% IMPERVIOUS	1.0	1.0	1.0	30.0	34.0	57.0	65.0	87.0	87.0	100.0
% DCIA	1.0	1.0	1.0	16.0	19.0	38.0	46.0	79.0	79.0	100.0
% NDCIA	0.0	0.0	0.0	14.0	15.0	19.0	19.0	8.0	8.0	0.0
% PERVIOUS	99.0	99.0	99.0	70.0	66.0	43.0	35.0	13.0	13.0	0.0
CHECK %	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

No.	Subbasin	Forest, Open, Park	Pasture	Agriculture	Residential Low Density	Residential Medium Density	Residential High Density	Institutional	Commercial	Industrial	Watercourses, Waterbodies	Check (%)	Pervious (%)	NDCIA (%)	DCIA (%)	Check (%)	DCIA 'n'	Pervious 'n'	DCIA Ia	Pervious Ia
1	SHD010	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
2	SHD020	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
3	SHD030	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
4	SHD040	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
5	SHD050	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
6	SHD060	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
7	SHD070	5	0	95	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.305	.10	.25
8	SHD080	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
9	SHD090	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
10	SHD100	10	0	90	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.310	.10	.25
11	SHD110	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
12	SHD120	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
13	SHD130	0	0	85	15	0	0	0	0	0	0	100.0	94.7	2.1	3.3	100.0	.020	.294	.10	.25
14	SHD140	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
15	SHD150	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
16	SHD160	12	0	0	88	0	0	0	0	0	0	100.0	73.5	12.3	14.2	100.0	.020	.274	.10	.23
17	ESD010	0	0	25	75	0	0	0	0	0	0	100.0	77.3	10.5	12.3	100.0	.020	.266	.10	.23
18	ESD020	0	0	0	60	40	0	0	0	0	0	100.0	68.4	14.4	17.2	100.0	.020	.251	.10	.22
19	ESD030	0	0	0	15	85	0	0	0	0	0	100.0	66.6	14.9	18.6	100.0	.020	.249	.10	.22
20	ESD040	0	0	0	0	100	0	0	0	0	0	100.0	66.0	15.0	19.0	100.0	.020	.248	.10	.22
21	ESD050	0	0	0	0	100	0	0	0	0	0	100.0	66.0	15.0	19.0	100.0	.020	.248	.10	.22
22	ESD060	0	0	0	0	100	0	0	0	0	0	100.0	66.0	15.0	19.0	100.0	.020	.248	.10	.22
23	ESD065	0	0	0	0	100	0	0	0	0	0	100.0	66.0	15.0	19.0	100.0	.020	.248	.10	.22
24	ESD070	0	0	0	0	100	0	0	0	0	0	100.0	66.0	15.0	19.0	100.0	.020	.248	.10	.22
25	ESD080	30	0	0	0	70	0	0	0	0	0	100.0	75.9	10.5	13.6	100.0	.020	.300	.10	.23
26	ESD090	95	0	0	5	0	0	0	0	0	0	100.0	97.6	0.7	1.8	100.0	.020	.394	.10	.25
27	ESD100	25	0	0	30	45	0	0	0	0	0	100.0	75.5	11.0	13.6	100.0	.020	.293	.10	.23
28	ESD110	5	0	0	25	65	0	5	0	0	0	100.0	67.1	14.2	18.7	100.0	.020	.257	.10	.22
29	ESD120	0	0	0	0	100	0	0	0	0	0	100.0	66.0	15.0	19.0	100.0	.020	.248	.10	.22
30	ESD130	50	0	0	0	10	0	40	0	0	0	100.0	70.1	9.1	20.8	100.0	.020	.330	.10	.23
31	ESD140	5	0	0	50	45	0	0	0	0	0	100.0	69.7	13.8	16.6	100.0	.020	.260	.10	.23
32	ESD150	0	0	50	0	50	0	0	0	0	0	100.0	82.5	7.5	10.0	100.0	.020	.277	.10	.24
33	ESD160	15	0	0	55	30	0	0	0	0	0	100.0	73.2	12.2	14.7	100.0	.020	.277	.10	.23
34	ESD165	0	0	0	100	0	0	0	0	0	0	100.0	70.0	14.0	16.0	100.0	.020	.253	.10	.23

No.	Subbasin	Forest, Open, Park	Pasture	Agriculture	Residential Low Density	Residential Medium Density	Residential High Density	Institutional	Commercial	Industrial	Watercourses, Waterbodies	Check (%)	Pervious (%)	NDCIA (%)	DCIA (%)	Check (%)	DCIA 'n'	Pervious 'n'	DCIA Ia	Pervious Ia
35	ESD170	0	0	30	55	5	0	10	0	0	0	100.0	75.0	10.4	14.7	100.0	.020	.266	.10	.23
36	ESD180	0	0	0	12	83	0	5	0	0	0	100.0	64.9	15.1	20.0	100.0	.020	.247	.10	.22
37	ESD185	0	0	0	0	64	0	36	0	0	0	100.0	54.8	16.4	28.7	100.0	.020	.235	.10	.22
38	ESD190	0	0	0	0	90	0	10	0	0	0	100.0	62.9	15.4	21.7	100.0	.020	.245	.10	.22
39	ESD200	0	0	38	0	62	0	0	0	0	0	100.0	78.5	9.3	12.2	100.0	.020	.270	.10	.23
40	ESD205	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
41	ESD210	0	0	0	0	0	0	0	100	0	0	100.0	13.0	8.0	79.0	100.0	.020	.193	.10	.19
42	ESD220	50	0	0	0	15	0	0	0	35	0	100.0	64.0	5.1	31.0	100.0	.020	.351	.10	.24
43	ESD230	0	0	0	0	100	0	0	0	0	0	100.0	66.0	15.0	19.0	100.0	.020	.248	.10	.22
44	ESD240	0	0	0	0	100	0	0	0	0	0	100.0	66.0	15.0	19.0	100.0	.020	.248	.10	.22
45	ESD250	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
46	COW010	0	0	0	100	0	0	0	0	0	0	100.0	70.0	14.0	16.0	100.0	.020	.253	.10	.23
47	COW020	0	0	0	100	0	0	0	0	0	0	100.0	70.0	14.0	16.0	100.0	.020	.253	.10	.23
48	COW030	0	0	0	100	0	0	0	0	0	0	100.0	70.0	14.0	16.0	100.0	.020	.253	.10	.23
49	COW035	0	0	0	100	0	0	0	0	0	0	100.0	70.0	14.0	16.0	100.0	.020	.253	.10	.23
50	COW040	0	0	0	100	0	0	0	0	0	0	100.0	70.0	14.0	16.0	100.0	.020	.253	.10	.23
51	COW042	0	0	0	78	0	0	22	0	0	0	100.0	62.3	15.1	22.6	100.0	.020	.245	.10	.22
52	COW044	0	0	0	100	0	0	0	0	0	0	100.0	70.0	14.0	16.0	100.0	.020	.253	.10	.23
53	COW046	0	0	0	50	50	0	0	0	0	0	100.0	68.0	14.5	17.5	100.0	.020	.251	.10	.22
54	COW048	0	0	0	0	100	0	0	0	0	0	100.0	66.0	15.0	19.0	100.0	.020	.248	.10	.22
55	COW050	0	0	0	0	95	0	5	0	0	0	100.0	64.5	15.2	20.4	100.0	.020	.247	.10	.22
56	COW060	0	0	0	70	15	0	15	0	0	0	100.0	64.2	14.9	21.0	100.0	.020	.247	.10	.22
57	COW070	0	0	0	15	85	0	0	0	0	0	100.0	66.6	14.9	18.6	100.0	.020	.249	.10	.22
58	COW080	0	0	0	0	100	0	0	0	0	0	100.0	66.0	15.0	19.0	100.0	.020	.248	.10	.22
59	COW085	0	0	0	0	100	0	0	0	0	0	100.0	66.0	15.0	19.0	100.0	.020	.248	.10	.22
60	COW090	0	0	0	0	95	0	0	5	0	0	100.0	63.4	14.7	22.0	100.0	.020	.247	.10	.22
61	COW100	0	0	0	0	55	0	10	35	0	0	100.0	44.4	13.0	42.7	100.0	.020	.237	.10	.22
62	COW110	0	0	0	0	80	0	0	20	0	0	100.0	55.4	13.6	31.0	100.0	.020	.245	.10	.22
63	COW120	0	0	0	0	90	0	5	5	0	0	100.0	61.8	14.9	23.4	100.0	.020	.246	.10	.22
64	COW130	0	0	0	0	100	0	0	0	0	0	100.0	66.0	15.0	19.0	100.0	.020	.248	.10	.22
65	COW140	0	0	0	0	86	0	14	0	0	0	100.0	61.7	15.6	22.8	100.0	.020	.244	.10	.22
66	COW145	0	0	0	0	95	0	5	0	0	0	100.0	64.5	15.2	20.4	100.0	.020	.247	.10	.22
67	COW150	0	0	0	0	70	0	0	30	0	0	100.0	50.1	12.9	37.0	100.0	.020	.243	.10	.22
68	COW160	0	0	0	0	5	0	0	95	0	0	100.0	15.7	8.4	76.0	100.0	.020	.203	.10	.20
69	COW170	0	0	0	0	50	0	0	50	0	0	100.0	39.5	11.5	49.0	100.0	.020	.237	.10	.22
70	COW180	0	0	0	0	100	0	0	0	0	0	100.0	66.0	15.0	19.0	100.0	.020	.248	.10	.22
71	COW185	0	0	0	0	100	0	0	0	0	0	100.0	66.0	15.0	19.0	100.0	.020	.248	.10	.22
72	COW190	0	0	0	0	87	0	2	4	7	0	100.0	59.6	14.3	26.1	100.0	.020	.246	.10	.22
73	COW200	0	0	0	0	35	0	0	65	0	0	100.0	31.6	10.5	58.0	100.0	.020	.230	.10	.21
74	COW210	0	0	0	0	25	0	0	75	0	0	100.0	26.3	9.8	64.0	100.0	.020	.224	.10	.21
75	COW220	0	0	0	0	5	0	0	95	0	0	100.0	15.7	8.4	76.0	100.0	.020	.203	.10	.20
76	COW230	0	0	0	0	70	0	0	30	0	0	100.0	50.1	12.9	37.0	100.0	.020	.243	.10	.22
77	COW240	0	0	0	0	95	0	0	5	0	0	100.0	63.4	14.7	22.0	100.0	.020	.247	.10	.22
78	COW250	0	0	0	0	100	0	0	0	0	0	100.0	66.0	15.0	19.0	100.0	.020	.248	.10	.22
79	COW260	0	0	0	0	100	0	0	0	0	0	100.0	66.0	15.0	19.0	100.0	.020	.248	.10	.22
80	COW270	0	0	20	0	80	0	0	0	0	0	100.0	72.6	12.0	15.4	100.0	.020	.260	.10	.23
81	COW280	15	0	10	0	75	0	0	0	0	0	100.0	74.3	11.3	14.5	100.0	.020	.281	.10	.23
82	COW285	0	0	0	0	100	0	0	0	0	0	100.0	66.0	15.0	19.0	100.0	.020	.248	.10	.22
83	COW290	0	0	0	0	100	0	0	0	0	0	100.0	66.0	15.0	19.0	100.0	.020	.248	.10	.22
84	COW295	0	0	0	0	100	0	0	0	0	0	100.0	66.0	15.0	19.0	100.0	.020	.248	.10	.22
85	COW300	20	0	0	0	70	0	10	0	0	0	100.0	69.5	12.4	18.1	100.0	.020	.282	.10	.23
86	COW310	10	0	45	0	30	0	15	0	0	0	100.0	79.5	7.4	13.2	100.0	.020	.288	.10	.24
87	COW320	45	0	5	0	30	0	20	0	0	0	100.0	76.3	8.3	15.4	100.0	.020	.325	.10	.24
88	COW330	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
89	COW340	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
90	COW350	0	0	95	0	5	0	0	0	0	0	100.0	97.4	0.8	1.9	100.0	.020	.298	.10	.25
91	GVI010	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
92	GVI020	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25

No.	Subbasin	Forest, Open, Park	Pasture	Agriculture	Residential Low Density	Residential Medium Density	Residential High Density	Institutional	Commercial	Industrial	Watercourses, Waterbodies	Check (%)	Pervious (%)	NDCIA (%)	DCIA (%)	Check (%)	DCIA 'n'	Pervious 'n'	DCIA Ia	Pervious Ia
93	GVI030	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
94	GVI040	0	0	95	0	5	0	0	0	0	0	100.0	97.4	0.8	1.9	100.0	.020	.298	.10	.25
95	GVI050	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
96	GVI060	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
97	GVI070	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
98	GVI080	0	0	82	18	0	0	0	0	0	0	100.0	93.8	2.5	3.7	100.0	.020	.293	.10	.25
99	GVI090	0	0	86	14	0	0	0	0	0	0	100.0	94.9	2.0	3.1	100.0	.020	.294	.10	.25
100	GVI100	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
101	GVI110	0	0	100	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.300	.10	.25
102	GVI120	0	0	35	65	0	0	0	0	0	0	100.0	80.2	9.1	10.8	100.0	.020	.271	.10	.23
103	GVI130	0	0	41	0	0	0	0	0	59	0	100.0	48.3	4.7	47.0	100.0	.020	.275	.10	.24
104	GVI140	0	0	81	0	0	0	0	0	19	0	100.0	82.7	1.5	15.8	100.0	.020	.295	.10	.25
105	GVI150	0	0	77	11	0	0	0	0	12	0	100.0	85.5	2.5	12.0	100.0	.020	.292	.10	.25
106	GVI160	0	0	54	46	0	0	0	0	0	0	100.0	85.7	6.4	7.9	100.0	.020	.280	.10	.24
107	GVI170	0	0	70	30	0	0	0	0	0	0	100.0	90.3	4.2	5.5	100.0	.020	.288	.10	.24
108	GVI180	0	0	66	0	0	0	34	0	0	0	100.0	77.2	6.5	16.3	100.0	.020	.278	.10	.24
109	GVI185	0	0	53	36	0	0	11	0	0	0	100.0	81.5	7.1	11.4	100.0	.020	.277	.10	.24
110	GVI190	0	0	40	42	0	0	0	0	18	0	100.0	71.3	7.3	21.3	100.0	.020	.274	.10	.24
111	GVI200	0	0	21	79	0	0	0	0	0	0	100.0	76.1	11.1	12.9	100.0	.020	.264	.10	.23
112	GVI210	0	0	0	50	50	0	0	0	0	0	100.0	68.0	14.5	17.5	100.0	.020	.251	.10	.22
113	GVI220	0	0	0	100	0	0	0	0	0	0	100.0	70.0	14.0	16.0	100.0	.020	.253	.10	.23
114	GVI230	0	0	15	85	0	0	0	0	0	0	100.0	74.4	11.9	13.8	100.0	.020	.261	.10	.23
115	GVI240	0	0	10	90	0	0	0	0	0	0	100.0	72.9	12.6	14.5	100.0	.020	.259	.10	.23
116	GVI250	0	0	90	10	0	0	0	0	0	0	100.0	96.1	1.4	2.5	100.0	.020	.296	.10	.25
117	GVI260	0	0	79	21	0	0	0	0	0	0	100.0	92.9	2.9	4.2	100.0	.020	.291	.10	.25
118	GVI270	0	0	37	0	0	0	0	63	0	0	100.0	44.8	5.0	50.1	100.0	.020	.272	.10	.23
119	GVI280	0	0	76	0	0	0	0	20	4	0	100.0	78.4	1.9	19.7	100.0	.020	.293	.10	.25
120	GVI290	10	0	35	0	25	0	0	20	10	0	100.0	65.0	6.2	28.9	100.0	.020	.290	.10	.24
121	GVI300	15	0	85	0	0	0	0	0	0	0	100.0	99.0	0.0	1.0	100.0	.020	.315	.10	.25
122	GVI310	0	0	71	0	0	0	1	0	28	0	100.0	74.3	2.4	23.3	100.0	.020	.291	.10	.25
123	GVI320	0	0	0	66	0	0	0	0	34	0	100.0	50.6	12.0	37.4	100.0	.020	.246	.10	.22
124	GVI330	0	0	75	0	0	0	0	0	25	0	100.0	77.5	2.0	20.5	100.0	.020	.293	.10	.25
125	GVI340	0	0	88	0	12	0	0	0	0	0	100.0	95.0	1.8	3.2	100.0	.020	.295	.10	.25

Table No. A-3
Runoff Parameters
Soil Infiltration
Hutchinson Stormwater Master Plan

Soil Type	Initial Infiltration Rate (in/hr)	Final Infiltration Rate (in/hr)	Decay Rate (1/sec)	Soil Storage (in)
A	8.00	0.75	0.000556	6.75
B	6.00	0.22	0.000556	5.00
C	4.00	0.10	0.00083	3.80
D	2.00	0.03	0.00115	1.40

		Percent of Soil Type										
No.	Subbasin	A	B	C	D	Total	Pervious (%)	NDCIA (%)	Initial Infiltration Rate (in/hr)	Final Infiltration Rate (in/hr)	Decay Rate (1/sec)	Soil Storage (in)
1	SHD010	98	0	0	3	100.0	99.0	0.0	7.85	0.73	0.000571	6.62
2	SHD020	24	0	0	76	100.0	99.0	0.0	3.43	0.20	0.001008	2.68
3	SHD030	24	23	0	53	100.0	99.0	0.0	4.36	0.24	0.000871	3.51
4	SHD040	97	0	0	3	100.0	99.0	0.0	7.82	0.73	0.000574	6.59
5	SHD050	69	10	0	21	100.0	99.0	0.0	6.54	0.54	0.000681	5.45
6	SHD060	0	0	0	100	100.0	99.0	0.0	2.00	0.03	0.001150	1.40
7	SHD070	82	3	0	15	100.0	99.0	0.0	7.04	0.63	0.000645	5.90
8	SHD080	0	67	0	33	100.0	99.0	0.0	4.68	0.16	0.000752	3.81
9	SHD090	0	100	0	0	100.0	99.0	0.0	6.00	0.22	0.000556	5.00
10	SHD100	100	0	0	0	100.0	99.0	0.0	8.00	0.75	0.000556	6.75
11	SHD110	100	0	0	0	100.0	99.0	0.0	8.00	0.75	0.000556	6.75
12	SHD120	26	34	0	40	100.0	99.0	0.0	4.92	0.28	0.000794	4.02
13	SHD130	0	87	0	13	100.0	94.7	2.1	5.36	0.19	0.000633	4.43
14	SHD140	0	84	0	16	100.0	99.0	0.0	5.36	0.19	0.000651	4.42
15	SHD150	92	0	0	8	100.0	99.0	0.0	7.52	0.69	0.000604	6.32
16	SHD160	0	100	0	0	100.0	73.5	12.3	5.14	0.19	0.000556	4.28
17	ESD010	0	100	0	0	100.0	77.3	10.5	5.28	0.19	0.000556	4.40
18	ESD020	0	100	0	0	100.0	68.4	14.4	4.96	0.18	0.000556	4.13
19	ESD030	0	100	0	0	100.0	66.6	14.9	4.91	0.18	0.000556	4.09

		Percent of Soil Type										
No.	Subbasin	A	B	C	D	Total	Pervious (%)	NDCIA (%)	Initial Infiltration Rate (in/hr)	Final Infiltration Rate (in/hr)	Decay Rate (1/sec)	Soil Storage (in)
20	ESD040	0	100	0	0	100.0	66.0	15.0	4.89	0.18	0.000556	4.07
21	ESD050	0	60	0	40	100.0	66.0	15.0	3.59	0.12	0.000794	2.90
22	ESD060	0	15	0	85	100.0	66.0	15.0	2.12	0.04	0.001061	1.58
23	ESD065	0	85	0	15	100.0	66.0	15.0	4.40	0.16	0.000645	3.63
24	ESD070	0	94	0	6	100.0	66.0	15.0	4.69	0.17	0.000592	3.90
25	ESD080	0	81	0	19	100.0	75.9	10.5	4.60	0.16	0.000669	3.79
26	ESD090	0	75	0	25	100.0	97.6	0.7	4.96	0.17	0.000705	4.07
27	ESD100	0	98	0	2	100.0	75.5	11.0	5.17	0.19	0.000568	4.30
28	ESD110	0	100	0	0	100.0	67.1	14.2	4.95	0.18	0.000556	4.13
29	ESD120	0	70	0	30	100.0	66.0	15.0	3.91	0.13	0.000734	3.19
30	ESD130	0	60	0	40	100.0	70.1	9.1	3.89	0.13	0.000794	3.15
31	ESD140	0	69	0	31	100.0	69.7	13.8	3.98	0.13	0.000740	3.24
32	ESD150	0	100	0	0	100.0	82.5	7.5	5.50	0.20	0.000556	4.58
33	ESD160	0	5	0	95	100.0	73.2	12.2	1.89	0.03	0.001120	1.35
34	ESD165	0	100	0	0	100.0	70.0	14.0	5.00	0.18	0.000556	4.17
35	ESD170	0	9	0	91	100.0	75.0	10.4	2.07	0.04	0.001097	1.51
36	ESD180	0	77	0	23	100.0	64.9	15.1	4.12	0.14	0.000693	3.39
37	ESD185	0	93	0	7	100.0	54.8	16.4	4.40	0.16	0.000598	3.65
38	ESD190	0	95	0	5	100.0	62.9	15.4	4.66	0.17	0.000586	3.87
39	ESD200	0	94	0	6	100.0	78.5	9.3	5.15	0.19	0.000592	4.28
40	ESD205	0	87	0	13	100.0	99.0	0.0	5.48	0.19	0.000633	4.53
41	ESD210	0	100	0	0	100.0	13.0	8.0	3.71	0.14	0.000556	3.10
42	ESD220	0	100	0	0	100.0	64.0	5.1	5.56	0.20	0.000556	4.63
43	ESD230	0	100	0	0	100.0	66.0	15.0	4.89	0.18	0.000556	4.07
44	ESD240	0	100	0	0	100.0	66.0	15.0	4.89	0.18	0.000556	4.07
45	ESD250	15	85	0	0	100.0	99.0	0.0	6.30	0.30	0.000556	5.26
46	COW010	0	100	0	0	100.0	70.0	14.0	5.00	0.18	0.000556	4.17
47	COW020	0	88	0	12	100.0	70.0	14.0	4.60	0.16	0.000627	3.81
48	COW030	0	100	0	0	100.0	70.0	14.0	5.00	0.18	0.000556	4.17
49	COW035	0	100	0	0	100.0	70.0	14.0	5.00	0.18	0.000556	4.17
50	COW040	0	100	0	0	100.0	70.0	14.0	5.00	0.18	0.000556	4.17
51	COW042	0	100	0	0	100.0	62.3	15.1	4.83	0.18	0.000556	4.02
52	COW044	0	100	0	0	100.0	70.0	14.0	5.00	0.18	0.000556	4.17
53	COW046	0	100	0	0	100.0	68.0	14.5	4.95	0.18	0.000556	4.12
54	COW048	0	100	0	0	100.0	66.0	15.0	4.89	0.18	0.000556	4.07
55	COW050	0	100	0	0	100.0	64.5	15.2	4.85	0.18	0.000556	4.05
56	COW060	0	95	0	5	100.0	64.2	14.9	4.71	0.17	0.000586	3.91
57	COW070	0	45	0	55	100.0	66.6	14.9	3.11	0.09	0.000883	2.47

		Percent of Soil Type										
No.	Subbasin	A	B	C	D	Total	Pervious (%)	NDCIA (%)	Initial Infiltration Rate (in/hr)	Final Infiltration Rate (in/hr)	Decay Rate (1/sec)	Soil Storage (in)
58	COW080	0	0	0	100	100.0	66.0	15.0	1.63	0.02	0.001150	1.14
59	COW085	0	5	0	95	100.0	66.0	15.0	1.79	0.03	0.001120	1.29
60	COW090	0	38	0	62	100.0	63.4	14.7	2.86	0.08	0.000924	2.25
61	COW100	0	91	0	9	100.0	44.4	13.0	4.37	0.16	0.000609	3.62
62	COW110	0	100	0	0	100.0	55.4	13.6	4.82	0.18	0.000556	4.01
63	COW120	0	100	0	0	100.0	61.8	14.9	4.84	0.18	0.000556	4.03
64	COW130	0	100	0	0	100.0	66.0	15.0	4.89	0.18	0.000556	4.07
65	COW140	0	100	0	0	100.0	61.7	15.6	4.79	0.18	0.000556	3.99
66	COW145	0	100	0	0	100.0	64.5	15.2	4.85	0.18	0.000556	4.05
67	COW150	0	100	0	0	100.0	50.1	12.9	4.77	0.17	0.000556	3.98
68	COW160	0	100	0	0	100.0	15.7	8.4	3.91	0.14	0.000556	3.26
69	COW170	0	100	0	0	100.0	39.5	11.5	4.65	0.17	0.000556	3.87
70	COW180	0	100	0	0	100.0	66.0	15.0	4.89	0.18	0.000556	4.07
71	COW185	0	100	0	0	100.0	66.0	15.0	4.89	0.18	0.000556	4.07
72	COW190	0	100	0	0	100.0	59.6	14.3	4.84	0.18	0.000556	4.03
73	COW200	0	100	0	0	100.0	31.6	10.5	4.51	0.17	0.000556	3.76
74	COW210	0	100	0	0	100.0	26.3	9.8	4.38	0.16	0.000556	3.65
75	COW220	0	100	0	0	100.0	15.7	8.4	3.91	0.14	0.000556	3.26
76	COW230	0	100	0	0	100.0	50.1	12.9	4.77	0.17	0.000556	3.98
77	COW240	0	37	0	63	100.0	63.4	14.7	2.83	0.08	0.000930	2.22
78	COW250	0	100	0	0	100.0	66.0	15.0	4.89	0.18	0.000556	4.07
79	COW260	0	100	0	0	100.0	66.0	15.0	4.89	0.18	0.000556	4.07
80	COW270	0	96	0	4	100.0	72.6	12.0	5.01	0.18	0.000580	4.17
81	COW280	0	100	0	0	100.0	74.3	11.3	5.21	0.19	0.000556	4.34
82	COW285	0	100	0	0	100.0	66.0	15.0	4.89	0.18	0.000556	4.07
83	COW290	0	100	0	0	100.0	66.0	15.0	4.89	0.18	0.000556	4.07
84	COW295	0	100	0	0	100.0	66.0	15.0	4.89	0.18	0.000556	4.07
85	COW300	0	100	0	0	100.0	69.5	12.4	5.09	0.19	0.000556	4.24
86	COW310	0	100	0	0	100.0	79.5	7.4	5.49	0.20	0.000556	4.58
87	COW320	0	100	0	0	100.0	76.3	8.3	5.41	0.20	0.000556	4.51
88	COW330	0	68	14	18	100.0	99.0	0.0	5.00	0.17	0.000701	4.18
89	COW340	8	92	0	0	100.0	99.0	0.0	6.16	0.26	0.000556	5.14
90	COW350	0	96	0	4	100.0	97.4	0.8	5.80	0.21	0.000580	4.82
91	GVI010	70	0	4	26	100.0	99.0	0.0	6.28	0.54	0.000721	5.24
92	GVI020	6	9	4	81	100.0	99.0	0.0	2.80	0.09	0.001048	2.14
93	GVI030	0	43	0	57	100.0	99.0	0.0	3.72	0.11	0.000895	2.95
94	GVI040	0	89	0	11	100.0	97.4	0.8	5.52	0.20	0.000621	4.57
95	GVI050	99	0	0	1	100.0	99.0	0.0	7.94	0.74	0.000562	6.70

		Percent of Soil Type										
No.	Subbasin	A	B	C	D	Total	Pervious (%)	NDCIA (%)	Initial Infiltration Rate (in/hr)	Final Infiltration Rate (in/hr)	Decay Rate (1/sec)	Soil Storage (in)
96	GVI060	20	7	3	70	100.0	99.0	0.0	3.54	0.19	0.000980	2.79
97	GVI070	72	0	0	28	100.0	99.0	0.0	6.32	0.55	0.000722	5.25
98	GVI080	25	7	0	68	100.0	93.8	2.5	3.68	0.21	0.000960	2.91
99	GVI090	0	35	0	65	100.0	94.9	2.0	3.33	0.09	0.000942	2.61
100	GVI100	54	1	0	45	100.0	99.0	0.0	5.28	0.42	0.000823	4.33
101	GVI110	96	0	0	4	100.0	99.0	0.0	7.76	0.72	0.000580	6.54
102	GVI120	72	0	0	28	100.0	80.2	9.1	5.68	0.49	0.000722	4.72
103	GVI130	46	0	0	54	100.0	48.3	4.7	4.34	0.33	0.000877	3.52
104	GVI140	79	2	0	19	100.0	82.7	1.5	6.70	0.59	0.000669	5.60
105	GVI150	68	0	0	32	100.0	85.5	2.5	5.91	0.50	0.000746	4.89
106	GVI160	32	17	0	51	100.0	85.7	6.4	4.28	0.27	0.000859	3.46
107	GVI170	41	0	0	59	100.0	77.2	6.5	4.12	0.30	0.000906	3.32
108	GVI180	0	84	0	16	100.0	77.2	6.5	4.95	0.17	0.000651	4.08
109	GVI185	0	100	0	0	100.0	81.5	7.1	5.52	0.20	0.000556	4.60
110	GVI190	0	42	0	58	100.0	71.3	7.3	3.34	0.10	0.000901	2.64
111	GVI200	35	40	0	25	100.0	76.1	11.1	4.98	0.31	0.000705	4.11
112	GVI210	0	72	0	28	100.0	68.0	14.5	4.02	0.14	0.000722	3.29
113	GVI220	0	49	0	51	100.0	70.0	14.0	3.30	0.10	0.000859	2.64
114	GVI230	0	40	0	60	100.0	74.4	11.9	3.10	0.09	0.000912	2.45
115	GVI240	0	8	0	92	100.0	72.9	12.6	1.98	0.03	0.001102	1.44
116	GVI250	0	100	0	0	100.0	96.1	1.4	5.91	0.22	0.000556	4.93
117	GVI260	0	69	0	31	100.0	92.9	2.9	4.61	0.15	0.000740	3.76
118	GVI270	0	62	0	38	100.0	44.8	5.0	4.03	0.13	0.000782	3.26
119	GVI280	0	72	0	28	100.0	78.4	1.9	4.76	0.16	0.000722	3.90
120	GVI290	10	90	0	0	100.0	65.0	6.2	5.66	0.25	0.000556	4.73
121	GVI300	13	87	0	0	100.0	99.0	0.0	6.26	0.29	0.000556	5.23
122	GVI310	5	95	0	0	100.0	74.3	2.4	5.91	0.24	0.000556	4.93
123	GVI320	0	100	0	0	100.0	50.6	12.0	4.85	0.18	0.000556	4.04
124	GVI330	0	100	0	0	100.0	77.5	2.0	5.85	0.21	0.000556	4.87
125	GVI340	0	58	0	42	100.0	95.0	1.8	4.24	0.14	0.000805	3.42

Appendix B
Water Quality Data

Appendix B - 1
Land Use by Basin - Hutchinson, KS

Subbasin	Total Acreage	Forest, Open, Park	Pasture	Agriculture, Golf Course	Low Density	Medium Density	High Density	Institutional	Commercial	Industrial	Watercourses, Waterbodies
SHD010	598	0.0	0.0	598.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHD020	394	0.0	0.0	393.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHD030	221	0.0	0.0	220.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHD040	257	0.0	0.0	257.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHD050	286	0.0	0.0	286.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHD060	442	0.0	0.0	442.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHD070	312	15.6	0.0	296.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHD080	455	0.0	0.0	455.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHD090	104	0.0	0.0	104.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHD100	403	40.3	0.0	362.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHD110	362	0.0	0.0	361.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHD120	467	0.0	0.0	466.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHD130	506	0.0	0.0	430.3	75.9	0.0	0.0	0.0	0.0	0.0	0.0
SHD140	285	0.0	0.0	284.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHD150	801	0.0	0.0	800.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHD160	197	0.0	0.0	0.0	197.3	0.0	0.0	0.0	0.0	0.0	0.0
ESD010	183	0.0	0.0	45.6	136.9	0.0	0.0	0.0	0.0	0.0	0.0
ESD020	120	0.0	0.0	0.0	71.8	47.9	0.0	0.0	0.0	0.0	0.0
ESD030	42	0.0	0.0	0.0	6.3	35.9	0.0	0.0	0.0	0.0	0.0
ESD040	150	0.0	0.0	0.0	0.0	150.4	0.0	0.0	0.0	0.0	0.0
ESD050	145	0.0	0.0	0.0	0.0	144.7	0.0	0.0	0.0	0.0	0.0
ESD060	58	0.0	0.0	0.0	0.0	57.5	0.0	0.0	0.0	0.0	0.0
ESD065	49	0.0	0.0	0.0	0.0	48.9	0.0	0.0	0.0	0.0	0.0
ESD070	42	0.0	0.0	0.0	0.0	42.0	0.0	0.0	0.0	0.0	0.0
ESD080	90	27.0	0.0	0.0	0.0	62.9	0.0	0.0	0.0	0.0	0.0
ESD090	73	69.7	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0
ESD100	53	13.2	0.0	0.0	15.8	23.8	0.0	0.0	0.0	0.0	0.0
ESD110	70	3.5	0.0	0.0	17.4	45.3	0.0	3.5	0.0	0.0	0.0
ESD120	131	0.0	0.0	0.0	0.0	131.1	0.0	0.0	0.0	0.0	0.0
ESD130	196	97.8	0.0	0.0	0.0	19.6	0.0	78.2	0.0	0.0	0.0
ESD140	120	6.0	0.0	0.0	60.2	54.2	0.0	0.0	0.0	0.0	0.0
ESD150	74	0.0	0.0	0.0	37.1	37.1	0.0	0.0	0.0	0.0	0.0
ESD160	47	14.1	0.0	0.0	33.0	0.0	0.0	0.0	0.0	0.0	0.0
ESD165	65	0.0	0.0	0.0	65.1	0.0	0.0	0.0	0.0	0.0	0.0
ESD170	107	0.0	0.0	32.0	58.7	5.3	0.0	10.7	0.0	0.0	0.0
ESD180	128	0.0	0.0	0.0	15.4	106.5	0.0	6.4	0.0	0.0	0.0
ESD185	103	61.7	0.0	0.0	0.0	0.0	0.0	41.1	0.0	0.0	0.0
ESD190	149	0.0	0.0	0.0	0.0	134.3	0.0	14.9	0.0	0.0	0.0
ESD200	153	0.0	0.0	90.3	0.0	62.7	0.0	0.0	0.0	0.0	0.0
ESD205	29	0.0	0.0	29.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ESD210	104	0.0	0.0	0.0	0.0	103.7	0.0	0.0	0.0	0.0	0.0
ESD220	126	63.1	0.0	0.0	0.0	18.9	0.0	0.0	0.0	44.2	0.0
ESD230	116	0.0	0.0	0.0	0.0	116.5	0.0	0.0	0.0	0.0	0.0
ESD240	50	0.0	0.0	0.0	0.0	49.7	0.0	0.0	0.0	0.0	0.0
ESD250	165	0.0	0.0	164.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COW010	110	0.0	0.0	0.0	110.0	0.0	0.0	0.0	0.0	0.0	0.0
COW020	73	0.0	0.0	0.0	72.9	0.0	0.0	0.0	0.0	0.0	0.0
COW030	77	0.0	0.0	0.0	76.9	0.0	0.0	0.0	0.0	0.0	0.0
COW035	17	0.0	0.0	0.0	17.0	0.0	0.0	0.0	0.0	0.0	0.0
COW040	46	0.0	0.0	0.0	45.7	0.0	0.0	0.0	0.0	0.0	0.0
COW042	36	0.0	0.0	0.0	27.9	0.0	0.0	7.9	0.0	0.0	0.0
COW044	88	0.0	0.0	0.0	88.4	0.0	0.0	0.0	0.0	0.0	0.0
COW046	81	0.0	0.0	0.0	40.6	40.6	0.0	0.0	0.0	0.0	0.0
COW048	39	0.0	0.0	0.0	0.0	39.1	0.0	0.0	0.0	0.0	0.0
COW050	109	0.0	0.0	0.0	0.0	103.8	0.0	5.5	0.0	0.0	0.0
COW060	84	0.0	0.0	0.0	58.6	12.6	0.0	12.6	0.0	0.0	0.0
COW070	45	0.0	0.0	0.0	6.7	38.1	0.0	0.0	0.0	0.0	0.0
COW080	54	0.0	0.0	0.0	0.0	53.6	0.0	0.0	0.0	0.0	0.0
COW085	50	0.0	0.0	0.0	0.0	49.8	0.0	0.0	0.0	0.0	0.0
COW090	103	0.0	0.0	0.0	0.0	92.9	0.0	0.0	10.3	0.0	0.0
COW100	74	0.0	0.0	0.0	0.0	40.7	0.0	7.4	25.9	0.0	0.0
COW110	113	0.0	0.0	0.0	0.0	90.0	0.0	0.0	22.5	0.0	0.0
COW120	57	0.0	0.0	0.0	0.0	51.3	0.0	2.9	2.9	0.0	0.0
COW130	19	0.0	0.0	0.0	0.0	19.3	0.0	0.0	0.0	0.0	0.0
COW140	64	0.0	0.0	0.0	0.0	55.0	0.0	8.9	0.0	0.0	0.0
COW145	79	0.0	0.0	0.0	0.0	75.2	0.0	4.0	0.0	0.0	0.0
COW150	121	0.0	0.0	0.0	0.0	84.9	0.0	0.0	36.4	0.0	0.0
COW160	44	0.0	0.0	0.0	0.0	2.2	0.0	0.0	41.9	0.0	0.0
COW170	46	0.0	0.0	0.0	0.0	23.0	0.0	0.0	23.0	0.0	0.0

Appendix B - 1
Land Use by Basin - Hutchinson, KS

Subbasin	Total Acreage	Forest, Open, Park	Pasture	Agriculture, Golf Course	Low Density	Medium Density	High Density	Institutional	Commercial	Industrial	Watercourses, Waterbodies
COW180	33	0.0	0.0	0.0	0.0	32.9	0.0	0.0	0.0	0.0	0.0
COW185	63	0.0	0.0	0.0	0.0	62.6	0.0	0.0	0.0	0.0	0.0
COW190	154	0.0	0.0	0.0	0.0	144.3	0.0	3.1	6.1	0.0	0.0
COW200	24	0.0	0.0	0.0	0.0	8.3	0.0	0.0	15.3	0.0	0.0
COW210	67	0.0	0.0	0.0	0.0	16.8	0.0	0.0	50.5	0.0	0.0
COW220	31	0.0	0.0	0.0	0.0	1.6	0.0	0.0	29.7	0.0	0.0
COW230	66	0.0	0.0	0.0	0.0	46.5	0.0	0.0	19.9	0.0	0.0
COW240	106	0.0	0.0	0.0	0.0	100.5	0.0	0.0	5.3	0.0	0.0
COW250	40	0.0	0.0	0.0	0.0	39.5	0.0	0.0	0.0	0.0	0.0
COW260	92	0.0	0.0	0.0	0.0	92.3	0.0	0.0	0.0	0.0	0.0
COW270	169	0.0	0.0	33.9	0.0	135.6	0.0	0.0	0.0	0.0	0.0
COW280	132	19.9	0.0	13.2	0.0	99.4	0.0	0.0	0.0	0.0	0.0
COW285	91	0.0	0.0	0.0	0.0	90.6	0.0	0.0	0.0	0.0	0.0
COW290	80	0.0	0.0	0.0	0.0	79.7	0.0	0.0	0.0	0.0	0.0
COW295	42	0.0	0.0	0.0	0.0	41.6	0.0	0.0	0.0	0.0	0.0
COW300	200	40.0	0.0	0.0	0.0	140.0	0.0	20.0	0.0	0.0	0.0
COW310	52	5.2	0.0	23.6	0.0	15.7	0.0	7.9	0.0	0.0	0.0
COW320	120	53.8	0.0	6.0	0.0	35.9	0.0	23.9	0.0	0.0	0.0
COW330	91	0.0	0.0	91.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COW340	180	0.0	0.0	179.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COW350	63	0.0	0.0	59.8	0.0	3.1	0.0	0.0	0.0	0.0	0.0
GVI010	639	0.0	0.0	639.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GVI020	391	0.0	0.0	391.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GVI030	648	0.0	0.0	647.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GVI040	419	0.0	0.0	389.2	0.0	29.3	0.0	0.0	0.0	0.0	0.0
GVI050	653	0.0	0.0	653.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GVI060	643	0.0	0.0	643.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GVI070	840	0.0	0.0	839.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GVI080	500	0.0	0.0	409.9	90.0	0.0	0.0	0.0	0.0	0.0	0.0
GVI090	201	0.0	0.0	145.0	56.4	0.0	0.0	0.0	0.0	0.0	0.0
GVI100	559	0.0	0.0	558.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GVI110	314	0.0	0.0	313.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GVI120	217	0.0	0.0	76.0	141.1	0.0	0.0	0.0	0.0	0.0	0.0
GVI130	177	0.0	0.0	72.4	0.0	0.0	0.0	0.0	0.0	104.1	0.0
GVI140	321	0.0	0.0	260.0	0.0	0.0	0.0	0.0	0.0	61.0	0.0
GVI150	258	0.0	0.0	198.4	28.3	0.0	0.0	0.0	0.0	30.9	0.0
GVI160	241	0.0	0.0	129.9	110.6	0.0	0.0	0.0	0.0	0.0	0.0
GVI170	471	0.0	0.0	329.8	141.4	0.0	0.0	0.0	0.0	0.0	0.0
GVI180	246	0.0	0.0	162.5	0.0	0.0	0.0	83.7	0.0	0.0	0.0
GVI185	207	0.0	0.0	111.6	74.4	0.0	0.0	20.7	0.0	0.0	0.0
GVI190	155	0.0	0.0	55.9	65.2	34.2	0.0	0.0	0.0	0.0	0.0
GVI200	131	0.0	0.0	20.9	109.7	0.0	0.0	0.0	0.0	0.0	0.0
GVI210	136	0.0	0.0	0.0	68.1	68.1	0.0	0.0	0.0	0.0	0.0
GVI220	79	0.0	0.0	0.0	78.6	0.0	0.0	0.0	0.0	0.0	0.0
GVI230	82	0.0	0.0	0.0	82.0	0.0	0.0	0.0	0.0	0.0	0.0
GVI240	77	0.0	0.0	0.0	76.9	0.0	0.0	0.0	0.0	0.0	0.0
GVI250	194	0.0	0.0	194.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GVI260	67	0.0	0.0	52.9	14.0	0.0	0.0	0.0	0.0	0.0	0.0
GVI270	84	0.0	0.0	84.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GVI280	245	0.0	0.0	235.2	0.0	0.0	0.0	0.0	0.0	9.8	0.0
GVI290	380	30.4	0.0	0.0	132.9	170.9	0.0	7.6	0.0	38.0	0.0
GVI300	178	26.7	0.0	151.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GVI310	236	0.0	0.0	200.5	0.0	0.0	0.0	0.0	0.0	35.4	0.0
GVI320	174	0.0	0.0	0.0	114.6	0.0	0.0	0.0	0.0	59.0	0.0
GVI330	66	0.0	0.0	39.2	0.0	0.0	0.0	0.0	0.0	27.2	0.0
GVI340	145	0.0	0.0	127.8	0.0	17.4	0.0	0.0	0.0	0.0	0.0
	22,923	588	-	14,664	2,723	3,878	-	371	290	410	-

Appendix B - 2

Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
SHD010	CITY	598.3	6.0	1.0	Flow	(ac-ft/yr)	224
SHD010	CITY	598.3	6.0	1.0	BOD	lbs/yr	7,059
SHD010	CITY	598.3	6.0	1.0	Cd	lbs/yr	0
SHD010	CITY	598.3	6.0	1.0	COD	lbs/yr	43,209
SHD010	CITY	598.3	6.0	1.0	Cu	lbs/yr	0
SHD010	CITY	598.3	6.0	1.0	DP	lbs/yr	323
SHD010	CITY	598.3	6.0	1.0	NO2+NO3	lbs/yr	61
SHD010	CITY	598.3	6.0	1.0	Pb	lbs/yr	0
SHD010	CITY	598.3	6.0	1.0	TDS	lbs/yr	69,377
SHD010	CITY	598.3	6.0	1.0	TKN	lbs/yr	1,485
SHD010	CITY	598.3	6.0	1.0	TP	lbs/yr	2,057
SHD010	CITY	598.3	6.0	1.0	TSS	lbs/yr	7,242
SHD010	CITY	598.3	6.0	1.0	Zn	lbs/yr	0
SHD020	COUNTY	393.6	3.9	1.0	Flow	(ac-ft/yr)	147
SHD020	COUNTY	393.6	3.9	1.0	BOD	lbs/yr	4,644
SHD020	COUNTY	393.6	3.9	1.0	Cd	lbs/yr	0
SHD020	COUNTY	393.6	3.9	1.0	COD	lbs/yr	28,425
SHD020	COUNTY	393.6	3.9	1.0	Cu	lbs/yr	0
SHD020	COUNTY	393.6	3.9	1.0	DP	lbs/yr	212
SHD020	COUNTY	393.6	3.9	1.0	NO2+NO3	lbs/yr	40
SHD020	COUNTY	393.6	3.9	1.0	Pb	lbs/yr	0
SHD020	COUNTY	393.6	3.9	1.0	TDS	lbs/yr	45,641
SHD020	COUNTY	393.6	3.9	1.0	TKN	lbs/yr	977
SHD020	COUNTY	393.6	3.9	1.0	TP	lbs/yr	1,353
SHD020	COUNTY	393.6	3.9	1.0	TSS	lbs/yr	4,764
SHD020	COUNTY	393.6	3.9	1.0	Zn	lbs/yr	0
SHD030	COUNTY	220.6	2.2	1.0	Flow	(ac-ft/yr)	83
SHD030	COUNTY	220.6	2.2	1.0	BOD	lbs/yr	2,603
SHD030	COUNTY	220.6	2.2	1.0	Cd	lbs/yr	0
SHD030	COUNTY	220.6	2.2	1.0	COD	lbs/yr	15,932
SHD030	COUNTY	220.6	2.2	1.0	Cu	lbs/yr	0
SHD030	COUNTY	220.6	2.2	1.0	DP	lbs/yr	119
SHD030	COUNTY	220.6	2.2	1.0	NO2+NO3	lbs/yr	22
SHD030	COUNTY	220.6	2.2	1.0	Pb	lbs/yr	0
SHD030	COUNTY	220.6	2.2	1.0	TDS	lbs/yr	25,580
SHD030	COUNTY	220.6	2.2	1.0	TKN	lbs/yr	548
SHD030	COUNTY	220.6	2.2	1.0	TP	lbs/yr	758
SHD030	COUNTY	220.6	2.2	1.0	TSS	lbs/yr	2,670

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
SHD030	COUNTY	220.6	2.2	1.0	Zn	lbs/yr	0

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
SHD040	COUNTY	257.2	2.6	1.0	Flow	(ac-ft/yr)	96
SHD040	COUNTY	257.2	2.6	1.0	BOD	lbs/yr	3,035
SHD040	COUNTY	257.2	2.6	1.0	Cd	lbs/yr	0
SHD040	COUNTY	257.2	2.6	1.0	COD	lbs/yr	18,575
SHD040	COUNTY	257.2	2.6	1.0	Cu	lbs/yr	0
SHD040	COUNTY	257.2	2.6	1.0	DP	lbs/yr	139
SHD040	COUNTY	257.2	2.6	1.0	NO2+NO3	lbs/yr	26
SHD040	COUNTY	257.2	2.6	1.0	Pb	lbs/yr	0
SHD040	COUNTY	257.2	2.6	1.0	TDS	lbs/yr	29,824
SHD040	COUNTY	257.2	2.6	1.0	TKN	lbs/yr	638
SHD040	COUNTY	257.2	2.6	1.0	TP	lbs/yr	884
SHD040	COUNTY	257.2	2.6	1.0	TSS	lbs/yr	3,113
SHD040	COUNTY	257.2	2.6	1.0	Zn	lbs/yr	0
SHD050	COUNTY	286.1	2.9	1.0	Flow	(ac-ft/yr)	107
SHD050	COUNTY	286.1	2.9	1.0	BOD	lbs/yr	3,376
SHD050	COUNTY	286.1	2.9	1.0	Cd	lbs/yr	0
SHD050	COUNTY	286.1	2.9	1.0	COD	lbs/yr	20,662
SHD050	COUNTY	286.1	2.9	1.0	Cu	lbs/yr	0
SHD050	COUNTY	286.1	2.9	1.0	DP	lbs/yr	154
SHD050	COUNTY	286.1	2.9	1.0	NO2+NO3	lbs/yr	29
SHD050	COUNTY	286.1	2.9	1.0	Pb	lbs/yr	0
SHD050	COUNTY	286.1	2.9	1.0	TDS	lbs/yr	33,175
SHD050	COUNTY	286.1	2.9	1.0	TKN	lbs/yr	710
SHD050	COUNTY	286.1	2.9	1.0	TP	lbs/yr	984
SHD050	COUNTY	286.1	2.9	1.0	TSS	lbs/yr	3,463
SHD050	COUNTY	286.1	2.9	1.0	Zn	lbs/yr	0
SHD060	COUNTY	442.2	4.4	1.0	Flow	(ac-ft/yr)	165
SHD060	COUNTY	442.2	4.4	1.0	BOD	lbs/yr	5,218
SHD060	COUNTY	442.2	4.4	1.0	Cd	lbs/yr	0
SHD060	COUNTY	442.2	4.4	1.0	COD	lbs/yr	31,935
SHD060	COUNTY	442.2	4.4	1.0	Cu	lbs/yr	0
SHD060	COUNTY	442.2	4.4	1.0	DP	lbs/yr	238
SHD060	COUNTY	442.2	4.4	1.0	NO2+NO3	lbs/yr	45
SHD060	COUNTY	442.2	4.4	1.0	Pb	lbs/yr	0
SHD060	COUNTY	442.2	4.4	1.0	TDS	lbs/yr	51,276
SHD060	COUNTY	442.2	4.4	1.0	TKN	lbs/yr	1,097
SHD060	COUNTY	442.2	4.4	1.0	TP	lbs/yr	1,520

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
SHD060	COUNTY	442.2	4.4	1.0	TSS	lbs/yr	5,353
SHD060	COUNTY	442.2	4.4	1.0	Zn	lbs/yr	0

Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
SHD070	COUNTY	15.6	0.2	1.0	Flow	(ac-ft/yr)	6
SHD070	COUNTY	15.6	0.2	1.0	BOD	lbs/yr	403
SHD070	COUNTY	15.6	0.2	1.0	Cd	lbs/yr	0
SHD070	COUNTY	15.6	0.2	1.0	COD	lbs/yr	1,136
SHD070	COUNTY	15.6	0.2	1.0	Cu	lbs/yr	0
SHD070	COUNTY	15.6	0.2	1.0	DP	lbs/yr	2
SHD070	COUNTY	15.6	0.2	1.0	NO2+NO3	lbs/yr	13
SHD070	COUNTY	15.6	0.2	1.0	Pb	lbs/yr	0
SHD070	COUNTY	15.6	0.2	1.0	TDS	lbs/yr	2,126
SHD070	COUNTY	15.6	0.2	1.0	TKN	lbs/yr	16
SHD070	COUNTY	15.6	0.2	1.0	TP	lbs/yr	5
SHD070	COUNTY	15.6	0.2	1.0	TSS	lbs/yr	1,147
SHD070	COUNTY	15.6	0.2	1.0	Zn	lbs/yr	0
SHD080	COUNTY	455.5	4.6	1.0	Flow	(ac-ft/yr)	170
SHD080	COUNTY	455.5	4.6	1.0	BOD	lbs/yr	5,375
SHD080	COUNTY	455.5	4.6	1.0	Cd	lbs/yr	0
SHD080	COUNTY	455.5	4.6	1.0	COD	lbs/yr	32,896
SHD080	COUNTY	455.5	4.6	1.0	Cu	lbs/yr	0
SHD080	COUNTY	455.5	4.6	1.0	DP	lbs/yr	246
SHD080	COUNTY	455.5	4.6	1.0	NO2+NO3	lbs/yr	46
SHD080	COUNTY	455.5	4.6	1.0	Pb	lbs/yr	0
SHD080	COUNTY	455.5	4.6	1.0	TDS	lbs/yr	52,819
SHD080	COUNTY	455.5	4.6	1.0	TKN	lbs/yr	1,131
SHD080	COUNTY	455.5	4.6	1.0	TP	lbs/yr	1,566
SHD080	COUNTY	455.5	4.6	1.0	TSS	lbs/yr	5,514
SHD080	COUNTY	455.5	4.6	1.0	Zn	lbs/yr	0
SHD090	COUNTY	104.4	1.0	1.0	Flow	(ac-ft/yr)	39
SHD090	COUNTY	104.4	1.0	1.0	BOD	lbs/yr	1,232
SHD090	COUNTY	104.4	1.0	1.0	Cd	lbs/yr	0
SHD090	COUNTY	104.4	1.0	1.0	COD	lbs/yr	7,540
SHD090	COUNTY	104.4	1.0	1.0	Cu	lbs/yr	0
SHD090	COUNTY	104.4	1.0	1.0	DP	lbs/yr	56
SHD090	COUNTY	104.4	1.0	1.0	NO2+NO3	lbs/yr	11
SHD090	COUNTY	104.4	1.0	1.0	Pb	lbs/yr	0
SHD090	COUNTY	104.4	1.0	1.0	TDS	lbs/yr	12,106
SHD090	COUNTY	104.4	1.0	1.0	TKN	lbs/yr	259
SHD090	COUNTY	104.4	1.0	1.0	TP	lbs/yr	359

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
SHD090	COUNTY	104.4	1.0	1.0	TSS	lbs/yr	1,264
SHD090	COUNTY	104.4	1.0	1.0	Zn	lbs/yr	0
SHD100	COUNTY	402.8	4.0	1.0	Flow	(ac-ft/yr)	151
SHD100	COUNTY	402.8	4.0	1.0	BOD	lbs/yr	5,318
SHD100	COUNTY	402.8	4.0	1.0	Cd	lbs/yr	0
SHD100	COUNTY	402.8	4.0	1.0	COD	lbs/yr	29,114
SHD100	COUNTY	402.8	4.0	1.0	Cu	lbs/yr	0
SHD100	COUNTY	402.8	4.0	1.0	DP	lbs/yr	201
SHD100	COUNTY	402.8	4.0	1.0	NO2+NO3	lbs/yr	72
SHD100	COUNTY	402.8	4.0	1.0	Pb	lbs/yr	0
SHD100	COUNTY	402.8	4.0	1.0	TDS	lbs/yr	47,528
SHD100	COUNTY	402.8	4.0	1.0	TKN	lbs/yr	941
SHD100	COUNTY	402.8	4.0	1.0	TP	lbs/yr	1,260
SHD100	COUNTY	402.8	4.0	1.0	TSS	lbs/yr	7,352
SHD100	COUNTY	402.8	4.0	1.0	Zn	lbs/yr	0
SHD110	COUNTY	361.5	3.6	1.0	Flow	(ac-ft/yr)	135
SHD110	COUNTY	361.5	3.6	1.0	BOD	lbs/yr	4,265
SHD110	COUNTY	361.5	3.6	1.0	Cd	lbs/yr	0
SHD110	COUNTY	361.5	3.6	1.0	COD	lbs/yr	26,107
SHD110	COUNTY	361.5	3.6	1.0	Cu	lbs/yr	0
SHD110	COUNTY	361.5	3.6	1.0	DP	lbs/yr	195
SHD110	COUNTY	361.5	3.6	1.0	NO2+NO3	lbs/yr	37
SHD110	COUNTY	361.5	3.6	1.0	Pb	lbs/yr	0
SHD110	COUNTY	361.5	3.6	1.0	TDS	lbs/yr	41,919
SHD110	COUNTY	361.5	3.6	1.0	TKN	lbs/yr	897
SHD110	COUNTY	361.5	3.6	1.0	TP	lbs/yr	1,243
SHD110	COUNTY	361.5	3.6	1.0	TSS	lbs/yr	4,376
SHD110	COUNTY	361.5	3.6	1.0	Zn	lbs/yr	0
SHD120	COUNTY	466.9	4.7	1.0	Flow	(ac-ft/yr)	175
SHD120	COUNTY	466.9	4.7	1.0	BOD	lbs/yr	5,509
SHD120	COUNTY	466.9	4.7	1.0	Cd	lbs/yr	0
SHD120	COUNTY	466.9	4.7	1.0	COD	lbs/yr	33,719
SHD120	COUNTY	466.9	4.7	1.0	Cu	lbs/yr	0
SHD120	COUNTY	466.9	4.7	1.0	DP	lbs/yr	252
SHD120	COUNTY	466.9	4.7	1.0	NO2+NO3	lbs/yr	47
SHD120	COUNTY	466.9	4.7	1.0	Pb	lbs/yr	0
SHD120	COUNTY	466.9	4.7	1.0	TDS	lbs/yr	54,141

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
SHD120	COUNTY	466.9	4.7	1.0	TKN	lbs/yr	1,159
SHD120	COUNTY	466.9	4.7	1.0	TP	lbs/yr	1,605
SHD120	COUNTY	466.9	4.7	1.0	TSS	lbs/yr	5,652
SHD120	COUNTY	466.9	4.7	1.0	Zn	lbs/yr	0
SHD130	COUNTY	506.2	16.4	3.2	Flow	(ac-ft/yr)	211
SHD130	COUNTY	506.2	16.4	3.2	BOD	lbs/yr	6,653
SHD130	COUNTY	506.2	16.4	3.2	Cd	lbs/yr	1
SHD130	COUNTY	506.2	16.4	3.2	COD	lbs/yr	40,720
SHD130	COUNTY	506.2	16.4	3.2	Cu	lbs/yr	1
SHD130	COUNTY	506.2	16.4	3.2	DP	lbs/yr	250
SHD130	COUNTY	506.2	16.4	3.2	NO2+NO3	lbs/yr	201
SHD130	COUNTY	506.2	16.4	3.2	Pb	lbs/yr	4
SHD130	COUNTY	506.2	16.4	3.2	TDS	lbs/yr	65,382
SHD130	COUNTY	506.2	16.4	3.2	TKN	lbs/yr	1,202
SHD130	COUNTY	506.2	16.4	3.2	TP	lbs/yr	1,516
SHD130	COUNTY	506.2	16.4	3.2	TSS	lbs/yr	12,286
SHD130	COUNTY	506.2	16.4	3.2	Zn	lbs/yr	3
SHD140	COUNTY	284.7	2.8	1.0	Flow	(ac-ft/yr)	106
SHD140	COUNTY	284.7	2.8	1.0	BOD	lbs/yr	3,359
SHD140	COUNTY	284.7	2.8	1.0	Cd	lbs/yr	0
SHD140	COUNTY	284.7	2.8	1.0	COD	lbs/yr	20,561
SHD140	COUNTY	284.7	2.8	1.0	Cu	lbs/yr	0
SHD140	COUNTY	284.7	2.8	1.0	DP	lbs/yr	153
SHD140	COUNTY	284.7	2.8	1.0	NO2+NO3	lbs/yr	29
SHD140	COUNTY	284.7	2.8	1.0	Pb	lbs/yr	0
SHD140	COUNTY	284.7	2.8	1.0	TDS	lbs/yr	33,013
SHD140	COUNTY	284.7	2.8	1.0	TKN	lbs/yr	707
SHD140	COUNTY	284.7	2.8	1.0	TP	lbs/yr	979
SHD140	COUNTY	284.7	2.8	1.0	TSS	lbs/yr	3,446
SHD140	COUNTY	284.7	2.8	1.0	Zn	lbs/yr	0
SHD150	COUNTY	800.9	8.0	1.0	Flow	(ac-ft/yr)	300
SHD150	COUNTY	800.9	8.0	1.0	BOD	lbs/yr	9,450
SHD150	COUNTY	800.9	8.0	1.0	Cd	lbs/yr	0
SHD150	COUNTY	800.9	8.0	1.0	COD	lbs/yr	57,840
SHD150	COUNTY	800.9	8.0	1.0	Cu	lbs/yr	0
SHD150	COUNTY	800.9	8.0	1.0	DP	lbs/yr	432
SHD150	COUNTY	800.9	8.0	1.0	NO2+NO3	lbs/yr	81

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
SHD150	COUNTY	800.9	8.0	1.0	Pb	lbs/yr	0
SHD150	COUNTY	800.9	8.0	1.0	TDS	lbs/yr	92,870
SHD150	COUNTY	800.9	8.0	1.0	TKN	lbs/yr	1,988
SHD150	COUNTY	800.9	8.0	1.0	TP	lbs/yr	2,754
SHD150	COUNTY	800.9	8.0	1.0	TSS	lbs/yr	9,694
SHD150	COUNTY	800.9	8.0	1.0	Zn	lbs/yr	0
SHD160	CITY	197.3	31.6	16.0	Flow	(ac-ft/yr)	130
SHD160	CITY	197.3	31.6	16.0	BOD	lbs/yr	4,096
SHD160	CITY	197.3	31.6	16.0	Cd	lbs/yr	1
SHD160	CITY	197.3	31.6	16.0	COD	lbs/yr	25,071
SHD160	CITY	197.3	31.6	16.0	Cu	lbs/yr	1
SHD160	CITY	197.3	31.6	16.0	DP	lbs/yr	46
SHD160	CITY	197.3	31.6	16.0	NO2+NO3	lbs/yr	410
SHD160	CITY	197.3	31.6	16.0	Pb	lbs/yr	10
SHD160	CITY	197.3	31.6	16.0	TDS	lbs/yr	40,254
SHD160	CITY	197.3	31.6	16.0	TKN	lbs/yr	350
SHD160	CITY	197.3	31.6	16.0	TP	lbs/yr	95
SHD160	CITY	197.3	31.6	16.0	TSS	lbs/yr	18,397
SHD160	CITY	197.3	31.6	16.0	Zn	lbs/yr	9
ESD010	CITY	182.5	22.4	12.3	Flow	(ac-ft/yr)	107
ESD010	CITY	182.5	22.4	12.3	BOD	lbs/yr	3,380
ESD010	CITY	182.5	22.4	12.3	Cd	lbs/yr	1
ESD010	CITY	182.5	22.4	12.3	COD	lbs/yr	20,689
ESD010	CITY	182.5	22.4	12.3	Cu	lbs/yr	1
ESD010	CITY	182.5	22.4	12.3	DP	lbs/yr	56
ESD010	CITY	182.5	22.4	12.3	NO2+NO3	lbs/yr	289
ESD010	CITY	182.5	22.4	12.3	Pb	lbs/yr	7
ESD010	CITY	182.5	22.4	12.3	TDS	lbs/yr	33,219
ESD010	CITY	182.5	22.4	12.3	TKN	lbs/yr	356
ESD010	CITY	182.5	22.4	12.3	TP	lbs/yr	223
ESD010	CITY	182.5	22.4	12.3	TSS	lbs/yr	13,317
ESD010	CITY	182.5	22.4	12.3	Zn	lbs/yr	6
ESD020	CITY	119.7	20.6	17.2	Flow	(ac-ft/yr)	82
ESD020	CITY	119.7	20.6	17.2	BOD	lbs/yr	3,353
ESD020	CITY	119.7	20.6	17.2	Cd	lbs/yr	1
ESD020	CITY	119.7	20.6	17.2	COD	lbs/yr	24,862
ESD020	CITY	119.7	20.6	17.2	Cu	lbs/yr	9

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
ESD020	CITY	119.7	20.6	17.2	DP	lbs/yr	43
ESD020	CITY	119.7	20.6	17.2	NO2+NO3	lbs/yr	264
ESD020	CITY	119.7	20.6	17.2	Pb	lbs/yr	5
ESD020	CITY	119.7	20.6	17.2	TDS	lbs/yr	23,496
ESD020	CITY	119.7	20.6	17.2	TKN	lbs/yr	517
ESD020	CITY	119.7	20.6	17.2	TP	lbs/yr	172
ESD020	CITY	119.7	20.6	17.2	TSS	lbs/yr	21,223
ESD020	CITY	119.7	20.6	17.2	Zn	lbs/yr	81
ESD030	CITY	42.2	7.8	18.6	Flow	(ac-ft/yr)	30
ESD030	CITY	42.2	7.8	18.6	BOD	lbs/yr	1,527
ESD030	CITY	42.2	7.8	18.6	Cd	lbs/yr	0
ESD030	CITY	42.2	7.8	18.6	COD	lbs/yr	12,596
ESD030	CITY	42.2	7.8	18.6	Cu	lbs/yr	6
ESD030	CITY	42.2	7.8	18.6	DP	lbs/yr	21
ESD030	CITY	42.2	7.8	18.6	NO2+NO3	lbs/yr	99
ESD030	CITY	42.2	7.8	18.6	Pb	lbs/yr	1
ESD030	CITY	42.2	7.8	18.6	TDS	lbs/yr	7,916
ESD030	CITY	42.2	7.8	18.6	TKN	lbs/yr	304
ESD030	CITY	42.2	7.8	18.6	TP	lbs/yr	106
ESD030	CITY	42.2	7.8	18.6	TSS	lbs/yr	11,476
ESD030	CITY	42.2	7.8	18.6	Zn	lbs/yr	58
ESD040	CITY	150.4	28.6	19.0	Flow	(ac-ft/yr)	108
ESD040	CITY	150.4	28.6	19.0	BOD	lbs/yr	5,848
ESD040	CITY	150.4	28.6	19.0	Cd	lbs/yr	0
ESD040	CITY	150.4	28.6	19.0	COD	lbs/yr	49,417
ESD040	CITY	150.4	28.6	19.0	Cu	lbs/yr	27
ESD040	CITY	150.4	28.6	19.0	DP	lbs/yr	82
ESD040	CITY	150.4	28.6	19.0	NO2+NO3	lbs/yr	360
ESD040	CITY	150.4	28.6	19.0	Pb	lbs/yr	4
ESD040	CITY	150.4	28.6	19.0	TDS	lbs/yr	27,779
ESD040	CITY	150.4	28.6	19.0	TKN	lbs/yr	1,225
ESD040	CITY	150.4	28.6	19.0	TP	lbs/yr	430
ESD040	CITY	150.4	28.6	19.0	TSS	lbs/yr	45,616
ESD040	CITY	150.4	28.6	19.0	Zn	lbs/yr	243
ESD050	CITY	144.7	27.5	19.0	Flow	(ac-ft/yr)	103
ESD050	CITY	144.7	27.5	19.0	BOD	lbs/yr	5,627
ESD050	CITY	144.7	27.5	19.0	Cd	lbs/yr	0

Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
ESD050	CITY	144.7	27.5	19.0	COD	lbs/yr	47,544
ESD050	CITY	144.7	27.5	19.0	Cu	lbs/yr	26
ESD050	CITY	144.7	27.5	19.0	DP	lbs/yr	79
ESD050	CITY	144.7	27.5	19.0	NO2+NO3	lbs/yr	346
ESD050	CITY	144.7	27.5	19.0	Pb	lbs/yr	4
ESD050	CITY	144.7	27.5	19.0	TDS	lbs/yr	26,726
ESD050	CITY	144.7	27.5	19.0	TKN	lbs/yr	1,179
ESD050	CITY	144.7	27.5	19.0	TP	lbs/yr	414
ESD050	CITY	144.7	27.5	19.0	TSS	lbs/yr	43,887
ESD050	CITY	144.7	27.5	19.0	Zn	lbs/yr	234
ESD060	CITY	57.5	10.9	19.0	Flow	(ac-ft/yr)	41
ESD060	CITY	57.5	10.9	19.0	BOD	lbs/yr	2,236
ESD060	CITY	57.5	10.9	19.0	Cd	lbs/yr	0
ESD060	CITY	57.5	10.9	19.0	COD	lbs/yr	18,893
ESD060	CITY	57.5	10.9	19.0	Cu	lbs/yr	10
ESD060	CITY	57.5	10.9	19.0	DP	lbs/yr	31
ESD060	CITY	57.5	10.9	19.0	NO2+NO3	lbs/yr	138
ESD060	CITY	57.5	10.9	19.0	Pb	lbs/yr	2
ESD060	CITY	57.5	10.9	19.0	TDS	lbs/yr	10,620
ESD060	CITY	57.5	10.9	19.0	TKN	lbs/yr	468
ESD060	CITY	57.5	10.9	19.0	TP	lbs/yr	164
ESD060	CITY	57.5	10.9	19.0	TSS	lbs/yr	17,440
ESD060	CITY	57.5	10.9	19.0	Zn	lbs/yr	93
ESD065	CITY	48.9	9.3	19.0	Flow	(ac-ft/yr)	35
ESD065	CITY	48.9	9.3	19.0	BOD	lbs/yr	1,901
ESD065	CITY	48.9	9.3	19.0	Cd	lbs/yr	0
ESD065	CITY	48.9	9.3	19.0	COD	lbs/yr	16,067
ESD065	CITY	48.9	9.3	19.0	Cu	lbs/yr	9
ESD065	CITY	48.9	9.3	19.0	DP	lbs/yr	27
ESD065	CITY	48.9	9.3	19.0	NO2+NO3	lbs/yr	117
ESD065	CITY	48.9	9.3	19.0	Pb	lbs/yr	1
ESD065	CITY	48.9	9.3	19.0	TDS	lbs/yr	9,032
ESD065	CITY	48.9	9.3	19.0	TKN	lbs/yr	398
ESD065	CITY	48.9	9.3	19.0	TP	lbs/yr	140
ESD065	CITY	48.9	9.3	19.0	TSS	lbs/yr	14,831
ESD065	CITY	48.9	9.3	19.0	Zn	lbs/yr	79
ESD070	CITY	42.0	8.0	19.0	Flow	(ac-ft/yr)	30

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
ESD070	CITY	42.0	8.0	19.0	BOD	lbs/yr	1,633
ESD070	CITY	42.0	8.0	19.0	Cd	lbs/yr	0
ESD070	CITY	42.0	8.0	19.0	COD	lbs/yr	13,800
ESD070	CITY	42.0	8.0	19.0	Cu	lbs/yr	7
ESD070	CITY	42.0	8.0	19.0	DP	lbs/yr	23
ESD070	CITY	42.0	8.0	19.0	NO2+NO3	lbs/yr	100
ESD070	CITY	42.0	8.0	19.0	Pb	lbs/yr	1
ESD070	CITY	42.0	8.0	19.0	TDS	lbs/yr	7,757
ESD070	CITY	42.0	8.0	19.0	TKN	lbs/yr	342
ESD070	CITY	42.0	8.0	19.0	TP	lbs/yr	120
ESD070	CITY	42.0	8.0	19.0	TSS	lbs/yr	12,738
ESD070	CITY	42.0	8.0	19.0	Zn	lbs/yr	68
ESD080	CITY	332.9	14.7	4.4	Flow	(ac-ft/yr)	146
ESD080	CITY	332.9	14.7	4.4	BOD	lbs/yr	9,422
ESD080	CITY	332.9	14.7	4.4	Cd	lbs/yr	0
ESD080	CITY	332.9	14.7	4.4	COD	lbs/yr	40,331
ESD080	CITY	332.9	14.7	4.4	Cu	lbs/yr	11
ESD080	CITY	332.9	14.7	4.4	DP	lbs/yr	73
ESD080	CITY	332.9	14.7	4.4	NO2+NO3	lbs/yr	384
ESD080	CITY	332.9	14.7	4.4	Pb	lbs/yr	2
ESD080	CITY	332.9	14.7	4.4	TDS	lbs/yr	48,419
ESD080	CITY	332.9	14.7	4.4	TKN	lbs/yr	787
ESD080	CITY	332.9	14.7	4.4	TP	lbs/yr	270
ESD080	CITY	332.9	14.7	4.4	TSS	lbs/yr	38,934
ESD080	CITY	332.9	14.7	4.4	Zn	lbs/yr	102
ESD090	CITY	73.4	1.3	1.8	Flow	(ac-ft/yr)	29
ESD090	CITY	73.4	1.3	1.8	BOD	lbs/yr	1,878
ESD090	CITY	73.4	1.3	1.8	Cd	lbs/yr	0
ESD090	CITY	73.4	1.3	1.8	COD	lbs/yr	5,546
ESD090	CITY	73.4	1.3	1.8	Cu	lbs/yr	0
ESD090	CITY	73.4	1.3	1.8	DP	lbs/yr	11
ESD090	CITY	73.4	1.3	1.8	NO2+NO3	lbs/yr	68
ESD090	CITY	73.4	1.3	1.8	Pb	lbs/yr	0
ESD090	CITY	73.4	1.3	1.8	TDS	lbs/yr	10,255
ESD090	CITY	73.4	1.3	1.8	TKN	lbs/yr	77
ESD090	CITY	73.4	1.3	1.8	TP	lbs/yr	25
ESD090	CITY	73.4	1.3	1.8	TSS	lbs/yr	5,471
ESD090	CITY	73.4	1.3	1.8	Zn	lbs/yr	0

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
ESD100	CITY	52.8	7.2	13.6	Flow	(ac-ft/yr)	32
ESD100	CITY	52.8	7.2	13.6	BOD	lbs/yr	1,595
ESD100	CITY	52.8	7.2	13.6	Cd	lbs/yr	0
ESD100	CITY	52.8	7.2	13.6	COD	lbs/yr	10,789
ESD100	CITY	52.8	7.2	13.6	Cu	lbs/yr	4
ESD100	CITY	52.8	7.2	13.6	DP	lbs/yr	19
ESD100	CITY	52.8	7.2	13.6	NO2+NO3	lbs/yr	101
ESD100	CITY	52.8	7.2	13.6	Pb	lbs/yr	1
ESD100	CITY	52.8	7.2	13.6	TDS	lbs/yr	9,419
ESD100	CITY	52.8	7.2	13.6	TKN	lbs/yr	235
ESD100	CITY	52.8	7.2	13.6	TP	lbs/yr	80
ESD100	CITY	52.8	7.2	13.6	TSS	lbs/yr	9,662
ESD100	CITY	52.8	7.2	13.6	Zn	lbs/yr	39
ESD110	CITY	69.7	12.8	18.3	Flow	(ac-ft/yr)	49
ESD110	CITY	69.7	12.8	18.3	BOD	lbs/yr	2,395
ESD110	CITY	69.7	12.8	18.3	Cd	lbs/yr	0
ESD110	CITY	69.7	12.8	18.3	COD	lbs/yr	18,046
ESD110	CITY	69.7	12.8	18.3	Cu	lbs/yr	8
ESD110	CITY	69.7	12.8	18.3	DP	lbs/yr	31
ESD110	CITY	69.7	12.8	18.3	NO2+NO3	lbs/yr	151
ESD110	CITY	69.7	12.8	18.3	Pb	lbs/yr	4
ESD110	CITY	69.7	12.8	18.3	TDS	lbs/yr	13,008
ESD110	CITY	69.7	12.8	18.3	TKN	lbs/yr	417
ESD110	CITY	69.7	12.8	18.3	TP	lbs/yr	142
ESD110	CITY	69.7	12.8	18.3	TSS	lbs/yr	15,621
ESD110	CITY	69.7	12.8	18.3	Zn	lbs/yr	75
ESD120	CITY	131.1	24.9	19.0	Flow	(ac-ft/yr)	94
ESD120	CITY	131.1	24.9	19.0	BOD	lbs/yr	5,098
ESD120	CITY	131.1	24.9	19.0	Cd	lbs/yr	0
ESD120	CITY	131.1	24.9	19.0	COD	lbs/yr	43,076
ESD120	CITY	131.1	24.9	19.0	Cu	lbs/yr	23
ESD120	CITY	131.1	24.9	19.0	DP	lbs/yr	71
ESD120	CITY	131.1	24.9	19.0	NO2+NO3	lbs/yr	314
ESD120	CITY	131.1	24.9	19.0	Pb	lbs/yr	4
ESD120	CITY	131.1	24.9	19.0	TDS	lbs/yr	24,214
ESD120	CITY	131.1	24.9	19.0	TKN	lbs/yr	1,068
ESD120	CITY	131.1	24.9	19.0	TP	lbs/yr	375

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
ESD120	CITY	131.1	24.9	19.0	TSS	lbs/yr	39,762
ESD120	CITY	131.1	24.9	19.0	Zn	lbs/yr	212
ESD130	CITY	195.6	34.4	17.6	Flow	(ac-ft/yr)	135
ESD130	CITY	195.6	34.4	17.6	BOD	lbs/yr	7,357
ESD130	CITY	195.6	34.4	17.6	Cd	lbs/yr	0
ESD130	CITY	195.6	34.4	17.6	COD	lbs/yr	29,105
ESD130	CITY	195.6	34.4	17.6	Cu	lbs/yr	6
ESD130	CITY	195.6	34.4	17.6	DP	lbs/yr	54
ESD130	CITY	195.6	34.4	17.6	NO2+NO3	lbs/yr	221
ESD130	CITY	195.6	34.4	17.6	Pb	lbs/yr	46
ESD130	CITY	195.6	34.4	17.6	TDS	lbs/yr	30,664
ESD130	CITY	195.6	34.4	17.6	TKN	lbs/yr	565
ESD130	CITY	195.6	34.4	17.6	TP	lbs/yr	151
ESD130	CITY	195.6	34.4	17.6	TSS	lbs/yr	13,178
ESD130	CITY	195.6	34.4	17.6	Zn	lbs/yr	55
ESD140	CITY	120.4	20.0	16.6	Flow	(ac-ft/yr)	81
ESD140	CITY	120.4	20.0	16.6	BOD	lbs/yr	3,512
ESD140	CITY	120.4	20.0	16.6	Cd	lbs/yr	1
ESD140	CITY	120.4	20.0	16.6	COD	lbs/yr	25,895
ESD140	CITY	120.4	20.0	16.6	Cu	lbs/yr	10
ESD140	CITY	120.4	20.0	16.6	DP	lbs/yr	44
ESD140	CITY	120.4	20.0	16.6	NO2+NO3	lbs/yr	260
ESD140	CITY	120.4	20.0	16.6	Pb	lbs/yr	4
ESD140	CITY	120.4	20.0	16.6	TDS	lbs/yr	23,111
ESD140	CITY	120.4	20.0	16.6	TKN	lbs/yr	554
ESD140	CITY	120.4	20.0	16.6	TP	lbs/yr	186
ESD140	CITY	120.4	20.0	16.6	TSS	lbs/yr	22,493
ESD140	CITY	120.4	20.0	16.6	Zn	lbs/yr	90
ESD150	CITY	74.2	13.0	17.5	Flow	(ac-ft/yr)	51
ESD150	CITY	74.2	13.0	17.5	BOD	lbs/yr	2,213
ESD150	CITY	74.2	13.0	17.5	Cd	lbs/yr	0
ESD150	CITY	74.2	13.0	17.5	COD	lbs/yr	16,904
ESD150	CITY	74.2	13.0	17.5	Cu	lbs/yr	7
ESD150	CITY	74.2	13.0	17.5	DP	lbs/yr	29
ESD150	CITY	74.2	13.0	17.5	NO2+NO3	lbs/yr	166
ESD150	CITY	74.2	13.0	17.5	Pb	lbs/yr	3
ESD150	CITY	74.2	13.0	17.5	TDS	lbs/yr	14,422

Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
ESD150	CITY	74.2	13.0	17.5	TKN	lbs/yr	368
ESD150	CITY	74.2	13.0	17.5	TP	lbs/yr	124
ESD150	CITY	74.2	13.0	17.5	TSS	lbs/yr	14,712
ESD150	CITY	74.2	13.0	17.5	Zn	lbs/yr	62
ESD160	CITY	47.1	5.4	11.5	Flow	(ac-ft/yr)	27
ESD160	CITY	47.1	5.4	11.5	BOD	lbs/yr	1,049
ESD160	CITY	47.1	5.4	11.5	Cd	lbs/yr	0
ESD160	CITY	47.1	5.4	11.5	COD	lbs/yr	5,220
ESD160	CITY	47.1	5.4	11.5	Cu	lbs/yr	0
ESD160	CITY	47.1	5.4	11.5	DP	lbs/yr	10
ESD160	CITY	47.1	5.4	11.5	NO2+NO3	lbs/yr	81
ESD160	CITY	47.1	5.4	11.5	Pb	lbs/yr	2
ESD160	CITY	47.1	5.4	11.5	TDS	lbs/yr	8,655
ESD160	CITY	47.1	5.4	11.5	TKN	lbs/yr	73
ESD160	CITY	47.1	5.4	11.5	TP	lbs/yr	21
ESD160	CITY	47.1	5.4	11.5	TSS	lbs/yr	4,114
ESD160	CITY	47.1	5.4	11.5	Zn	lbs/yr	1
ESD165	CITY	65.1	10.4	16.0	Flow	(ac-ft/yr)	43
ESD165	CITY	65.1	10.4	16.0	BOD	lbs/yr	1,352
ESD165	CITY	65.1	10.4	16.0	Cd	lbs/yr	0
ESD165	CITY	65.1	10.4	16.0	COD	lbs/yr	8,272
ESD165	CITY	65.1	10.4	16.0	Cu	lbs/yr	0
ESD165	CITY	65.1	10.4	16.0	DP	lbs/yr	15
ESD165	CITY	65.1	10.4	16.0	NO2+NO3	lbs/yr	135
ESD165	CITY	65.1	10.4	16.0	Pb	lbs/yr	3
ESD165	CITY	65.1	10.4	16.0	TDS	lbs/yr	13,282
ESD165	CITY	65.1	10.4	16.0	TKN	lbs/yr	115
ESD165	CITY	65.1	10.4	16.0	TP	lbs/yr	31
ESD165	CITY	65.1	10.4	16.0	TSS	lbs/yr	6,070
ESD165	CITY	65.1	10.4	16.0	Zn	lbs/yr	3
ESD170	CITY	106.7	14.8	13.9	Flow	(ac-ft/yr)	66
ESD170	CITY	106.7	14.8	13.9	BOD	lbs/yr	2,359
ESD170	CITY	106.7	14.8	13.9	Cd	lbs/yr	0
ESD170	CITY	106.7	14.8	13.9	COD	lbs/yr	13,638
ESD170	CITY	106.7	14.8	13.9	Cu	lbs/yr	2
ESD170	CITY	106.7	14.8	13.9	DP	lbs/yr	38
ESD170	CITY	106.7	14.8	13.9	NO2+NO3	lbs/yr	150

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
ESD170	CITY	106.7	14.8	13.9	Pb	lbs/yr	9
ESD170	CITY	106.7	14.8	13.9	TDS	lbs/yr	18,542
ESD170	CITY	106.7	14.8	13.9	TKN	lbs/yr	269
ESD170	CITY	106.7	14.8	13.9	TP	lbs/yr	162
ESD170	CITY	106.7	14.8	13.9	TSS	lbs/yr	7,474
ESD170	CITY	106.7	14.8	13.9	Zn	lbs/yr	14
ESD185	CITY	102.8	16.2	15.8	Flow	(ac-ft/yr)	67
ESD185	CITY	102.8	16.2	15.8	BOD	lbs/yr	3,732
ESD185	CITY	102.8	16.2	15.8	Cd	lbs/yr	0
ESD185	CITY	102.8	16.2	15.8	COD	lbs/yr	12,662
ESD185	CITY	102.8	16.2	15.8	Cu	lbs/yr	1
ESD185	CITY	102.8	16.2	15.8	DP	lbs/yr	24
ESD185	CITY	102.8	16.2	15.8	NO2+NO3	lbs/yr	100
ESD185	CITY	102.8	16.2	15.8	Pb	lbs/yr	24
ESD185	CITY	102.8	16.2	15.8	TDS	lbs/yr	15,617
ESD185	CITY	102.8	16.2	15.8	TKN	lbs/yr	224
ESD185	CITY	102.8	16.2	15.8	TP	lbs/yr	53
ESD185	CITY	102.8	16.2	15.8	TSS	lbs/yr	4,559
ESD185	CITY	102.8	16.2	15.8	Zn	lbs/yr	12
ESD190	CITY	149.2	31.2	20.9	Flow	(ac-ft/yr)	112
ESD190	CITY	149.2	31.2	20.9	BOD	lbs/yr	5,997
ESD190	CITY	149.2	31.2	20.9	Cd	lbs/yr	0
ESD190	CITY	149.2	31.2	20.9	COD	lbs/yr	47,089
ESD190	CITY	149.2	31.2	20.9	Cu	lbs/yr	24
ESD190	CITY	149.2	31.2	20.9	DP	lbs/yr	79
ESD190	CITY	149.2	31.2	20.9	NO2+NO3	lbs/yr	338
ESD190	CITY	149.2	31.2	20.9	Pb	lbs/yr	12
ESD190	CITY	149.2	31.2	20.9	TDS	lbs/yr	27,418
ESD190	CITY	149.2	31.2	20.9	TKN	lbs/yr	1,152
ESD190	CITY	149.2	31.2	20.9	TP	lbs/yr	396
ESD190	CITY	149.2	31.2	20.9	TSS	lbs/yr	40,741
ESD190	CITY	149.2	31.2	20.9	Zn	lbs/yr	221
ESD200	CITY	153.0	12.8	8.4	Flow	(ac-ft/yr)	79
ESD200	CITY	153.0	12.8	8.4	BOD	lbs/yr	3,504
ESD200	CITY	153.0	12.8	8.4	Cd	lbs/yr	0
ESD200	CITY	153.0	12.8	8.4	COD	lbs/yr	27,123
ESD200	CITY	153.0	12.8	8.4	Cu	lbs/yr	11

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
ESD200	CITY	153.0	12.8	8.4	DP	lbs/yr	83
ESD200	CITY	153.0	12.8	8.4	NO2+NO3	lbs/yr	159
ESD200	CITY	153.0	12.8	8.4	Pb	lbs/yr	2
ESD200	CITY	153.0	12.8	8.4	TDS	lbs/yr	22,052
ESD200	CITY	153.0	12.8	8.4	TKN	lbs/yr	735
ESD200	CITY	153.0	12.8	8.4	TP	lbs/yr	490
ESD200	CITY	153.0	12.8	8.4	TSS	lbs/yr	20,110
ESD200	CITY	153.0	12.8	8.4	Zn	lbs/yr	101
ESD205	CITY	29.0	0.3	1.0	Flow	(ac-ft/yr)	11
ESD205	CITY	29.0	0.3	1.0	BOD	lbs/yr	342
ESD205	CITY	29.0	0.3	1.0	Cd	lbs/yr	0
ESD205	CITY	29.0	0.3	1.0	COD	lbs/yr	2,094
ESD205	CITY	29.0	0.3	1.0	Cu	lbs/yr	0
ESD205	CITY	29.0	0.3	1.0	DP	lbs/yr	16
ESD205	CITY	29.0	0.3	1.0	NO2+NO3	lbs/yr	3
ESD205	CITY	29.0	0.3	1.0	Pb	lbs/yr	0
ESD205	CITY	29.0	0.3	1.0	TDS	lbs/yr	3,363
ESD205	CITY	29.0	0.3	1.0	TKN	lbs/yr	72
ESD205	CITY	29.0	0.3	1.0	TP	lbs/yr	100
ESD205	CITY	29.0	0.3	1.0	TSS	lbs/yr	351
ESD205	CITY	29.0	0.3	1.0	Zn	lbs/yr	0
ESD210	CITY	103.7	19.7	19.0	Flow	(ac-ft/yr)	74
ESD210	CITY	103.7	19.7	19.0	BOD	lbs/yr	4,032
ESD210	CITY	103.7	19.7	19.0	Cd	lbs/yr	0
ESD210	CITY	103.7	19.7	19.0	COD	lbs/yr	34,073
ESD210	CITY	103.7	19.7	19.0	Cu	lbs/yr	18
ESD210	CITY	103.7	19.7	19.0	DP	lbs/yr	56
ESD210	CITY	103.7	19.7	19.0	NO2+NO3	lbs/yr	248
ESD210	CITY	103.7	19.7	19.0	Pb	lbs/yr	3
ESD210	CITY	103.7	19.7	19.0	TDS	lbs/yr	19,153
ESD210	CITY	103.7	19.7	19.0	TKN	lbs/yr	845
ESD210	CITY	103.7	19.7	19.0	TP	lbs/yr	296
ESD210	CITY	103.7	19.7	19.0	TSS	lbs/yr	31,452
ESD210	CITY	103.7	19.7	19.0	Zn	lbs/yr	168
ESD220	CITY	126.2	39.1	31.0	Flow	(ac-ft/yr)	119
ESD220	CITY	126.2	39.1	31.0	BOD	lbs/yr	4,524
ESD220	CITY	126.2	39.1	31.0	Cd	lbs/yr	0

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
ESD220	CITY	126.2	39.1	31.0	COD	lbs/yr	33,725
ESD220	CITY	126.2	39.1	31.0	Cu	lbs/yr	14
ESD220	CITY	126.2	39.1	31.0	DP	lbs/yr	117
ESD220	CITY	126.2	39.1	31.0	NO2+NO3	lbs/yr	247
ESD220	CITY	126.2	39.1	31.0	Pb	lbs/yr	5
ESD220	CITY	126.2	39.1	31.0	TDS	lbs/yr	25,443
ESD220	CITY	126.2	39.1	31.0	TKN	lbs/yr	614
ESD220	CITY	126.2	39.1	31.0	TP	lbs/yr	173
ESD220	CITY	126.2	39.1	31.0	TSS	lbs/yr	41,970
ESD220	CITY	126.2	39.1	31.0	Zn	lbs/yr	113
ESD230	CITY	116.5	22.1	19.0	Flow	(ac-ft/yr)	83
ESD230	CITY	116.5	22.1	19.0	BOD	lbs/yr	4,530
ESD230	CITY	116.5	22.1	19.0	Cd	lbs/yr	0
ESD230	CITY	116.5	22.1	19.0	COD	lbs/yr	38,279
ESD230	CITY	116.5	22.1	19.0	Cu	lbs/yr	21
ESD230	CITY	116.5	22.1	19.0	DP	lbs/yr	63
ESD230	CITY	116.5	22.1	19.0	NO2+NO3	lbs/yr	279
ESD230	CITY	116.5	22.1	19.0	Pb	lbs/yr	3
ESD230	CITY	116.5	22.1	19.0	TDS	lbs/yr	21,518
ESD230	CITY	116.5	22.1	19.0	TKN	lbs/yr	949
ESD230	CITY	116.5	22.1	19.0	TP	lbs/yr	333
ESD230	CITY	116.5	22.1	19.0	TSS	lbs/yr	35,334
ESD230	CITY	116.5	22.1	19.0	Zn	lbs/yr	188
ESD240	CITY	49.7	9.4	19.0	Flow	(ac-ft/yr)	36
ESD240	CITY	49.7	9.4	19.0	BOD	lbs/yr	1,933
ESD240	CITY	49.7	9.4	19.0	Cd	lbs/yr	0
ESD240	CITY	49.7	9.4	19.0	COD	lbs/yr	16,330
ESD240	CITY	49.7	9.4	19.0	Cu	lbs/yr	9
ESD240	CITY	49.7	9.4	19.0	DP	lbs/yr	27
ESD240	CITY	49.7	9.4	19.0	NO2+NO3	lbs/yr	119
ESD240	CITY	49.7	9.4	19.0	Pb	lbs/yr	1
ESD240	CITY	49.7	9.4	19.0	TDS	lbs/yr	9,180
ESD240	CITY	49.7	9.4	19.0	TKN	lbs/yr	405
ESD240	CITY	49.7	9.4	19.0	TP	lbs/yr	142
ESD240	CITY	49.7	9.4	19.0	TSS	lbs/yr	15,074
ESD240	CITY	49.7	9.4	19.0	Zn	lbs/yr	80
ESD250	CITY	164.5	1.6	1.0	Flow	(ac-ft/yr)	62

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
ESD250	CITY	164.5	1.6	1.0	BOD	lbs/yr	1,941
ESD250	CITY	164.5	1.6	1.0	Cd	lbs/yr	0
ESD250	CITY	164.5	1.6	1.0	COD	lbs/yr	11,880
ESD250	CITY	164.5	1.6	1.0	Cu	lbs/yr	0
ESD250	CITY	164.5	1.6	1.0	DP	lbs/yr	89
ESD250	CITY	164.5	1.6	1.0	NO2+NO3	lbs/yr	17
ESD250	CITY	164.5	1.6	1.0	Pb	lbs/yr	0
ESD250	CITY	164.5	1.6	1.0	TDS	lbs/yr	19,075
ESD250	CITY	164.5	1.6	1.0	TKN	lbs/yr	408
ESD250	CITY	164.5	1.6	1.0	TP	lbs/yr	566
ESD250	CITY	164.5	1.6	1.0	TSS	lbs/yr	1,991
ESD250	CITY	164.5	1.6	1.0	Zn	lbs/yr	0
COW010	CITY	110.0	17.6	16.0	Flow	(ac-ft/yr)	72
COW010	CITY	110.0	17.6	16.0	BOD	lbs/yr	2,284
COW010	CITY	110.0	17.6	16.0	Cd	lbs/yr	1
COW010	CITY	110.0	17.6	16.0	COD	lbs/yr	13,978
COW010	CITY	110.0	17.6	16.0	Cu	lbs/yr	1
COW010	CITY	110.0	17.6	16.0	DP	lbs/yr	26
COW010	CITY	110.0	17.6	16.0	NO2+NO3	lbs/yr	228
COW010	CITY	110.0	17.6	16.0	Pb	lbs/yr	6
COW010	CITY	110.0	17.6	16.0	TDS	lbs/yr	22,443
COW010	CITY	110.0	17.6	16.0	TKN	lbs/yr	195
COW010	CITY	110.0	17.6	16.0	TP	lbs/yr	53
COW010	CITY	110.0	17.6	16.0	TSS	lbs/yr	10,257
COW010	CITY	110.0	17.6	16.0	Zn	lbs/yr	5
COW020	CITY	72.9	11.7	16.0	Flow	(ac-ft/yr)	48
COW020	CITY	72.9	11.7	16.0	BOD	lbs/yr	1,513
COW020	CITY	72.9	11.7	16.0	Cd	lbs/yr	1
COW020	CITY	72.9	11.7	16.0	COD	lbs/yr	9,263
COW020	CITY	72.9	11.7	16.0	Cu	lbs/yr	1
COW020	CITY	72.9	11.7	16.0	DP	lbs/yr	17
COW020	CITY	72.9	11.7	16.0	NO2+NO3	lbs/yr	151
COW020	CITY	72.9	11.7	16.0	Pb	lbs/yr	4
COW020	CITY	72.9	11.7	16.0	TDS	lbs/yr	14,874
COW020	CITY	72.9	11.7	16.0	TKN	lbs/yr	129
COW020	CITY	72.9	11.7	16.0	TP	lbs/yr	35
COW020	CITY	72.9	11.7	16.0	TSS	lbs/yr	6,797
COW020	CITY	72.9	11.7	16.0	Zn	lbs/yr	3

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
COW030	CITY	76.9	12.3	16.0	Flow	(ac-ft/yr)	51
COW030	CITY	76.9	12.3	16.0	BOD	lbs/yr	1,596
COW030	CITY	76.9	12.3	16.0	Cd	lbs/yr	1
COW030	CITY	76.9	12.3	16.0	COD	lbs/yr	9,772
COW030	CITY	76.9	12.3	16.0	Cu	lbs/yr	1
COW030	CITY	76.9	12.3	16.0	DP	lbs/yr	18
COW030	CITY	76.9	12.3	16.0	NO2+NO3	lbs/yr	160
COW030	CITY	76.9	12.3	16.0	Pb	lbs/yr	4
COW030	CITY	76.9	12.3	16.0	TDS	lbs/yr	15,690
COW030	CITY	76.9	12.3	16.0	TKN	lbs/yr	136
COW030	CITY	76.9	12.3	16.0	TP	lbs/yr	37
COW030	CITY	76.9	12.3	16.0	TSS	lbs/yr	7,170
COW030	CITY	76.9	12.3	16.0	Zn	lbs/yr	3
COW035	CITY	17.0	2.7	16.0	Flow	(ac-ft/yr)	11
COW035	CITY	17.0	2.7	16.0	BOD	lbs/yr	353
COW035	CITY	17.0	2.7	16.0	Cd	lbs/yr	0
COW035	CITY	17.0	2.7	16.0	COD	lbs/yr	2,160
COW035	CITY	17.0	2.7	16.0	Cu	lbs/yr	0
COW035	CITY	17.0	2.7	16.0	DP	lbs/yr	4
COW035	CITY	17.0	2.7	16.0	NO2+NO3	lbs/yr	35
COW035	CITY	17.0	2.7	16.0	Pb	lbs/yr	1
COW035	CITY	17.0	2.7	16.0	TDS	lbs/yr	3,468
COW035	CITY	17.0	2.7	16.0	TKN	lbs/yr	30
COW035	CITY	17.0	2.7	16.0	TP	lbs/yr	8
COW035	CITY	17.0	2.7	16.0	TSS	lbs/yr	1,585
COW035	CITY	17.0	2.7	16.0	Zn	lbs/yr	1
COW040	CITY	45.7	7.3	16.0	Flow	(ac-ft/yr)	30
COW040	CITY	45.7	7.3	16.0	BOD	lbs/yr	949
COW040	CITY	45.7	7.3	16.0	Cd	lbs/yr	0
COW040	CITY	45.7	7.3	16.0	COD	lbs/yr	5,807
COW040	CITY	45.7	7.3	16.0	Cu	lbs/yr	0
COW040	CITY	45.7	7.3	16.0	DP	lbs/yr	11
COW040	CITY	45.7	7.3	16.0	NO2+NO3	lbs/yr	95
COW040	CITY	45.7	7.3	16.0	Pb	lbs/yr	2
COW040	CITY	45.7	7.3	16.0	TDS	lbs/yr	9,324
COW040	CITY	45.7	7.3	16.0	TKN	lbs/yr	81
COW040	CITY	45.7	7.3	16.0	TP	lbs/yr	22

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
COW040	CITY	45.7	7.3	16.0	TSS	lbs/yr	4,261
COW040	CITY	45.7	7.3	16.0	Zn	lbs/yr	2
COW042	CITY	35.8	7.5	20.9	Flow	(ac-ft/yr)	27
COW042	CITY	35.8	7.5	20.9	BOD	lbs/yr	990
COW042	CITY	35.8	7.5	20.9	Cd	lbs/yr	0
COW042	CITY	35.8	7.5	20.9	COD	lbs/yr	5,115
COW042	CITY	35.8	7.5	20.9	Cu	lbs/yr	0
COW042	CITY	35.8	7.5	20.9	DP	lbs/yr	9
COW042	CITY	35.8	7.5	20.9	NO2+NO3	lbs/yr	67
COW042	CITY	35.8	7.5	20.9	Pb	lbs/yr	6
COW042	CITY	35.8	7.5	20.9	TDS	lbs/yr	7,078
COW042	CITY	35.8	7.5	20.9	TKN	lbs/yr	80
COW042	CITY	35.8	7.5	20.9	TP	lbs/yr	20
COW042	CITY	35.8	7.5	20.9	TSS	lbs/yr	2,606
COW042	CITY	35.8	7.5	20.9	Zn	lbs/yr	4
COW044	CITY	88.4	14.1	16.0	Flow	(ac-ft/yr)	58
COW044	CITY	88.4	14.1	16.0	BOD	lbs/yr	1,835
COW044	CITY	88.4	14.1	16.0	Cd	lbs/yr	1
COW044	CITY	88.4	14.1	16.0	COD	lbs/yr	11,233
COW044	CITY	88.4	14.1	16.0	Cu	lbs/yr	1
COW044	CITY	88.4	14.1	16.0	DP	lbs/yr	21
COW044	CITY	88.4	14.1	16.0	NO2+NO3	lbs/yr	184
COW044	CITY	88.4	14.1	16.0	Pb	lbs/yr	4
COW044	CITY	88.4	14.1	16.0	TDS	lbs/yr	18,036
COW044	CITY	88.4	14.1	16.0	TKN	lbs/yr	157
COW044	CITY	88.4	14.1	16.0	TP	lbs/yr	43
COW044	CITY	88.4	14.1	16.0	TSS	lbs/yr	8,243
COW044	CITY	88.4	14.1	16.0	Zn	lbs/yr	4
COW046	CITY	81.2	14.2	17.5	Flow	(ac-ft/yr)	56
COW046	CITY	81.2	14.2	17.5	BOD	lbs/yr	2,422
COW046	CITY	81.2	14.2	17.5	Cd	lbs/yr	0
COW046	CITY	81.2	14.2	17.5	COD	lbs/yr	18,499
COW046	CITY	81.2	14.2	17.5	Cu	lbs/yr	7
COW046	CITY	81.2	14.2	17.5	DP	lbs/yr	32
COW046	CITY	81.2	14.2	17.5	NO2+NO3	lbs/yr	181
COW046	CITY	81.2	14.2	17.5	Pb	lbs/yr	3
COW046	CITY	81.2	14.2	17.5	TDS	lbs/yr	15,782

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
COW046	CITY	81.2	14.2	17.5	TKN	lbs/yr	403
COW046	CITY	81.2	14.2	17.5	TP	lbs/yr	136
COW046	CITY	81.2	14.2	17.5	TSS	lbs/yr	16,100
COW046	CITY	81.2	14.2	17.5	Zn	lbs/yr	67
COW048	CITY	39.1	7.4	19.0	Flow	(ac-ft/yr)	28
COW048	CITY	39.1	7.4	19.0	BOD	lbs/yr	1,520
COW048	CITY	39.1	7.4	19.0	Cd	lbs/yr	0
COW048	CITY	39.1	7.4	19.0	COD	lbs/yr	12,847
COW048	CITY	39.1	7.4	19.0	Cu	lbs/yr	7
COW048	CITY	39.1	7.4	19.0	DP	lbs/yr	21
COW048	CITY	39.1	7.4	19.0	NO2+NO3	lbs/yr	94
COW048	CITY	39.1	7.4	19.0	Pb	lbs/yr	1
COW048	CITY	39.1	7.4	19.0	TDS	lbs/yr	7,222
COW048	CITY	39.1	7.4	19.0	TKN	lbs/yr	319
COW048	CITY	39.1	7.4	19.0	TP	lbs/yr	112
COW048	CITY	39.1	7.4	19.0	TSS	lbs/yr	11,859
COW048	CITY	39.1	7.4	19.0	Zn	lbs/yr	63
COW050	CITY	109.3	21.8	20.0	Flow	(ac-ft/yr)	80
COW050	CITY	109.3	21.8	20.0	BOD	lbs/yr	4,322
COW050	CITY	109.3	21.8	20.0	Cd	lbs/yr	0
COW050	CITY	109.3	21.8	20.0	COD	lbs/yr	35,199
COW050	CITY	109.3	21.8	20.0	Cu	lbs/yr	19
COW050	CITY	109.3	21.8	20.0	DP	lbs/yr	59
COW050	CITY	109.3	21.8	20.0	NO2+NO3	lbs/yr	254
COW050	CITY	109.3	21.8	20.0	Pb	lbs/yr	6
COW050	CITY	109.3	21.8	20.0	TDS	lbs/yr	20,136
COW050	CITY	109.3	21.8	20.0	TKN	lbs/yr	867
COW050	CITY	109.3	21.8	20.0	TP	lbs/yr	301
COW050	CITY	109.3	21.8	20.0	TSS	lbs/yr	31,485
COW050	CITY	109.3	21.8	20.0	Zn	lbs/yr	169
COW060	CITY	71.2	11.8	16.5	Flow	(ac-ft/yr)	48
COW060	CITY	71.2	11.8	16.5	BOD	lbs/yr	1,707
COW060	CITY	71.2	11.8	16.5	Cd	lbs/yr	0
COW060	CITY	71.2	11.8	16.5	COD	lbs/yr	11,586
COW060	CITY	71.2	11.8	16.5	Cu	lbs/yr	3
COW060	CITY	71.2	11.8	16.5	DP	lbs/yr	20
COW060	CITY	71.2	11.8	16.5	NO2+NO3	lbs/yr	152

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
COW060	CITY	71.2	11.8	16.5	Pb	lbs/yr	3
COW060	CITY	71.2	11.8	16.5	TDS	lbs/yr	14,283
COW060	CITY	71.2	11.8	16.5	TKN	lbs/yr	206
COW060	CITY	71.2	11.8	16.5	TP	lbs/yr	64
COW060	CITY	71.2	11.8	16.5	TSS	lbs/yr	9,286
COW060	CITY	71.2	11.8	16.5	Zn	lbs/yr	23
COW070	CITY	44.8	8.3	18.6	Flow	(ac-ft/yr)	32
COW070	CITY	44.8	8.3	18.6	BOD	lbs/yr	1,621
COW070	CITY	44.8	8.3	18.6	Cd	lbs/yr	0
COW070	CITY	44.8	8.3	18.6	COD	lbs/yr	13,370
COW070	CITY	44.8	8.3	18.6	Cu	lbs/yr	7
COW070	CITY	44.8	8.3	18.6	DP	lbs/yr	22
COW070	CITY	44.8	8.3	18.6	NO2+NO3	lbs/yr	105
COW070	CITY	44.8	8.3	18.6	Pb	lbs/yr	1
COW070	CITY	44.8	8.3	18.6	TDS	lbs/yr	8,404
COW070	CITY	44.8	8.3	18.6	TKN	lbs/yr	322
COW070	CITY	44.8	8.3	18.6	TP	lbs/yr	112
COW070	CITY	44.8	8.3	18.6	TSS	lbs/yr	12,180
COW070	CITY	44.8	8.3	18.6	Zn	lbs/yr	62
COW080	CITY	53.6	10.2	19.0	Flow	(ac-ft/yr)	38
COW080	CITY	53.6	10.2	19.0	BOD	lbs/yr	2,084
COW080	CITY	53.6	10.2	19.0	Cd	lbs/yr	0
COW080	CITY	53.6	10.2	19.0	COD	lbs/yr	17,611
COW080	CITY	53.6	10.2	19.0	Cu	lbs/yr	9
COW080	CITY	53.6	10.2	19.0	DP	lbs/yr	29
COW080	CITY	53.6	10.2	19.0	NO2+NO3	lbs/yr	128
COW080	CITY	53.6	10.2	19.0	Pb	lbs/yr	1
COW080	CITY	53.6	10.2	19.0	TDS	lbs/yr	9,900
COW080	CITY	53.6	10.2	19.0	TKN	lbs/yr	437
COW080	CITY	53.6	10.2	19.0	TP	lbs/yr	153
COW080	CITY	53.6	10.2	19.0	TSS	lbs/yr	16,257
COW080	CITY	53.6	10.2	19.0	Zn	lbs/yr	87
COW085	CITY	49.8	9.5	19.0	Flow	(ac-ft/yr)	36
COW085	CITY	49.8	9.5	19.0	BOD	lbs/yr	1,936
COW085	CITY	49.8	9.5	19.0	Cd	lbs/yr	0
COW085	CITY	49.8	9.5	19.0	COD	lbs/yr	16,363
COW085	CITY	49.8	9.5	19.0	Cu	lbs/yr	9

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
COW085	CITY	49.8	9.5	19.0	DP	lbs/yr	27
COW085	CITY	49.8	9.5	19.0	NO2+NO3	lbs/yr	119
COW085	CITY	49.8	9.5	19.0	Pb	lbs/yr	1
COW085	CITY	49.8	9.5	19.0	TDS	lbs/yr	9,198
COW085	CITY	49.8	9.5	19.0	TKN	lbs/yr	406
COW085	CITY	49.8	9.5	19.0	TP	lbs/yr	142
COW085	CITY	49.8	9.5	19.0	TSS	lbs/yr	15,104
COW085	CITY	49.8	9.5	19.0	Zn	lbs/yr	80
COW090	CITY	103.2	25.8	25.0	Flow	(ac-ft/yr)	85
COW090	CITY	103.2	25.8	25.0	BOD	lbs/yr	4,183
COW090	CITY	103.2	25.8	25.0	Cd	lbs/yr	0
COW090	CITY	103.2	25.8	25.0	COD	lbs/yr	33,480
COW090	CITY	103.2	25.8	25.0	Cu	lbs/yr	18
COW090	CITY	103.2	25.8	25.0	DP	lbs/yr	63
COW090	CITY	103.2	25.8	25.0	NO2+NO3	lbs/yr	271
COW090	CITY	103.2	25.8	25.0	Pb	lbs/yr	13
COW090	CITY	103.2	25.8	25.0	TDS	lbs/yr	20,270
COW090	CITY	103.2	25.8	25.0	TKN	lbs/yr	823
COW090	CITY	103.2	25.8	25.0	TP	lbs/yr	287
COW090	CITY	103.2	25.8	25.0	TSS	lbs/yr	32,895
COW090	CITY	103.2	25.8	25.0	Zn	lbs/yr	233
COW100	CITY	74.0	31.0	41.9	Flow	(ac-ft/yr)	85
COW100	CITY	74.0	31.0	41.9	BOD	lbs/yr	3,402
COW100	CITY	74.0	31.0	41.9	Cd	lbs/yr	0
COW100	CITY	74.0	31.0	41.9	COD	lbs/yr	22,276
COW100	CITY	74.0	31.0	41.9	Cu	lbs/yr	12
COW100	CITY	74.0	31.0	41.9	DP	lbs/yr	56
COW100	CITY	74.0	31.0	41.9	NO2+NO3	lbs/yr	230
COW100	CITY	74.0	31.0	41.9	Pb	lbs/yr	32
COW100	CITY	74.0	31.0	41.9	TDS	lbs/yr	16,638
COW100	CITY	74.0	31.0	41.9	TKN	lbs/yr	527
COW100	CITY	74.0	31.0	41.9	TP	lbs/yr	177
COW100	CITY	74.0	31.0	41.9	TSS	lbs/yr	24,214
COW100	CITY	74.0	31.0	41.9	Zn	lbs/yr	275
COW110	CITY	112.5	34.9	31.0	Flow	(ac-ft/yr)	106
COW110	CITY	112.5	34.9	31.0	BOD	lbs/yr	4,746
COW110	CITY	112.5	34.9	31.0	Cd	lbs/yr	0

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
COW110	CITY	112.5	34.9	31.0	COD	lbs/yr	36,028
COW110	CITY	112.5	34.9	31.0	Cu	lbs/yr	20
COW110	CITY	112.5	34.9	31.0	DP	lbs/yr	76
COW110	CITY	112.5	34.9	31.0	NO2+NO3	lbs/yr	323
COW110	CITY	112.5	34.9	31.0	Pb	lbs/yr	25
COW110	CITY	112.5	34.9	31.0	TDS	lbs/yr	23,419
COW110	CITY	112.5	34.9	31.0	TKN	lbs/yr	878
COW110	CITY	112.5	34.9	31.0	TP	lbs/yr	305
COW110	CITY	112.5	34.9	31.0	TSS	lbs/yr	37,605
COW110	CITY	112.5	34.9	31.0	Zn	lbs/yr	326
COW120	CITY	57.1	13.1	23.0	Flow	(ac-ft/yr)	45
COW120	CITY	57.1	13.1	23.0	BOD	lbs/yr	2,306
COW120	CITY	57.1	13.1	23.0	Cd	lbs/yr	0
COW120	CITY	57.1	13.1	23.0	COD	lbs/yr	18,264
COW120	CITY	57.1	13.1	23.0	Cu	lbs/yr	10
COW120	CITY	57.1	13.1	23.0	DP	lbs/yr	33
COW120	CITY	57.1	13.1	23.0	NO2+NO3	lbs/yr	140
COW120	CITY	57.1	13.1	23.0	Pb	lbs/yr	6
COW120	CITY	57.1	13.1	23.0	TDS	lbs/yr	10,860
COW120	CITY	57.1	13.1	23.0	TKN	lbs/yr	448
COW120	CITY	57.1	13.1	23.0	TP	lbs/yr	155
COW120	CITY	57.1	13.1	23.0	TSS	lbs/yr	16,889
COW120	CITY	57.1	13.1	23.0	Zn	lbs/yr	107
COW130	CITY	19.3	3.7	19.0	Flow	(ac-ft/yr)	14
COW130	CITY	19.3	3.7	19.0	BOD	lbs/yr	750
COW130	CITY	19.3	3.7	19.0	Cd	lbs/yr	0
COW130	CITY	19.3	3.7	19.0	COD	lbs/yr	6,341
COW130	CITY	19.3	3.7	19.0	Cu	lbs/yr	3
COW130	CITY	19.3	3.7	19.0	DP	lbs/yr	11
COW130	CITY	19.3	3.7	19.0	NO2+NO3	lbs/yr	46
COW130	CITY	19.3	3.7	19.0	Pb	lbs/yr	1
COW130	CITY	19.3	3.7	19.0	TDS	lbs/yr	3,565
COW130	CITY	19.3	3.7	19.0	TKN	lbs/yr	157
COW130	CITY	19.3	3.7	19.0	TP	lbs/yr	55
COW130	CITY	19.3	3.7	19.0	TSS	lbs/yr	5,854
COW130	CITY	19.3	3.7	19.0	Zn	lbs/yr	31
COW140	CITY	63.9	13.8	21.6	Flow	(ac-ft/yr)	49

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
COW140	CITY	63.9	13.8	21.6	BOD	lbs/yr	2,602
COW140	CITY	63.9	13.8	21.6	Cd	lbs/yr	0
COW140	CITY	63.9	13.8	21.6	COD	lbs/yr	19,840
COW140	CITY	63.9	13.8	21.6	Cu	lbs/yr	10
COW140	CITY	63.9	13.8	21.6	DP	lbs/yr	33
COW140	CITY	63.9	13.8	21.6	NO2+NO3	lbs/yr	142
COW140	CITY	63.9	13.8	21.6	Pb	lbs/yr	7
COW140	CITY	63.9	13.8	21.6	TDS	lbs/yr	11,719
COW140	CITY	63.9	13.8	21.6	TKN	lbs/yr	483
COW140	CITY	63.9	13.8	21.6	TP	lbs/yr	164
COW140	CITY	63.9	13.8	21.6	TSS	lbs/yr	16,686
COW140	CITY	63.9	13.8	21.6	Zn	lbs/yr	91
COW145	CITY	79.2	15.8	20.0	Flow	(ac-ft/yr)	58
COW145	CITY	79.2	15.8	20.0	BOD	lbs/yr	3,132
COW145	CITY	79.2	15.8	20.0	Cd	lbs/yr	0
COW145	CITY	79.2	15.8	20.0	COD	lbs/yr	25,504
COW145	CITY	79.2	15.8	20.0	Cu	lbs/yr	13
COW145	CITY	79.2	15.8	20.0	DP	lbs/yr	42
COW145	CITY	79.2	15.8	20.0	NO2+NO3	lbs/yr	184
COW145	CITY	79.2	15.8	20.0	Pb	lbs/yr	4
COW145	CITY	79.2	15.8	20.0	TDS	lbs/yr	14,591
COW145	CITY	79.2	15.8	20.0	TKN	lbs/yr	628
COW145	CITY	79.2	15.8	20.0	TP	lbs/yr	218
COW145	CITY	79.2	15.8	20.0	TSS	lbs/yr	22,810
COW145	CITY	79.2	15.8	20.0	Zn	lbs/yr	123
COW150	CITY	121.3	44.9	37.0	Flow	(ac-ft/yr)	128
COW150	CITY	121.3	44.9	37.0	BOD	lbs/yr	5,317
COW150	CITY	121.3	44.9	37.0	Cd	lbs/yr	0
COW150	CITY	121.3	44.9	37.0	COD	lbs/yr	38,341
COW150	CITY	121.3	44.9	37.0	Cu	lbs/yr	22
COW150	CITY	121.3	44.9	37.0	DP	lbs/yr	90
COW150	CITY	121.3	44.9	37.0	NO2+NO3	lbs/yr	377
COW150	CITY	121.3	44.9	37.0	Pb	lbs/yr	39
COW150	CITY	121.3	44.9	37.0	TDS	lbs/yr	26,676
COW150	CITY	121.3	44.9	37.0	TKN	lbs/yr	926
COW150	CITY	121.3	44.9	37.0	TP	lbs/yr	320
COW150	CITY	121.3	44.9	37.0	TSS	lbs/yr	42,426
COW150	CITY	121.3	44.9	37.0	Zn	lbs/yr	429

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
COW160	CITY	44.1	33.5	76.0	Flow	(ac-ft/yr)	79
COW160	CITY	44.1	33.5	76.0	BOD	lbs/yr	2,406
COW160	CITY	44.1	33.5	76.0	Cd	lbs/yr	0
COW160	CITY	44.1	33.5	76.0	COD	lbs/yr	12,746
COW160	CITY	44.1	33.5	76.0	Cu	lbs/yr	8
COW160	CITY	44.1	33.5	76.0	DP	lbs/yr	52
COW160	CITY	44.1	33.5	76.0	NO2+NO3	lbs/yr	206
COW160	CITY	44.1	33.5	76.0	Pb	lbs/yr	42
COW160	CITY	44.1	33.5	76.0	TDS	lbs/yr	13,063
COW160	CITY	44.1	33.5	76.0	TKN	lbs/yr	288
COW160	CITY	44.1	33.5	76.0	TP	lbs/yr	95
COW160	CITY	44.1	33.5	76.0	TSS	lbs/yr	19,863
COW160	CITY	44.1	33.5	76.0	Zn	lbs/yr	339
COW170	CITY	46.0	22.5	49.0	Flow	(ac-ft/yr)	59
COW170	CITY	46.0	22.5	49.0	BOD	lbs/yr	2,168
COW170	CITY	46.0	22.5	49.0	Cd	lbs/yr	0
COW170	CITY	46.0	22.5	49.0	COD	lbs/yr	14,157
COW170	CITY	46.0	22.5	49.0	Cu	lbs/yr	8
COW170	CITY	46.0	22.5	49.0	DP	lbs/yr	40
COW170	CITY	46.0	22.5	49.0	NO2+NO3	lbs/yr	165
COW170	CITY	46.0	22.5	49.0	Pb	lbs/yr	24
COW170	CITY	46.0	22.5	49.0	TDS	lbs/yr	11,196
COW170	CITY	46.0	22.5	49.0	TKN	lbs/yr	336
COW170	CITY	46.0	22.5	49.0	TP	lbs/yr	114
COW170	CITY	46.0	22.5	49.0	TSS	lbs/yr	17,513
COW170	CITY	46.0	22.5	49.0	Zn	lbs/yr	221
COW180	CITY	32.9	6.3	19.0	Flow	(ac-ft/yr)	24
COW180	CITY	32.9	6.3	19.0	BOD	lbs/yr	1,279
COW180	CITY	32.9	6.3	19.0	Cd	lbs/yr	0
COW180	CITY	32.9	6.3	19.0	COD	lbs/yr	10,810
COW180	CITY	32.9	6.3	19.0	Cu	lbs/yr	6
COW180	CITY	32.9	6.3	19.0	DP	lbs/yr	18
COW180	CITY	32.9	6.3	19.0	NO2+NO3	lbs/yr	79
COW180	CITY	32.9	6.3	19.0	Pb	lbs/yr	1
COW180	CITY	32.9	6.3	19.0	TDS	lbs/yr	6,077
COW180	CITY	32.9	6.3	19.0	TKN	lbs/yr	268
COW180	CITY	32.9	6.3	19.0	TP	lbs/yr	94

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
COW180	CITY	32.9	6.3	19.0	TSS	lbs/yr	9,978
COW180	CITY	32.9	6.3	19.0	Zn	lbs/yr	53
COW185	CITY	62.6	11.9	19.0	Flow	(ac-ft/yr)	45
COW185	CITY	62.6	11.9	19.0	BOD	lbs/yr	2,434
COW185	CITY	62.6	11.9	19.0	Cd	lbs/yr	0
COW185	CITY	62.6	11.9	19.0	COD	lbs/yr	20,569
COW185	CITY	62.6	11.9	19.0	Cu	lbs/yr	11
COW185	CITY	62.6	11.9	19.0	DP	lbs/yr	34
COW185	CITY	62.6	11.9	19.0	NO2+NO3	lbs/yr	150
COW185	CITY	62.6	11.9	19.0	Pb	lbs/yr	2
COW185	CITY	62.6	11.9	19.0	TDS	lbs/yr	11,562
COW185	CITY	62.6	11.9	19.0	TKN	lbs/yr	510
COW185	CITY	62.6	11.9	19.0	TP	lbs/yr	179
COW185	CITY	62.6	11.9	19.0	TSS	lbs/yr	18,986
COW185	CITY	62.6	11.9	19.0	Zn	lbs/yr	101
COW190	CITY	153.5	33.4	21.8	Flow	(ac-ft/yr)	118
COW190	CITY	153.5	33.4	21.8	BOD	lbs/yr	6,110
COW190	CITY	153.5	33.4	21.8	Cd	lbs/yr	0
COW190	CITY	153.5	33.4	21.8	COD	lbs/yr	49,780
COW190	CITY	153.5	33.4	21.8	Cu	lbs/yr	27
COW190	CITY	153.5	33.4	21.8	DP	lbs/yr	87
COW190	CITY	153.5	33.4	21.8	NO2+NO3	lbs/yr	378
COW190	CITY	153.5	33.4	21.8	Pb	lbs/yr	12
COW190	CITY	153.5	33.4	21.8	TDS	lbs/yr	29,038
COW190	CITY	153.5	33.4	21.8	TKN	lbs/yr	1,227
COW190	CITY	153.5	33.4	21.8	TP	lbs/yr	428
COW190	CITY	153.5	33.4	21.8	TSS	lbs/yr	46,562
COW190	CITY	153.5	33.4	21.8	Zn	lbs/yr	283
COW200	CITY	23.6	13.7	57.9	Flow	(ac-ft/yr)	34
COW200	CITY	23.6	13.7	57.9	BOD	lbs/yr	1,170
COW200	CITY	23.6	13.7	57.9	Cd	lbs/yr	0
COW200	CITY	23.6	13.7	57.9	COD	lbs/yr	7,118
COW200	CITY	23.6	13.7	57.9	Cu	lbs/yr	4
COW200	CITY	23.6	13.7	57.9	DP	lbs/yr	23
COW200	CITY	23.6	13.7	57.9	NO2+NO3	lbs/yr	93
COW200	CITY	23.6	13.7	57.9	Pb	lbs/yr	16
COW200	CITY	23.6	13.7	57.9	TDS	lbs/yr	6,155

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
COW200	CITY	23.6	13.7	57.9	TKN	lbs/yr	166
COW200	CITY	23.6	13.7	57.9	TP	lbs/yr	56
COW200	CITY	23.6	13.7	57.9	TSS	lbs/yr	9,527
COW200	CITY	23.6	13.7	57.9	Zn	lbs/yr	136
COW210	CITY	67.3	43.1	64.0	Flow	(ac-ft/yr)	106
COW210	CITY	67.3	43.1	64.0	BOD	lbs/yr	3,450
COW210	CITY	67.3	43.1	64.0	Cd	lbs/yr	0
COW210	CITY	67.3	43.1	64.0	COD	lbs/yr	20,011
COW210	CITY	67.3	43.1	64.0	Cu	lbs/yr	13
COW210	CITY	67.3	43.1	64.0	DP	lbs/yr	70
COW210	CITY	67.3	43.1	64.0	NO2+NO3	lbs/yr	282
COW210	CITY	67.3	43.1	64.0	Pb	lbs/yr	51
COW210	CITY	67.3	43.1	64.0	TDS	lbs/yr	18,357
COW210	CITY	67.3	43.1	64.0	TKN	lbs/yr	462
COW210	CITY	67.3	43.1	64.0	TP	lbs/yr	155
COW210	CITY	67.3	43.1	64.0	TSS	lbs/yr	28,231
COW210	CITY	67.3	43.1	64.0	Zn	lbs/yr	431
COW220	CITY	31.3	23.8	75.9	Flow	(ac-ft/yr)	56
COW220	CITY	31.3	23.8	75.9	BOD	lbs/yr	1,707
COW220	CITY	31.3	23.8	75.9	Cd	lbs/yr	0
COW220	CITY	31.3	23.8	75.9	COD	lbs/yr	9,048
COW220	CITY	31.3	23.8	75.9	Cu	lbs/yr	6
COW220	CITY	31.3	23.8	75.9	DP	lbs/yr	37
COW220	CITY	31.3	23.8	75.9	NO2+NO3	lbs/yr	146
COW220	CITY	31.3	23.8	75.9	Pb	lbs/yr	30
COW220	CITY	31.3	23.8	75.9	TDS	lbs/yr	9,267
COW220	CITY	31.3	23.8	75.9	TKN	lbs/yr	204
COW220	CITY	31.3	23.8	75.9	TP	lbs/yr	67
COW220	CITY	31.3	23.8	75.9	TSS	lbs/yr	14,092
COW220	CITY	31.3	23.8	75.9	Zn	lbs/yr	240
COW230	CITY	66.4	24.6	37.0	Flow	(ac-ft/yr)	70
COW230	CITY	66.4	24.6	37.0	BOD	lbs/yr	2,910
COW230	CITY	66.4	24.6	37.0	Cd	lbs/yr	0
COW230	CITY	66.4	24.6	37.0	COD	lbs/yr	20,989
COW230	CITY	66.4	24.6	37.0	Cu	lbs/yr	12
COW230	CITY	66.4	24.6	37.0	DP	lbs/yr	49
COW230	CITY	66.4	24.6	37.0	NO2+NO3	lbs/yr	206

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
COW230	CITY	66.4	24.6	37.0	Pb	lbs/yr	21
COW230	CITY	66.4	24.6	37.0	TDS	lbs/yr	14,600
COW230	CITY	66.4	24.6	37.0	TKN	lbs/yr	507
COW230	CITY	66.4	24.6	37.0	TP	lbs/yr	175
COW230	CITY	66.4	24.6	37.0	TSS	lbs/yr	23,220
COW230	CITY	66.4	24.6	37.0	Zn	lbs/yr	234
COW240	CITY	105.8	23.3	22.0	Flow	(ac-ft/yr)	82
COW240	CITY	105.8	23.3	22.0	BOD	lbs/yr	4,201
COW240	CITY	105.8	23.3	22.0	Cd	lbs/yr	0
COW240	CITY	105.8	23.3	22.0	COD	lbs/yr	34,542
COW240	CITY	105.8	23.3	22.0	Cu	lbs/yr	19
COW240	CITY	105.8	23.3	22.0	DP	lbs/yr	61
COW240	CITY	105.8	23.3	22.0	NO2+NO3	lbs/yr	266
COW240	CITY	105.8	23.3	22.0	Pb	lbs/yr	8
COW240	CITY	105.8	23.3	22.0	TDS	lbs/yr	20,163
COW240	CITY	105.8	23.3	22.0	TKN	lbs/yr	853
COW240	CITY	105.8	23.3	22.0	TP	lbs/yr	298
COW240	CITY	105.8	23.3	22.0	TSS	lbs/yr	32,909
COW240	CITY	105.8	23.3	22.0	Zn	lbs/yr	205
COW250	CITY	39.5	7.5	19.0	Flow	(ac-ft/yr)	28
COW250	CITY	39.5	7.5	19.0	BOD	lbs/yr	1,536
COW250	CITY	39.5	7.5	19.0	Cd	lbs/yr	0
COW250	CITY	39.5	7.5	19.0	COD	lbs/yr	12,979
COW250	CITY	39.5	7.5	19.0	Cu	lbs/yr	7
COW250	CITY	39.5	7.5	19.0	DP	lbs/yr	22
COW250	CITY	39.5	7.5	19.0	NO2+NO3	lbs/yr	94
COW250	CITY	39.5	7.5	19.0	Pb	lbs/yr	1
COW250	CITY	39.5	7.5	19.0	TDS	lbs/yr	7,296
COW250	CITY	39.5	7.5	19.0	TKN	lbs/yr	322
COW250	CITY	39.5	7.5	19.0	TP	lbs/yr	113
COW250	CITY	39.5	7.5	19.0	TSS	lbs/yr	11,980
COW250	CITY	39.5	7.5	19.0	Zn	lbs/yr	64
COW260	CITY	92.3	17.5	19.0	Flow	(ac-ft/yr)	66
COW260	CITY	92.3	17.5	19.0	BOD	lbs/yr	3,589
COW260	CITY	92.3	17.5	19.0	Cd	lbs/yr	0
COW260	CITY	92.3	17.5	19.0	COD	lbs/yr	30,327
COW260	CITY	92.3	17.5	19.0	Cu	lbs/yr	16

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
COW260	CITY	92.3	17.5	19.0	DP	lbs/yr	50
COW260	CITY	92.3	17.5	19.0	NO2+NO3	lbs/yr	221
COW260	CITY	92.3	17.5	19.0	Pb	lbs/yr	2
COW260	CITY	92.3	17.5	19.0	TDS	lbs/yr	17,048
COW260	CITY	92.3	17.5	19.0	TKN	lbs/yr	752
COW260	CITY	92.3	17.5	19.0	TP	lbs/yr	264
COW260	CITY	92.3	17.5	19.0	TSS	lbs/yr	27,994
COW260	CITY	92.3	17.5	19.0	Zn	lbs/yr	149
COW270	CITY	135.6	25.8	19.0	Flow	(ac-ft/yr)	97
COW270	CITY	135.6	25.8	19.0	BOD	lbs/yr	5,273
COW270	CITY	135.6	25.8	19.0	Cd	lbs/yr	0
COW270	CITY	135.6	25.8	19.0	COD	lbs/yr	44,554
COW270	CITY	135.6	25.8	19.0	Cu	lbs/yr	24
COW270	CITY	135.6	25.8	19.0	DP	lbs/yr	74
COW270	CITY	135.6	25.8	19.0	NO2+NO3	lbs/yr	324
COW270	CITY	135.6	25.8	19.0	Pb	lbs/yr	4
COW270	CITY	135.6	25.8	19.0	TDS	lbs/yr	25,045
COW270	CITY	135.6	25.8	19.0	TKN	lbs/yr	1,105
COW270	CITY	135.6	25.8	19.0	TP	lbs/yr	388
COW270	CITY	135.6	25.8	19.0	TSS	lbs/yr	41,127
COW270	CITY	135.6	25.8	19.0	Zn	lbs/yr	219
COW280	CITY	132.5	19.2	14.5	Flow	(ac-ft/yr)	83
COW280	CITY	132.5	19.2	14.5	BOD	lbs/yr	4,535
COW280	CITY	132.5	19.2	14.5	Cd	lbs/yr	0
COW280	CITY	132.5	19.2	14.5	COD	lbs/yr	35,063
COW280	CITY	132.5	19.2	14.5	Cu	lbs/yr	18
COW280	CITY	132.5	19.2	14.5	DP	lbs/yr	64
COW280	CITY	132.5	19.2	14.5	NO2+NO3	lbs/yr	256
COW280	CITY	132.5	19.2	14.5	Pb	lbs/yr	3
COW280	CITY	132.5	19.2	14.5	TDS	lbs/yr	22,602
COW280	CITY	132.5	19.2	14.5	TKN	lbs/yr	863
COW280	CITY	132.5	19.2	14.5	TP	lbs/yr	336
COW280	CITY	132.5	19.2	14.5	TSS	lbs/yr	31,771
COW280	CITY	132.5	19.2	14.5	Zn	lbs/yr	161
COW285	CITY	90.6	17.2	19.0	Flow	(ac-ft/yr)	65
COW285	CITY	90.6	17.2	19.0	BOD	lbs/yr	3,523
COW285	CITY	90.6	17.2	19.0	Cd	lbs/yr	0

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
COW285	CITY	90.6	17.2	19.0	COD	lbs/yr	29,769
COW285	CITY	90.6	17.2	19.0	Cu	lbs/yr	16
COW285	CITY	90.6	17.2	19.0	DP	lbs/yr	49
COW285	CITY	90.6	17.2	19.0	NO2+NO3	lbs/yr	217
COW285	CITY	90.6	17.2	19.0	Pb	lbs/yr	2
COW285	CITY	90.6	17.2	19.0	TDS	lbs/yr	16,734
COW285	CITY	90.6	17.2	19.0	TKN	lbs/yr	738
COW285	CITY	90.6	17.2	19.0	TP	lbs/yr	259
COW285	CITY	90.6	17.2	19.0	TSS	lbs/yr	27,479
COW285	CITY	90.6	17.2	19.0	Zn	lbs/yr	146
COW290	CITY	79.7	15.1	19.0	Flow	(ac-ft/yr)	57
COW290	CITY	79.7	15.1	19.0	BOD	lbs/yr	3,099
COW290	CITY	79.7	15.1	19.0	Cd	lbs/yr	0
COW290	CITY	79.7	15.1	19.0	COD	lbs/yr	26,187
COW290	CITY	79.7	15.1	19.0	Cu	lbs/yr	14
COW290	CITY	79.7	15.1	19.0	DP	lbs/yr	43
COW290	CITY	79.7	15.1	19.0	NO2+NO3	lbs/yr	191
COW290	CITY	79.7	15.1	19.0	Pb	lbs/yr	2
COW290	CITY	79.7	15.1	19.0	TDS	lbs/yr	14,721
COW290	CITY	79.7	15.1	19.0	TKN	lbs/yr	649
COW290	CITY	79.7	15.1	19.0	TP	lbs/yr	228
COW290	CITY	79.7	15.1	19.0	TSS	lbs/yr	24,173
COW290	CITY	79.7	15.1	19.0	Zn	lbs/yr	129
COW295	CITY	41.6	7.9	19.0	Flow	(ac-ft/yr)	30
COW295	CITY	41.6	7.9	19.0	BOD	lbs/yr	1,618
COW295	CITY	41.6	7.9	19.0	Cd	lbs/yr	0
COW295	CITY	41.6	7.9	19.0	COD	lbs/yr	13,669
COW295	CITY	41.6	7.9	19.0	Cu	lbs/yr	7
COW295	CITY	41.6	7.9	19.0	DP	lbs/yr	23
COW295	CITY	41.6	7.9	19.0	NO2+NO3	lbs/yr	99
COW295	CITY	41.6	7.9	19.0	Pb	lbs/yr	1
COW295	CITY	41.6	7.9	19.0	TDS	lbs/yr	7,684
COW295	CITY	41.6	7.9	19.0	TKN	lbs/yr	339
COW295	CITY	41.6	7.9	19.0	TP	lbs/yr	119
COW295	CITY	41.6	7.9	19.0	TSS	lbs/yr	12,617
COW295	CITY	41.6	7.9	19.0	Zn	lbs/yr	67
COW300	CITY	200.0	34.6	17.3	Flow	(ac-ft/yr)	137

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
COW300	CITY	200.0	34.6	17.3	BOD	lbs/yr	7,518
COW300	CITY	200.0	34.6	17.3	Cd	lbs/yr	0
COW300	CITY	200.0	34.6	17.3	COD	lbs/yr	52,888
COW300	CITY	200.0	34.6	17.3	Cu	lbs/yr	25
COW300	CITY	200.0	34.6	17.3	DP	lbs/yr	90
COW300	CITY	200.0	34.6	17.3	NO2+NO3	lbs/yr	392
COW300	CITY	200.0	34.6	17.3	Pb	lbs/yr	15
COW300	CITY	200.0	34.6	17.3	TDS	lbs/yr	34,817
COW300	CITY	200.0	34.6	17.3	TKN	lbs/yr	1,259
COW300	CITY	200.0	34.6	17.3	TP	lbs/yr	429
COW300	CITY	200.0	34.6	17.3	TSS	lbs/yr	45,414
COW300	CITY	200.0	34.6	17.3	Zn	lbs/yr	232
COW310	CITY	52.4	6.3	12.0	Flow	(ac-ft/yr)	30
COW310	CITY	52.4	6.3	12.0	BOD	lbs/yr	1,434
COW310	CITY	52.4	6.3	12.0	Cd	lbs/yr	0
COW310	CITY	52.4	6.3	12.0	COD	lbs/yr	8,812
COW310	CITY	52.4	6.3	12.0	Cu	lbs/yr	3
COW310	CITY	52.4	6.3	12.0	DP	lbs/yr	25
COW310	CITY	52.4	6.3	12.0	NO2+NO3	lbs/yr	53
COW310	CITY	52.4	6.3	12.0	Pb	lbs/yr	5
COW310	CITY	52.4	6.3	12.0	TDS	lbs/yr	7,731
COW310	CITY	52.4	6.3	12.0	TKN	lbs/yr	223
COW310	CITY	52.4	6.3	12.0	TP	lbs/yr	134
COW310	CITY	52.4	6.3	12.0	TSS	lbs/yr	5,434
COW310	CITY	52.4	6.3	12.0	Zn	lbs/yr	28
COW320	CITY	119.6	16.5	13.8	Flow	(ac-ft/yr)	74
COW320	CITY	119.6	16.5	13.8	BOD	lbs/yr	4,100
COW320	CITY	119.6	16.5	13.8	Cd	lbs/yr	0
COW320	CITY	119.6	16.5	13.8	COD	lbs/yr	20,897
COW320	CITY	119.6	16.5	13.8	Cu	lbs/yr	7
COW320	CITY	119.6	16.5	13.8	DP	lbs/yr	40
COW320	CITY	119.6	16.5	13.8	NO2+NO3	lbs/yr	160
COW320	CITY	119.6	16.5	13.8	Pb	lbs/yr	15
COW320	CITY	119.6	16.5	13.8	TDS	lbs/yr	18,851
COW320	CITY	119.6	16.5	13.8	TKN	lbs/yr	456
COW320	CITY	119.6	16.5	13.8	TP	lbs/yr	160
COW320	CITY	119.6	16.5	13.8	TSS	lbs/yr	14,930
COW320	CITY	119.6	16.5	13.8	Zn	lbs/yr	65

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
COW330	CITY	91.2	0.9	1.0	Flow	(ac-ft/yr)	34
COW330	CITY	91.2	0.9	1.0	BOD	lbs/yr	1,076
COW330	CITY	91.2	0.9	1.0	Cd	lbs/yr	0
COW330	CITY	91.2	0.9	1.0	COD	lbs/yr	6,586
COW330	CITY	91.2	0.9	1.0	Cu	lbs/yr	0
COW330	CITY	91.2	0.9	1.0	DP	lbs/yr	49
COW330	CITY	91.2	0.9	1.0	NO2+NO3	lbs/yr	9
COW330	CITY	91.2	0.9	1.0	Pb	lbs/yr	0
COW330	CITY	91.2	0.9	1.0	TDS	lbs/yr	10,575
COW330	CITY	91.2	0.9	1.0	TKN	lbs/yr	226
COW330	CITY	91.2	0.9	1.0	TP	lbs/yr	314
COW330	CITY	91.2	0.9	1.0	TSS	lbs/yr	1,104
COW330	CITY	91.2	0.9	1.0	Zn	lbs/yr	0
COW340	CITY	179.7	1.8	1.0	Flow	(ac-ft/yr)	67
COW340	CITY	179.7	1.8	1.0	BOD	lbs/yr	2,120
COW340	CITY	179.7	1.8	1.0	Cd	lbs/yr	0
COW340	CITY	179.7	1.8	1.0	COD	lbs/yr	12,978
COW340	CITY	179.7	1.8	1.0	Cu	lbs/yr	0
COW340	CITY	179.7	1.8	1.0	DP	lbs/yr	97
COW340	CITY	179.7	1.8	1.0	NO2+NO3	lbs/yr	18
COW340	CITY	179.7	1.8	1.0	Pb	lbs/yr	0
COW340	CITY	179.7	1.8	1.0	TDS	lbs/yr	20,838
COW340	CITY	179.7	1.8	1.0	TKN	lbs/yr	446
COW340	CITY	179.7	1.8	1.0	TP	lbs/yr	618
COW340	CITY	179.7	1.8	1.0	TSS	lbs/yr	2,175
COW340	CITY	179.7	1.8	1.0	Zn	lbs/yr	0
COW350	CITY	62.9	1.2	1.9	Flow	(ac-ft/yr)	25
COW350	CITY	62.9	1.2	1.9	BOD	lbs/yr	826
COW350	CITY	62.9	1.2	1.9	Cd	lbs/yr	0
COW350	CITY	62.9	1.2	1.9	COD	lbs/yr	5,337
COW350	CITY	62.9	1.2	1.9	Cu	lbs/yr	1
COW350	CITY	62.9	1.2	1.9	DP	lbs/yr	34
COW350	CITY	62.9	1.2	1.9	NO2+NO3	lbs/yr	13
COW350	CITY	62.9	1.2	1.9	Pb	lbs/yr	0
COW350	CITY	62.9	1.2	1.9	TDS	lbs/yr	7,507
COW350	CITY	62.9	1.2	1.9	TKN	lbs/yr	174
COW350	CITY	62.9	1.2	1.9	TP	lbs/yr	214

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
COW350	CITY	62.9	1.2	1.9	TSS	lbs/yr	1,664
COW350	CITY	62.9	1.2	1.9	Zn	lbs/yr	5
GVI010	COUNTY	639.1	6.4	1.0	Flow	(ac-ft/yr)	239
GVI010	COUNTY	639.1	6.4	1.0	BOD	lbs/yr	7,541
GVI010	COUNTY	639.1	6.4	1.0	Cd	lbs/yr	0
GVI010	COUNTY	639.1	6.4	1.0	COD	lbs/yr	46,155
GVI010	COUNTY	639.1	6.4	1.0	Cu	lbs/yr	0
GVI010	COUNTY	639.1	6.4	1.0	DP	lbs/yr	345
GVI010	COUNTY	639.1	6.4	1.0	NO2+NO3	lbs/yr	65
GVI010	COUNTY	639.1	6.4	1.0	Pb	lbs/yr	0
GVI010	COUNTY	639.1	6.4	1.0	TDS	lbs/yr	74,109
GVI010	COUNTY	639.1	6.4	1.0	TKN	lbs/yr	1,586
GVI010	COUNTY	639.1	6.4	1.0	TP	lbs/yr	2,197
GVI010	COUNTY	639.1	6.4	1.0	TSS	lbs/yr	7,736
GVI010	COUNTY	639.1	6.4	1.0	Zn	lbs/yr	0
GVI020	COUNTY	391.4	3.9	1.0	Flow	(ac-ft/yr)	146
GVI020	COUNTY	391.4	3.9	1.0	BOD	lbs/yr	4,618
GVI020	COUNTY	391.4	3.9	1.0	Cd	lbs/yr	0
GVI020	COUNTY	391.4	3.9	1.0	COD	lbs/yr	28,267
GVI020	COUNTY	391.4	3.9	1.0	Cu	lbs/yr	0
GVI020	COUNTY	391.4	3.9	1.0	DP	lbs/yr	211
GVI020	COUNTY	391.4	3.9	1.0	NO2+NO3	lbs/yr	40
GVI020	COUNTY	391.4	3.9	1.0	Pb	lbs/yr	0
GVI020	COUNTY	391.4	3.9	1.0	TDS	lbs/yr	45,386
GVI020	COUNTY	391.4	3.9	1.0	TKN	lbs/yr	971
GVI020	COUNTY	391.4	3.9	1.0	TP	lbs/yr	1,346
GVI020	COUNTY	391.4	3.9	1.0	TSS	lbs/yr	4,738
GVI020	COUNTY	391.4	3.9	1.0	Zn	lbs/yr	0
GVI030	COUNTY	647.6	6.5	1.0	Flow	(ac-ft/yr)	242
GVI030	COUNTY	647.6	6.5	1.0	BOD	lbs/yr	7,641
GVI030	COUNTY	647.6	6.5	1.0	Cd	lbs/yr	0
GVI030	COUNTY	647.6	6.5	1.0	COD	lbs/yr	46,769
GVI030	COUNTY	647.6	6.5	1.0	Cu	lbs/yr	0
GVI030	COUNTY	647.6	6.5	1.0	DP	lbs/yr	349
GVI030	COUNTY	647.6	6.5	1.0	NO2+NO3	lbs/yr	66
GVI030	COUNTY	647.6	6.5	1.0	Pb	lbs/yr	0
GVI030	COUNTY	647.6	6.5	1.0	TDS	lbs/yr	75,094

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
GVI030	COUNTY	647.6	6.5	1.0	TKN	lbs/yr	1,607
GVI030	COUNTY	647.6	6.5	1.0	TP	lbs/yr	2,226
GVI030	COUNTY	647.6	6.5	1.0	TSS	lbs/yr	7,839
GVI030	COUNTY	647.6	6.5	1.0	Zn	lbs/yr	0
GVI040	COUNTY	418.5	9.5	2.3	Flow	(ac-ft/yr)	167
GVI040	COUNTY	418.5	9.5	2.3	BOD	lbs/yr	5,732
GVI040	COUNTY	418.5	9.5	2.3	Cd	lbs/yr	0
GVI040	COUNTY	418.5	9.5	2.3	COD	lbs/yr	37,735
GVI040	COUNTY	418.5	9.5	2.3	Cu	lbs/yr	5
GVI040	COUNTY	418.5	9.5	2.3	DP	lbs/yr	226
GVI040	COUNTY	418.5	9.5	2.3	NO2+NO3	lbs/yr	110
GVI040	COUNTY	418.5	9.5	2.3	Pb	lbs/yr	1
GVI040	COUNTY	418.5	9.5	2.3	TDS	lbs/yr	50,542
GVI040	COUNTY	418.5	9.5	2.3	TKN	lbs/yr	1,205
GVI040	COUNTY	418.5	9.5	2.3	TP	lbs/yr	1,422
GVI040	COUNTY	418.5	9.5	2.3	TSS	lbs/yr	13,598
GVI040	COUNTY	418.5	9.5	2.3	Zn	lbs/yr	47
GVI040	CITY	653.3	6.5	1.0	Flow	(ac-ft/yr)	244
GVI040	CITY	653.3	6.5	1.0	BOD	lbs/yr	7,708
GVI040	CITY	653.3	6.5	1.0	Cd	lbs/yr	0
GVI040	CITY	653.3	6.5	1.0	COD	lbs/yr	47,181
GVI040	CITY	653.3	6.5	1.0	Cu	lbs/yr	0
GVI040	CITY	653.3	6.5	1.0	DP	lbs/yr	352
GVI040	CITY	653.3	6.5	1.0	NO2+NO3	lbs/yr	66
GVI040	CITY	653.3	6.5	1.0	Pb	lbs/yr	0
GVI040	CITY	653.3	6.5	1.0	TDS	lbs/yr	75,755
GVI040	CITY	653.3	6.5	1.0	TKN	lbs/yr	1,621
GVI040	CITY	653.3	6.5	1.0	TP	lbs/yr	2,246
GVI040	CITY	653.3	6.5	1.0	TSS	lbs/yr	7,908
GVI040	CITY	653.3	6.5	1.0	Zn	lbs/yr	0
GVI060	CITY	643.3	6.4	1.0	Flow	(ac-ft/yr)	241
GVI060	CITY	643.3	6.4	1.0	BOD	lbs/yr	7,590
GVI060	CITY	643.3	6.4	1.0	Cd	lbs/yr	0
GVI060	CITY	643.3	6.4	1.0	COD	lbs/yr	46,459
GVI060	CITY	643.3	6.4	1.0	Cu	lbs/yr	0
GVI060	CITY	643.3	6.4	1.0	DP	lbs/yr	347
GVI060	CITY	643.3	6.4	1.0	NO2+NO3	lbs/yr	65

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
GVI060	CITY	643.3	6.4	1.0	Pb	lbs/yr	0
GVI060	CITY	643.3	6.4	1.0	TDS	lbs/yr	74,596
GVI060	CITY	643.3	6.4	1.0	TKN	lbs/yr	1,597
GVI060	CITY	643.3	6.4	1.0	TP	lbs/yr	2,212
GVI060	CITY	643.3	6.4	1.0	TSS	lbs/yr	7,787
GVI060	CITY	643.3	6.4	1.0	Zn	lbs/yr	0
GVI070	COUNTY	839.8	8.4	1.0	Flow	(ac-ft/yr)	314
GVI070	COUNTY	839.8	8.4	1.0	BOD	lbs/yr	9,909
GVI070	COUNTY	839.8	8.4	1.0	Cd	lbs/yr	0
GVI070	COUNTY	839.8	8.4	1.0	COD	lbs/yr	60,650
GVI070	COUNTY	839.8	8.4	1.0	Cu	lbs/yr	0
GVI070	COUNTY	839.8	8.4	1.0	DP	lbs/yr	453
GVI070	COUNTY	839.8	8.4	1.0	NO2+NO3	lbs/yr	85
GVI070	COUNTY	839.8	8.4	1.0	Pb	lbs/yr	0
GVI070	COUNTY	839.8	8.4	1.0	TDS	lbs/yr	97,381
GVI070	COUNTY	839.8	8.4	1.0	TKN	lbs/yr	2,084
GVI070	COUNTY	839.8	8.4	1.0	TP	lbs/yr	2,887
GVI070	COUNTY	839.8	8.4	1.0	TSS	lbs/yr	10,165
GVI070	COUNTY	839.8	8.4	1.0	Zn	lbs/yr	0
GVI080	COUNTY	499.9	18.5	3.7	Flow	(ac-ft/yr)	213
GVI080	COUNTY	499.9	18.5	3.7	BOD	lbs/yr	6,705
GVI080	COUNTY	499.9	18.5	3.7	Cd	lbs/yr	1
GVI080	COUNTY	499.9	18.5	3.7	COD	lbs/yr	41,039
GVI080	COUNTY	499.9	18.5	3.7	Cu	lbs/yr	1
GVI080	COUNTY	499.9	18.5	3.7	DP	lbs/yr	242
GVI080	COUNTY	499.9	18.5	3.7	NO2+NO3	lbs/yr	229
GVI080	COUNTY	499.9	18.5	3.7	Pb	lbs/yr	5
GVI080	COUNTY	499.9	18.5	3.7	TDS	lbs/yr	65,893
GVI080	COUNTY	499.9	18.5	3.7	TKN	lbs/yr	1,177
GVI080	COUNTY	499.9	18.5	3.7	TP	lbs/yr	1,453
GVI080	COUNTY	499.9	18.5	3.7	TSS	lbs/yr	13,354
GVI080	COUNTY	499.9	18.5	3.7	Zn	lbs/yr	4
GVI090	COUNTY	201.4	10.5	5.2	Flow	(ac-ft/yr)	91
GVI090	COUNTY	201.4	10.5	5.2	BOD	lbs/yr	2,882
GVI090	COUNTY	201.4	10.5	5.2	Cd	lbs/yr	0
GVI090	COUNTY	201.4	10.5	5.2	COD	lbs/yr	17,638
GVI090	COUNTY	201.4	10.5	5.2	Cu	lbs/yr	0

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
GVI090	COUNTY	201.4	10.5	5.2	DP	lbs/yr	91
GVI090	COUNTY	201.4	10.5	5.2	NO2+NO3	lbs/yr	132
GVI090	COUNTY	201.4	10.5	5.2	Pb	lbs/yr	3
GVI090	COUNTY	201.4	10.5	5.2	TDS	lbs/yr	28,321
GVI090	COUNTY	201.4	10.5	5.2	TKN	lbs/yr	460
GVI090	COUNTY	201.4	10.5	5.2	TP	lbs/yr	526
GVI090	COUNTY	201.4	10.5	5.2	TSS	lbs/yr	7,014
GVI090	COUNTY	201.4	10.5	5.2	Zn	lbs/yr	3
GVI100	COUNTY	558.7	5.6	1.0	Flow	(ac-ft/yr)	209
GVI100	COUNTY	558.7	5.6	1.0	BOD	lbs/yr	6,592
GVI100	COUNTY	558.7	5.6	1.0	Cd	lbs/yr	0
GVI100	COUNTY	558.7	5.6	1.0	COD	lbs/yr	40,349
GVI100	COUNTY	558.7	5.6	1.0	Cu	lbs/yr	0
GVI100	COUNTY	558.7	5.6	1.0	DP	lbs/yr	301
GVI100	COUNTY	558.7	5.6	1.0	NO2+NO3	lbs/yr	57
GVI100	COUNTY	558.7	5.6	1.0	Pb	lbs/yr	0
GVI100	COUNTY	558.7	5.6	1.0	TDS	lbs/yr	64,786
GVI100	COUNTY	558.7	5.6	1.0	TKN	lbs/yr	1,387
GVI100	COUNTY	558.7	5.6	1.0	TP	lbs/yr	1,921
GVI100	COUNTY	558.7	5.6	1.0	TSS	lbs/yr	6,763
GVI100	COUNTY	558.7	5.6	1.0	Zn	lbs/yr	0
GVI110	COUNTY	313.8	3.1	1.0	Flow	(ac-ft/yr)	117
GVI110	COUNTY	313.8	3.1	1.0	BOD	lbs/yr	3,703
GVI110	COUNTY	313.8	3.1	1.0	Cd	lbs/yr	0
GVI110	COUNTY	313.8	3.1	1.0	COD	lbs/yr	22,662
GVI110	COUNTY	313.8	3.1	1.0	Cu	lbs/yr	0
GVI110	COUNTY	313.8	3.1	1.0	DP	lbs/yr	169
GVI110	COUNTY	313.8	3.1	1.0	NO2+NO3	lbs/yr	32
GVI110	COUNTY	313.8	3.1	1.0	Pb	lbs/yr	0
GVI110	COUNTY	313.8	3.1	1.0	TDS	lbs/yr	36,387
GVI110	COUNTY	313.8	3.1	1.0	TKN	lbs/yr	779
GVI110	COUNTY	313.8	3.1	1.0	TP	lbs/yr	1,079
GVI110	COUNTY	313.8	3.1	1.0	TSS	lbs/yr	3,798
GVI110	COUNTY	313.8	3.1	1.0	Zn	lbs/yr	0
GVI120	CITY	217.1	23.3	10.7	Flow	(ac-ft/yr)	121
GVI120	CITY	217.1	23.3	10.7	BOD	lbs/yr	3,826
GVI120	CITY	217.1	23.3	10.7	Cd	lbs/yr	1

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
GVI120	CITY	217.1	23.3	10.7	COD	lbs/yr	23,418
GVI120	CITY	217.1	23.3	10.7	Cu	lbs/yr	1
GVI120	CITY	217.1	23.3	10.7	DP	lbs/yr	74
GVI120	CITY	217.1	23.3	10.7	NO2+NO3	lbs/yr	301
GVI120	CITY	217.1	23.3	10.7	Pb	lbs/yr	7
GVI120	CITY	217.1	23.3	10.7	TDS	lbs/yr	37,601
GVI120	CITY	217.1	23.3	10.7	TKN	lbs/yr	439
GVI120	CITY	217.1	23.3	10.7	TP	lbs/yr	329
GVI120	CITY	217.1	23.3	10.7	TSS	lbs/yr	14,077
GVI120	CITY	217.1	23.3	10.7	Zn	lbs/yr	6
GVI130	CITY	176.5	83.0	47.0	Flow	(ac-ft/yr)	220
GVI130	CITY	176.5	83.0	47.0	BOD	lbs/yr	5,938
GVI130	CITY	176.5	83.0	47.0	Cd	lbs/yr	1
GVI130	CITY	176.5	83.0	47.0	COD	lbs/yr	59,209
GVI130	CITY	176.5	83.0	47.0	Cu	lbs/yr	26
GVI130	CITY	176.5	83.0	47.0	DP	lbs/yr	270
GVI130	CITY	176.5	83.0	47.0	NO2+NO3	lbs/yr	353
GVI130	CITY	176.5	83.0	47.0	Pb	lbs/yr	10
GVI130	CITY	176.5	83.0	47.0	TDS	lbs/yr	39,840
GVI130	CITY	176.5	83.0	47.0	TKN	lbs/yr	1,113
GVI130	CITY	176.5	83.0	47.0	TP	lbs/yr	480
GVI130	CITY	176.5	83.0	47.0	TSS	lbs/yr	75,295
GVI130	CITY	176.5	83.0	47.0	Zn	lbs/yr	194
GVI140	CITY	321.0	50.8	15.8	Flow	(ac-ft/yr)	210
GVI140	CITY	321.0	50.8	15.8	BOD	lbs/yr	6,047
GVI140	CITY	321.0	50.8	15.8	Cd	lbs/yr	1
GVI140	CITY	321.0	50.8	15.8	COD	lbs/yr	50,408
GVI140	CITY	321.0	50.8	15.8	Cu	lbs/yr	15
GVI140	CITY	321.0	50.8	15.8	DP	lbs/yr	275
GVI140	CITY	321.0	50.8	15.8	NO2+NO3	lbs/yr	229
GVI140	CITY	321.0	50.8	15.8	Pb	lbs/yr	6
GVI140	CITY	321.0	50.8	15.8	TDS	lbs/yr	48,575
GVI140	CITY	321.0	50.8	15.8	TKN	lbs/yr	1,192
GVI140	CITY	321.0	50.8	15.8	TP	lbs/yr	1,029
GVI140	CITY	321.0	50.8	15.8	TSS	lbs/yr	46,755
GVI140	CITY	321.0	50.8	15.8	Zn	lbs/yr	114
GVI150	CITY	257.6	30.9	12.0	Flow	(ac-ft/yr)	150

Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
GVI150	CITY	257.6	30.9	12.0	BOD	lbs/yr	4,437
GVI150	CITY	257.6	30.9	12.0	Cd	lbs/yr	1
GVI150	CITY	257.6	30.9	12.0	COD	lbs/yr	33,947
GVI150	CITY	257.6	30.9	12.0	Cu	lbs/yr	8
GVI150	CITY	257.6	30.9	12.0	DP	lbs/yr	182
GVI150	CITY	257.6	30.9	12.0	NO2+NO3	lbs/yr	182
GVI150	CITY	257.6	30.9	12.0	Pb	lbs/yr	5
GVI150	CITY	257.6	30.9	12.0	TDS	lbs/yr	38,114
GVI150	CITY	257.6	30.9	12.0	TKN	lbs/yr	819
GVI150	CITY	257.6	30.9	12.0	TP	lbs/yr	764
GVI150	CITY	257.6	30.9	12.0	TSS	lbs/yr	27,130
GVI150	CITY	257.6	30.9	12.0	Zn	lbs/yr	59
GVI160	CITY	240.5	19.0	7.9	Flow	(ac-ft/yr)	121
GVI160	CITY	240.5	19.0	7.9	BOD	lbs/yr	3,829
GVI160	CITY	240.5	19.0	7.9	Cd	lbs/yr	1
GVI160	CITY	240.5	19.0	7.9	COD	lbs/yr	23,435
GVI160	CITY	240.5	19.0	7.9	Cu	lbs/yr	1
GVI160	CITY	240.5	19.0	7.9	DP	lbs/yr	96
GVI160	CITY	240.5	19.0	7.9	NO2+NO3	lbs/yr	243
GVI160	CITY	240.5	19.0	7.9	Pb	lbs/yr	6
GVI160	CITY	240.5	19.0	7.9	TDS	lbs/yr	37,628
GVI160	CITY	240.5	19.0	7.9	TKN	lbs/yr	518
GVI160	CITY	240.5	19.0	7.9	TP	lbs/yr	500
GVI160	CITY	240.5	19.0	7.9	TSS	lbs/yr	11,885
GVI160	CITY	240.5	19.0	7.9	Zn	lbs/yr	5
GVI170	COUNTY	471.2	25.9	5.5	Flow	(ac-ft/yr)	216
GVI170	COUNTY	471.2	25.9	5.5	BOD	lbs/yr	6,827
GVI170	COUNTY	471.2	25.9	5.5	Cd	lbs/yr	1
GVI170	COUNTY	471.2	25.9	5.5	COD	lbs/yr	41,785
GVI170	COUNTY	471.2	25.9	5.5	Cu	lbs/yr	1
GVI170	COUNTY	471.2	25.9	5.5	DP	lbs/yr	211
GVI170	COUNTY	471.2	25.9	5.5	NO2+NO3	lbs/yr	327
GVI170	COUNTY	471.2	25.9	5.5	Pb	lbs/yr	7
GVI170	COUNTY	471.2	25.9	5.5	TDS	lbs/yr	67,092
GVI170	COUNTY	471.2	25.9	5.5	TKN	lbs/yr	1,069
GVI170	COUNTY	471.2	25.9	5.5	TP	lbs/yr	1,202
GVI170	COUNTY	471.2	25.9	5.5	TSS	lbs/yr	17,177
GVI170	COUNTY	471.2	25.9	5.5	Zn	lbs/yr	6

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
GVI180	COUNTY	246.2	33.4	13.6	Flow	(ac-ft/yr)	151
GVI180	COUNTY	246.2	33.4	13.6	BOD	lbs/yr	6,272
GVI180	COUNTY	246.2	33.4	13.6	Cd	lbs/yr	0
GVI180	COUNTY	246.2	33.4	13.6	COD	lbs/yr	28,371
GVI180	COUNTY	246.2	33.4	13.6	Cu	lbs/yr	2
GVI180	COUNTY	246.2	33.4	13.6	DP	lbs/yr	119
GVI180	COUNTY	246.2	33.4	13.6	NO2+NO3	lbs/yr	112
GVI180	COUNTY	246.2	33.4	13.6	Pb	lbs/yr	49
GVI180	COUNTY	246.2	33.4	13.6	TDS	lbs/yr	33,521
GVI180	COUNTY	246.2	33.4	13.6	TKN	lbs/yr	731
GVI180	COUNTY	246.2	33.4	13.6	TP	lbs/yr	625
GVI180	COUNTY	246.2	33.4	13.6	TSS	lbs/yr	2,011
GVI180	COUNTY	246.2	33.4	13.6	Zn	lbs/yr	24
GVI185	CITY	206.7	20.9	10.1	Flow	(ac-ft/yr)	113
GVI185	CITY	206.7	20.9	10.1	BOD	lbs/yr	3,938
GVI185	CITY	206.7	20.9	10.1	Cd	lbs/yr	1
GVI185	CITY	206.7	20.9	10.1	COD	lbs/yr	21,628
GVI185	CITY	206.7	20.9	10.1	Cu	lbs/yr	1
GVI185	CITY	206.7	20.9	10.1	DP	lbs/yr	85
GVI185	CITY	206.7	20.9	10.1	NO2+NO3	lbs/yr	189
GVI185	CITY	206.7	20.9	10.1	Pb	lbs/yr	16
GVI185	CITY	206.7	20.9	10.1	TDS	lbs/yr	31,751
GVI185	CITY	206.7	20.9	10.1	TKN	lbs/yr	490
GVI185	CITY	206.7	20.9	10.1	TP	lbs/yr	436
GVI185	CITY	206.7	20.9	10.1	TSS	lbs/yr	8,299
GVI185	CITY	206.7	20.9	10.1	Zn	lbs/yr	9
GVI190	CITY	155.3	17.5	11.3	Flow	(ac-ft/yr)	88
GVI190	CITY	155.3	17.5	11.3	BOD	lbs/yr	3,343
GVI190	CITY	155.3	17.5	11.3	Cd	lbs/yr	1
GVI190	CITY	155.3	17.5	11.3	COD	lbs/yr	23,559
GVI190	CITY	155.3	17.5	11.3	Cu	lbs/yr	7
GVI190	CITY	155.3	17.5	11.3	DP	lbs/yr	64
GVI190	CITY	155.3	17.5	11.3	NO2+NO3	lbs/yr	223
GVI190	CITY	155.3	17.5	11.3	Pb	lbs/yr	4
GVI190	CITY	155.3	17.5	11.3	TDS	lbs/yr	26,101
GVI190	CITY	155.3	17.5	11.3	TKN	lbs/yr	533
GVI190	CITY	155.3	17.5	11.3	TP	lbs/yr	321

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
GVI190	CITY	155.3	17.5	11.3	TSS	lbs/yr	17,129
GVI190	CITY	155.3	17.5	11.3	Zn	lbs/yr	58
GVI200	CITY	130.6	17.8	13.6	Flow	(ac-ft/yr)	80
GVI200	CITY	130.6	17.8	13.6	BOD	lbs/yr	2,524
GVI200	CITY	130.6	17.8	13.6	Cd	lbs/yr	1
GVI200	CITY	130.6	17.8	13.6	COD	lbs/yr	15,449
GVI200	CITY	130.6	17.8	13.6	Cu	lbs/yr	1
GVI200	CITY	130.6	17.8	13.6	DP	lbs/yr	37
GVI200	CITY	130.6	17.8	13.6	NO2+NO3	lbs/yr	230
GVI200	CITY	130.6	17.8	13.6	Pb	lbs/yr	5
GVI200	CITY	130.6	17.8	13.6	TDS	lbs/yr	24,805
GVI200	CITY	130.6	17.8	13.6	TKN	lbs/yr	246
GVI200	CITY	130.6	17.8	13.6	TP	lbs/yr	125
GVI200	CITY	130.6	17.8	13.6	TSS	lbs/yr	10,482
GVI200	CITY	130.6	17.8	13.6	Zn	lbs/yr	5
GVI210	CITY	136.2	23.8	17.5	Flow	(ac-ft/yr)	94
GVI210	CITY	136.2	23.8	17.5	BOD	lbs/yr	4,062
GVI210	CITY	136.2	23.8	17.5	Cd	lbs/yr	1
GVI210	CITY	136.2	23.8	17.5	COD	lbs/yr	31,029
GVI210	CITY	136.2	23.8	17.5	Cu	lbs/yr	13
GVI210	CITY	136.2	23.8	17.5	DP	lbs/yr	53
GVI210	CITY	136.2	23.8	17.5	NO2+NO3	lbs/yr	304
GVI210	CITY	136.2	23.8	17.5	Pb	lbs/yr	5
GVI210	CITY	136.2	23.8	17.5	TDS	lbs/yr	26,472
GVI210	CITY	136.2	23.8	17.5	TKN	lbs/yr	675
GVI210	CITY	136.2	23.8	17.5	TP	lbs/yr	228
GVI210	CITY	136.2	23.8	17.5	TSS	lbs/yr	27,004
GVI210	CITY	136.2	23.8	17.5	Zn	lbs/yr	113
GVI220	CITY	78.6	12.6	16.0	Flow	(ac-ft/yr)	52
GVI220	CITY	78.6	12.6	16.0	BOD	lbs/yr	1,632
GVI220	CITY	78.6	12.6	16.0	Cd	lbs/yr	1
GVI220	CITY	78.6	12.6	16.0	COD	lbs/yr	9,988
GVI220	CITY	78.6	12.6	16.0	Cu	lbs/yr	1
GVI220	CITY	78.6	12.6	16.0	DP	lbs/yr	18
GVI220	CITY	78.6	12.6	16.0	NO2+NO3	lbs/yr	163
GVI220	CITY	78.6	12.6	16.0	Pb	lbs/yr	4
GVI220	CITY	78.6	12.6	16.0	TDS	lbs/yr	16,036

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
GVI220	CITY	78.6	12.6	16.0	TKN	lbs/yr	139
GVI220	CITY	78.6	12.6	16.0	TP	lbs/yr	38
GVI220	CITY	78.6	12.6	16.0	TSS	lbs/yr	7,329
GVI220	CITY	78.6	12.6	16.0	Zn	lbs/yr	4
GVI230	CITY	82.0	13.1	16.0	Flow	(ac-ft/yr)	54
GVI230	CITY	82.0	13.1	16.0	BOD	lbs/yr	1,702
GVI230	CITY	82.0	13.1	16.0	Cd	lbs/yr	1
GVI230	CITY	82.0	13.1	16.0	COD	lbs/yr	10,420
GVI230	CITY	82.0	13.1	16.0	Cu	lbs/yr	1
GVI230	CITY	82.0	13.1	16.0	DP	lbs/yr	19
GVI230	CITY	82.0	13.1	16.0	NO2+NO3	lbs/yr	170
GVI230	CITY	82.0	13.1	16.0	Pb	lbs/yr	4
GVI230	CITY	82.0	13.1	16.0	TDS	lbs/yr	16,730
GVI230	CITY	82.0	13.1	16.0	TKN	lbs/yr	145
GVI230	CITY	82.0	13.1	16.0	TP	lbs/yr	40
GVI230	CITY	82.0	13.1	16.0	TSS	lbs/yr	7,646
GVI230	CITY	82.0	13.1	16.0	Zn	lbs/yr	4
GVI240	CITY	76.9	12.3	16.0	Flow	(ac-ft/yr)	51
GVI240	CITY	76.9	12.3	16.0	BOD	lbs/yr	1,596
GVI240	CITY	76.9	12.3	16.0	Cd	lbs/yr	1
GVI240	CITY	76.9	12.3	16.0	COD	lbs/yr	9,772
GVI240	CITY	76.9	12.3	16.0	Cu	lbs/yr	1
GVI240	CITY	76.9	12.3	16.0	DP	lbs/yr	18
GVI240	CITY	76.9	12.3	16.0	NO2+NO3	lbs/yr	160
GVI240	CITY	76.9	12.3	16.0	Pb	lbs/yr	4
GVI240	CITY	76.9	12.3	16.0	TDS	lbs/yr	15,690
GVI240	CITY	76.9	12.3	16.0	TKN	lbs/yr	136
GVI240	CITY	76.9	12.3	16.0	TP	lbs/yr	37
GVI240	CITY	76.9	12.3	16.0	TSS	lbs/yr	7,170
GVI240	CITY	76.9	12.3	16.0	Zn	lbs/yr	3
GVI250	CITY	194.2	1.9	1.0	Flow	(ac-ft/yr)	73
GVI250	CITY	194.2	1.9	1.0	BOD	lbs/yr	2,291
GVI250	CITY	194.2	1.9	1.0	Cd	lbs/yr	0
GVI250	CITY	194.2	1.9	1.0	COD	lbs/yr	14,025
GVI250	CITY	194.2	1.9	1.0	Cu	lbs/yr	0
GVI250	CITY	194.2	1.9	1.0	DP	lbs/yr	105
GVI250	CITY	194.2	1.9	1.0	NO2+NO3	lbs/yr	20

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
GVI250	CITY	194.2	1.9	1.0	Pb	lbs/yr	0
GVI250	CITY	194.2	1.9	1.0	TDS	lbs/yr	22,519
GVI250	CITY	194.2	1.9	1.0	TKN	lbs/yr	482
GVI250	CITY	194.2	1.9	1.0	TP	lbs/yr	668
GVI250	CITY	194.2	1.9	1.0	TSS	lbs/yr	2,351
GVI250	CITY	194.2	1.9	1.0	Zn	lbs/yr	0
GVI260	CITY	66.9	2.8	4.1	Flow	(ac-ft/yr)	29
GVI260	CITY	66.9	2.8	4.1	BOD	lbs/yr	915
GVI260	CITY	66.9	2.8	4.1	Cd	lbs/yr	0
GVI260	CITY	66.9	2.8	4.1	COD	lbs/yr	5,599
GVI260	CITY	66.9	2.8	4.1	Cu	lbs/yr	0
GVI260	CITY	66.9	2.8	4.1	DP	lbs/yr	32
GVI260	CITY	66.9	2.8	4.1	NO2+NO3	lbs/yr	34
GVI260	CITY	66.9	2.8	4.1	Pb	lbs/yr	1
GVI260	CITY	66.9	2.8	4.1	TDS	lbs/yr	8,991
GVI260	CITY	66.9	2.8	4.1	TKN	lbs/yr	156
GVI260	CITY	66.9	2.8	4.1	TP	lbs/yr	189
GVI260	CITY	66.9	2.8	4.1	TSS	lbs/yr	1,946
GVI260	CITY	66.9	2.8	4.1	Zn	lbs/yr	1
GVI270	CITY	84.2	0.8	1.0	Flow	(ac-ft/yr)	31
GVI270	CITY	84.2	0.8	1.0	BOD	lbs/yr	993
GVI270	CITY	84.2	0.8	1.0	Cd	lbs/yr	0
GVI270	CITY	84.2	0.8	1.0	COD	lbs/yr	6,081
GVI270	CITY	84.2	0.8	1.0	Cu	lbs/yr	0
GVI270	CITY	84.2	0.8	1.0	DP	lbs/yr	45
GVI270	CITY	84.2	0.8	1.0	NO2+NO3	lbs/yr	9
GVI270	CITY	84.2	0.8	1.0	Pb	lbs/yr	0
GVI270	CITY	84.2	0.8	1.0	TDS	lbs/yr	9,764
GVI270	CITY	84.2	0.8	1.0	TKN	lbs/yr	209
GVI270	CITY	84.2	0.8	1.0	TP	lbs/yr	289
GVI270	CITY	84.2	0.8	1.0	TSS	lbs/yr	1,019
GVI270	CITY	84.2	0.8	1.0	Zn	lbs/yr	0
GVI280	CITY	245.0	10.1	4.1	Flow	(ac-ft/yr)	106
GVI280	CITY	245.0	10.1	4.1	BOD	lbs/yr	3,254
GVI280	CITY	245.0	10.1	4.1	Cd	lbs/yr	0
GVI280	CITY	245.0	10.1	4.1	COD	lbs/yr	22,068
GVI280	CITY	245.0	10.1	4.1	Cu	lbs/yr	2

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
GVI280	CITY	245.0	10.1	4.1	DP	lbs/yr	149
GVI280	CITY	245.0	10.1	4.1	NO2+NO3	lbs/yr	56
GVI280	CITY	245.0	10.1	4.1	Pb	lbs/yr	1
GVI280	CITY	245.0	10.1	4.1	TDS	lbs/yr	30,233
GVI280	CITY	245.0	10.1	4.1	TKN	lbs/yr	672
GVI280	CITY	245.0	10.1	4.1	TP	lbs/yr	830
GVI280	CITY	245.0	10.1	4.1	TSS	lbs/yr	9,853
GVI280	CITY	245.0	10.1	4.1	Zn	lbs/yr	18
GVI290	CITY	379.8	86.9	22.9	Flow	(ac-ft/yr)	300
GVI290	CITY	379.8	86.9	22.9	BOD	lbs/yr	12,441
GVI290	CITY	379.8	86.9	22.9	Cd	lbs/yr	2
GVI290	CITY	379.8	86.9	22.9	COD	lbs/yr	96,469
GVI290	CITY	379.8	86.9	22.9	Cu	lbs/yr	41
GVI290	CITY	379.8	86.9	22.9	DP	lbs/yr	215
GVI290	CITY	379.8	86.9	22.9	NO2+NO3	lbs/yr	846
GVI290	CITY	379.8	86.9	22.9	Pb	lbs/yr	20
GVI290	CITY	379.8	86.9	22.9	TDS	lbs/yr	75,635
GVI290	CITY	379.8	86.9	22.9	TKN	lbs/yr	2,029
GVI290	CITY	379.8	86.9	22.9	TP	lbs/yr	653
GVI290	CITY	379.8	86.9	22.9	TSS	lbs/yr	93,631
GVI290	CITY	379.8	86.9	22.9	Zn	lbs/yr	355
GVI300	CITY	178.3	1.8	1.0	Flow	(ac-ft/yr)	67
GVI300	CITY	178.3	1.8	1.0	BOD	lbs/yr	2,479
GVI300	CITY	178.3	1.8	1.0	Cd	lbs/yr	0
GVI300	CITY	178.3	1.8	1.0	COD	lbs/yr	12,893
GVI300	CITY	178.3	1.8	1.0	Cu	lbs/yr	0
GVI300	CITY	178.3	1.8	1.0	DP	lbs/yr	86
GVI300	CITY	178.3	1.8	1.0	NO2+NO3	lbs/yr	39
GVI300	CITY	178.3	1.8	1.0	Pb	lbs/yr	0
GVI300	CITY	178.3	1.8	1.0	TDS	lbs/yr	21,218
GVI300	CITY	178.3	1.8	1.0	TKN	lbs/yr	403
GVI300	CITY	178.3	1.8	1.0	TP	lbs/yr	530
GVI300	CITY	178.3	1.8	1.0	TSS	lbs/yr	3,799
GVI300	CITY	178.3	1.8	1.0	Zn	lbs/yr	0
GVI310	CITY	235.9	30.0	12.7	Flow	(ac-ft/yr)	141
GVI310	CITY	235.9	30.0	12.7	BOD	lbs/yr	4,094
GVI310	CITY	235.9	30.0	12.7	Cd	lbs/yr	0

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
GVI310	CITY	235.9	30.0	12.7	COD	lbs/yr	32,836
GVI310	CITY	235.9	30.0	12.7	Cu	lbs/yr	9
GVI310	CITY	235.9	30.0	12.7	DP	lbs/yr	187
GVI310	CITY	235.9	30.0	12.7	NO2+NO3	lbs/yr	138
GVI310	CITY	235.9	30.0	12.7	Pb	lbs/yr	4
GVI310	CITY	235.9	30.0	12.7	TDS	lbs/yr	33,942
GVI310	CITY	235.9	30.0	12.7	TKN	lbs/yr	815
GVI310	CITY	235.9	30.0	12.7	TP	lbs/yr	768
GVI310	CITY	235.9	30.0	12.7	TSS	lbs/yr	27,734
GVI310	CITY	235.9	30.0	12.7	Zn	lbs/yr	66
GVI320	CITY	173.6	64.9	37.4	Flow	(ac-ft/yr)	185
GVI320	CITY	173.6	64.9	37.4	BOD	lbs/yr	5,260
GVI320	CITY	173.6	64.9	37.4	Cd	lbs/yr	1
GVI320	CITY	173.6	64.9	37.4	COD	lbs/yr	45,156
GVI320	CITY	173.6	64.9	37.4	Cu	lbs/yr	16
GVI320	CITY	173.6	64.9	37.4	DP	lbs/yr	157
GVI320	CITY	173.6	64.9	37.4	NO2+NO3	lbs/yr	434
GVI320	CITY	173.6	64.9	37.4	Pb	lbs/yr	12
GVI320	CITY	173.6	64.9	37.4	TDS	lbs/yr	41,203
GVI320	CITY	173.6	64.9	37.4	TKN	lbs/yr	732
GVI320	CITY	173.6	64.9	37.4	TP	lbs/yr	186
GVI320	CITY	173.6	64.9	37.4	TSS	lbs/yr	52,864
GVI320	CITY	173.6	64.9	37.4	Zn	lbs/yr	115
GVI330	CITY	66.4	21.9	33.0	Flow	(ac-ft/yr)	65
GVI330	CITY	66.4	21.9	33.0	BOD	lbs/yr	1,791
GVI330	CITY	66.4	21.9	33.0	Cd	lbs/yr	0
GVI330	CITY	66.4	21.9	33.0	COD	lbs/yr	16,935
GVI330	CITY	66.4	21.9	33.0	Cu	lbs/yr	7
GVI330	CITY	66.4	21.9	33.0	DP	lbs/yr	81
GVI330	CITY	66.4	21.9	33.0	NO2+NO3	lbs/yr	94
GVI330	CITY	66.4	21.9	33.0	Pb	lbs/yr	3
GVI330	CITY	66.4	21.9	33.0	TDS	lbs/yr	12,762
GVI330	CITY	66.4	21.9	33.0	TKN	lbs/yr	341
GVI330	CITY	66.4	21.9	33.0	TP	lbs/yr	195
GVI330	CITY	66.4	21.9	33.0	TSS	lbs/yr	19,919
GVI330	CITY	66.4	21.9	33.0	Zn	lbs/yr	51
GVI340	CITY	145.2	4.6	3.2	Flow	(ac-ft/yr)	60

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Hutchinson-Existing Stormwater Loads (lbs/yr)

Name	Jurisdiction	Tributary Area (acres)	DCIA Area (acres)	% DCIA	Parameter	Units	Storm Water
GVI340	CITY	145.2	4.6	3.2	BOD	lbs/yr	2,185
GVI340	CITY	145.2	4.6	3.2	Cd	lbs/yr	0
GVI340	CITY	145.2	4.6	3.2	COD	lbs/yr	14,947
GVI340	CITY	145.2	4.6	3.2	Cu	lbs/yr	3
GVI340	CITY	145.2	4.6	3.2	DP	lbs/yr	78
GVI340	CITY	145.2	4.6	3.2	NO2+NO3	lbs/yr	55
GVI340	CITY	145.2	4.6	3.2	Pb	lbs/yr	0
GVI340	CITY	145.2	4.6	3.2	TDS	lbs/yr	18,033
GVI340	CITY	145.2	4.6	3.2	TKN	lbs/yr	459
GVI340	CITY	145.2	4.6	3.2	TP	lbs/yr	489
GVI340	CITY	145.2	4.6	3.2	TSS	lbs/yr	6,824
GVI340	CITY	145.2	4.6	3.2	Zn	lbs/yr	28

Appendix C
Water Quality
Best Management Practices

Appendix C

Best Management Practices (BMPs) are techniques, approaches, or designs that promote sound use and protection of natural resources. The following BMPs were evaluated for application in the City.

Structural Stormwater Controls

Extended Dry Detention Ponds
Wet Detention Ponds
Exfiltration Trenches
Shallow Grassed Swales
Retention Ponds
Alternative Pervious Parking Surfaces
Water Quality Inlets
Underdrains and Stormwater Filter Systems
Alum Injection Systems
Aeration
Storage/Treatment Facilities (e.g., oil and grease skimmers)

Nonstructural Source Controls

Public Information Programs
Stormwater Management Ordinance Requirements
Fertilizer Application Controls
Pesticide Use Controls
Solid Waste Management
Street Sweeping
Aquifer Recharge and DCIA Minimization
Illicit Connections (non-stormwater discharges) Identification and Removal
Control of Illegal Dumping
Erosion and Sediment
Source Control on Construction Sites

This appendix compares the BMPs considered for use in the City for the treatment and management of stormwater runoff. The use of a specific BMP depends on the site conditions and objectives such as water quality protection, flood control, aquifer recharge, or volume control. In many cases, there are multiple goals or needs for a given project. Therefore, BMPs can be "mixed and matched" to develop a "treatment train". This treatment train concept maximizes the use of available site conditions from the point of runoff generation to the receiving water discharge in order to maximize water quantity (flood control), water quality (pollutant load reduction), aquifer recharge, and wetlands benefits. **Figure C-1** shows a schematic flowchart of the treatment train concept. The following comparative discussion of BMPs concentrates on structural controls screened for applications in the City.

Comparison of Structural BMPs

Extended Dry Detention Ponds

Extended dry detention ponds combine the beneficial features of retention ponds (dry, grassed bottom) and wet detention ponds (detain flood waters and high pollutant removal efficiencies for settleable solids) in a hybrid design. However, they do not necessarily use certain valuable features of retention ponds (volume control and aquifer recharge) or wet detention ponds (high dissolved nutrient removal efficiencies) unless they are designed with some upstream retention prior to detention or they incorporate a small permanent pool, respectively. These systems require the water table to be below the surface, but do not need highly permeable soils. These systems are desirable for the removal of toxic solids in industrial area retrofits or where a detention system is desired without a permanent pool.

Extended dry detention ponds increase detention times to provide treatment for the captured first-flush runoff in order to enhance solids settling and the removal of suspended pollutants. Extended detention facilities are drawn down through a control structure at a rate that is slow enough to achieve maximum pollutant removal by sedimentation. These types of detention ponds can be designed to achieve heavy metal loading reductions (e.g., 75 percent for lead and 40 percent for zinc) that are similar to wet detention ponds, since heavy metals in urban runoff tend to be primarily in suspended form. However, wet detention pond BMPs can achieve greater loading reductions for nutrients, which tend to appear primarily in dissolved form in urban runoff. Extended dry detention ponds require much less storage and cost less than wet detention ponds because they rely solely upon sedimentation processes without the expense of additional storage for the pool (i.e., portion of the pond that holds water at all times). However, in many retrofit cases, a certain fixed amount of open water area typically needs to be excavated to reduce flooding. Since this area needs to be at least six feet deep to discourage undesirable aquatic weeds, some wet detention will occur as an additional benefit. Therefore, the most cost-effective solution in many cases will be a combination of a wet detention pond with extended dry detention.

Potential Benefits of an Extended Detention Pond

- Reduction of downstream flooding problems by attenuating the peak rate of flow
- Reduction in pollutant loadings to receiving bodies of water for suspended pollutants
- Reduction in cost for downstream conveyance facilities
- Creation of fill that can be used on site or sold
- Low frequency of failure as compared with filtration systems

Potential Limitations of an Extended Detention Pond

- Do not remove dissolved pollutants unless a permanent pool is included
- Potential safety hazards if not designed and constructed properly

- No permanent pool to store sediment inflow
- Occasional nuisance problems such as debris and mosquitoes
- Regular maintenance is required to prevent nuisance plant species from emerging

Wet Detention Ponds

Detention refers to the temporary storage of excess runoff onsite prior to its gradual release after the peak of the storm inflow has passed. Runoff is held for a period of time and is slowly released to a natural or man-made watercourse, usually at a rate no greater than the pre-development peak discharge rate. For water quantity, detention facilities will not reduce the total volume of runoff but will redistribute the rate of runoff over a longer period of time by providing temporary storage for the stormwater. Another objective of a wet detention facility is to remove urban pollutants produced from the tributary area.

A wet detention system includes a permanent pool of water, a shallow littoral zone with aquatic plants (or a larger permanent pool with no littoral zone), and the capacity to provide detention for an extended time necessary for the treatment of a required volume of runoff. In wet detention ponds, pollutant removal occurs primarily within a permanent pool during the period of time between storm events. They are typically sized to provide a 2-week (or 3-week with no littoral zone) hydraulic residence time during the wet season. The primary mechanism for the removal of particulate forms of pollutants in wet detention ponds is sedimentation. Wet detention ponds can also achieve substantial reductions in soluble nutrients due to biological and physical/chemical processes within the permanent pool as shown on **Figure C-2.** The facility consists of a permanent storage pool (i.e., section of the pond which holds water at all times), and for new developments or where site conditions allow, an overlying zone of temporary storage to accommodate increases in the depth of water resulting from runoff. As shown on **Figure C-2**, pollutant removal within the wet detention pond can be attributed to the following important pollutant removal processes that occur within the permanent pool: uptake of nutrients by algae and rooted aquatic plants; adsorption of nutrients and heavy metals onto bottom sediments; biological oxidation of organic materials; and sedimentation of suspended solids and attached pollutants.

Uptake by algae and rooted aquatic plants is probably the most important process for the removal of nutrients. Sedimentation and adsorption onto bottom sediments is probably the most important removal mechanism for heavy metals. Adsorption conditions at the bottom of the permanent pool will maximize the uptake of phosphorus and heavy metals by bottom sediments and minimize pollutant releases from the sediments into the water column. Since ponds that exhibit thermal stratification (i.e., separation of the permanent pool into an upper layer of high temperature and a lower layer of low temperature) are likely to exhibit anaerobic bottom waters during the summer months, relatively shallow (6 to 12 feet deep) permanent pools that maximize vertical mixing are preferable to relatively deep ponds. Another consideration for depth is to ensure that the pond is deep enough to prohibit nuisance aquatic plant species in the open water portion of the pond.

Wet detention BMPs do offer some other advantages which should be considered in BMP selection. Wet detention ponds are usually more attractive looking than dry ponds, particularly if there is desirable wetland vegetation around the perimeter of the permanent pool. When properly designed and constructed, wet detention ponds are actually considered as property value amenities in many areas. Also, wet detention ponds offer the advantage that sediment and debris accumulate within the permanent pool. Since these accumulations are out-of-sight and well below the pond outlet, wet detention ponds tend to require less frequent clean-outs to maintain an attractive appearance and prevent clogging.

If the contributing area is too small, storm runoff and dry weather inflows into the wet detention ponds may be too small to maintain a permanent pool during "dry" seasons. While excessive drawdown of the permanent pool does not pose a nonpoint pollution control problem, it may cause aesthetic problems.

While wet detention ponds may be designed to produce new wetland systems and additional water quality protection may justify potential wetlands impacts, extreme care and precaution must be exercised where stormwater treatment is provided through the use of existing wetlands. In these cases, the pond should be designed to re-establish wetland benefits to impacted wetlands and some swale pretreatment of pollutants should be provided.

Potential Benefits of a Wet Detention Pond

- Reduction of downstream flooding problems by attenuating the peak rate of flow
- Reduction in pollutant loadings to receiving waters for dissolved and suspended pollutants
- Reduction in cost for downstream conveyance facilities
- Creation of local wildlife habitat
- Possible higher property values for lots adjacent to properly designed and constructed ponds
- Creation of fill which can be used on site or sold
- Low frequency of failure as compared with filtration systems
- Can be used in areas with high water tables and less permeable soils

Potential Limitations of a Wet Detention Pond

- Potential safety hazards if not designed and constructed properly
- Occasional nuisance problems such as odors, algae, debris, and mosquitoes
- Regular maintenance of the littoral zone is required to prevent nuisance plant species from dominating this zone
- Eventual need for sediment removal from the permanent pool

Exfiltration Trenches

An exfiltration trench is the onsite retention of stormwater accomplished through underground exfiltration. The subsurface retention facilities are commonly excavated trenches with perforated pipe, backfilled with coarse graded aggregate. Stormwater runoff is collected for temporary storage and infiltration. Water is exfiltrated from the pipe and trench walls for groundwater recharge and treatment. The addition of the pipe increases the storage available in the system and helps promote infiltration by causing the runoff waters to be more effectively and evenly distributed over the entire length of the trench.

Exfiltration trenches are used to retain the "first flush" of stormwater runoff. This promotes pollutant load reductions to receiving waters, reduces the runoff volume and peak discharge rate from a site, filters suspended pollutants out of groundwater discharges, and promotes the recharge of groundwater.

Exfiltration trenches are practical in highly permeable soils (Hydrologic Group A) where the subsoil is sufficiently permeable to provide a reasonable rate of infiltration, and where the water table is sufficiently lower than the design depth of the facility to allow for recovery of the storage prior to the next storm event (generally required in 72 hours). This practice can be used where space is limited and land is expensive. It is frequently used for the disposal of runoff from roof drains, parking lots, and roadways. This practice is not recommended where runoff water contains high concentrations of suspended materials unless a presettling or filtering mechanism is provided. Likewise, grease and oil traps are also highly recommended prior to discharge to these systems. Providing sediment sumps in inlets or raising inlet tops above grade for pretreatment in swales will reduce sediment buildup in the trench. These precautions are primarily for maintenance since exfiltration systems are very susceptible to clogging and sediment buildup, which reduces their hydraulic efficiency and storage capacity to unacceptable levels. **Figure C-3** shows a profile view of a typical exfiltration trench.

Potential Benefits of an Exfiltration Trench

- They mimic the natural groundwater recharge capabilities of the site
- Are relatively easy to fit into the margins, perimeters, and other space-constrained areas of a development site, including under pavement
- Can provide off-line treatment for environmentally sensitive waters
- Can be used to retrofit already developed sites where space is limited

Potential Limitations of an Exfiltration Trench

- Require highly permeable soils to function properly
- Difficulties in keeping sediment out of the structure during site construction
- Not recommended for clay or highly erodible soils

- Have relative short life spans before replacement or extensive restoration/maintenance of system is required

Shallow Grassed Swales

Shallow grassed swales or grassed waterways are natural or constructed shallow trenches shaped or gradually graded to required dimensions and established in suitable vegetation for the safe conveyance, storage, and treatment of runoff. A swale may be defined as a man-made trench that:

- Has a top width-to-depth ratio of the cross section equal to or greater than 6:1, or side slopes equal to or greater than 3 feet horizontal to 1 foot vertical

- Contains contiguous areas of standing or flowing water only following a rainfall event

- Is planted with or has stabilized vegetation suitable for soil stabilization, stormwater treatment, and nutrient uptake

- Is designed to take into account the soil erodibility, soil percolation, slope length, and drainage area to prevent erosion and reduce the pollutant concentration of any discharge

Swales are normally used for conveyance systems to transport runoff off site or to a stormwater facility. They are best suited at sites with soils of moderate to high infiltration capacity (Hydrologic Group A, B, or C soils). With slight modification (e.g., check dams, raised inlets, or swale blocks), swales can be used to add storage or conveyance, control erosion, provide aquifer recharge, and/or reduce the pollutant load from concentrated stormwater runoff in urban areas (A or B soils). They also may be used as pretreatment in the overall treatment train stormwater system. Implementation examples of swales include: outlet channels from detention and filtration systems; stormwater collection and treatment along roadways or residential areas; and pretreatment to reduce stormwater pollutant loads before conveying stormwater off site. **Figure C-4** shows an example of a typical swale, and **Figure C-5** shows a typical check dam which can be used to modify a swale to provide retention/ detention benefits.

Potential Benefits of Shallow Grassed Swales

- Usually less expensive than installing curb and gutters

- Hardly noticeable if shallow swales are designed and constructed with gradual slopes

- Can provide off-line treatment for environmentally sensitive waters

- Can reduce peak rates of discharge by storing, detaining, or attenuating flows

- Can reduce the volume of runoff discharged from a site by infiltrating runoff

- Maintenance can be performed by the adjacent owner

- Can be used in space-constrained areas such as along lot lines, rear of lots, and along roadsides
- Can be used as pretreatment or water quality treatment with other BMPs in a treatment train
- Recovers storage and treatment volumes quickly where soils are permeable

Potential Limitations of Shallow Grassed Swales

- Effective only as a conveyance system in unsuitable soils
- Possible nuisances such as odors, mosquitoes, nuisance plant species can occur if not designed and constructed properly
- Aesthetically unpleasing if improperly designed and constructed (deep with steep side slopes - looks like a ditch)
- Difficult to provide stormwater attenuation and water quality volume for sites with a high percentage of impervious area unless soils are highly permeable and adequate land is available

Swales perform as infiltration BMPs in areas with permeable soils that are not restricted by a high water table. These retention controls can be very effective where suitable conditions exist (e.g., with Hydrologic Group A soils and a low water table), and these are recommended for recharge requirements on Hydrologic Group A soils, whenever possible.

Infiltration Basins and Retention Basins

A retention basin is an infiltration system designed to retain stormwater onsite, thus reducing pollution, recharging groundwater, and controlling flood waters. Typically, these basins have dry bottoms covered with native grasses. The site characteristics where retention basins function best are where soils are highly permeable, and the seasonal high water table is situated well below the soil surface (at least 2 to 3 feet below pond bottom). These systems can be incorporated into multi-purpose park areas when designed with very gradual slopes. As discussed earlier, retention basins need to be inspected regularly to check for infiltration capacity. **Figure C-6** shows a profile view of a typical retention basin.

Infiltration controls are typically best suited for onsite applications where the water table is low, soils are highly permeable, and the contributing area is limited to a single development site or subdivision (e.g., 1 to 50 acres). To be effective, retention controls must be an integral part of the initial design and construction of a site. However, retention BMPs may be suitable for use at individual urban redevelopment or retrofit sites within the watershed.

The application of retention BMPs should be considered on a case-by-case basis within the study area where soils and water table conditions are suitable (e.g., sands hills area).

Potential Benefits of a Retention Basin

- Mimics the natural water balance of a site by promoting groundwater recharge close to the point of runoff generation
- Can provide off-line treatment for environmentally sensitive waters
- Reduces peak rate and volume of flood discharge by retaining water onsite
- Can be used as sediment traps during the construction phase of a project
- Are reasonably cost-effective in comparison with other BMPs for both construction and maintenance costs (where soils are favorable)
- Effectively reduces pollutant loadings to receiving waters

Potential Limitations of a Retention Basin

- Requires well-drained soils to function properly
- Unsuitable soils limit drawdown capacity, thereby reducing pollutant removal and flood control capacity
- Soluble pollutants can be conveyed into groundwater
- Possible nuisances such as odors, mosquitoes, and nuisance vegetation can occur if not designed and constructed properly

Alternate Pervious Parking Surfaces

Porous Pavement

A porous pavement generally consists of a layer of porous or pervious concrete overlying an underground reservoir filled with stone aggregates. It is mainly designed to treat rainfall that falls on the pavement. After stormwater runoff infiltrates through the pavement, it is collected in reservoirs where it infiltrates into the subsoil. Porous pavements are typically used in the construction of parking lots where they constitute a built-in stormwater treatment device.

The design of a porous pavement can be modified to enable the system to accept runoff from surrounding areas and rooftops. This modification includes the installation of perforated inflow pipes to distribute the runoff throughout the stone reservoir. In addition, a pretreatment system is needed to remove trash, sediment, oil, and grease to prevent them from clogging the reservoirs.

Potential Benefits of Porous Pavement

The cost-effectiveness of porous pavement can be estimated by determining the additional expenses incurred for constructing a parking lot with a porous pavement instead of conventional pavement, and by deducting the savings resulting from reduced land consumption and elimination of the need for additional BMPs. Porous pavements reduce stormwater volumes discharged to surface waters, thereby reducing pollutant loadings and increasing groundwater recharge.

This is achieved by:

- Sorption
- Trapping and Straining
- Bacterial Reduction
- Groundwater Diversion

Potential Limitations of Porous Pavement

Porous pavements are not intended for the removal of coarse particulate pollutants, however, they are efficient in the removal of fine particulate pollutants. An estimate of cost-effectiveness can be made on a case-by-case basis only, because of variables such as parking lot dimension, site size, amount of offsite runoff, and pretreatment requirements. In general, porous pavements are more cost-effective on sites between 1/4 acre and 10 acres in size.

The construction of a porous pavement system requires that rigorous construction practices be implemented. Adequate field testing and subgrade preparation are required before construction. Sediment control is needed before, during, and after construction.

Porous pavements are best suited for sites with the following features:

- Infiltration rate greater than 0.27 inch per hour
- Soil with clay content less than 30 percent
- Slope less than 5 percent
- Minimum of 2- to 4-foot clearance between the bottom of the reservoir and the seasonally high water table

Water Quality Inlets and Baffle Boxes

Water quality inlets include oil/water separators, grit chambers, and baffle boxes. They are designed to prevent sediment, oil, and grease from entering storm drains and stormwater infiltration systems.

Two basic designs are described by Schueler (MWCOG, 1987): the Montgomery County design and the Rockville design.

- The Montgomery County design consists of a rectangular concrete box divided into three chambers where sediment, grit, and oil are separated from stormwater runoff as it passes through the chambers before exiting through an outlet to the storm drain system. The first chamber is designed for sediment trapping, and the second chamber is designed for oil separation. Each chamber contains a permanent pool and is accessible through manhole covers.

- The Rockville design also consists of three chambers. However, runoff is allowed to exfiltrate into the subsoil through weep holes located at the bottom of the chambers. These holes prevent the formation of permanent pools and provide additional pollutant removal through exfiltration.

Precast oil/water separators are also available and can be easily installed on small commercial and industrial sites. The new coalescent plant separators are relatively efficient. These could be used for gas station and industrial area applications.

Potential Benefits of Water Quality Inlets

Water quality inlets are designed for sites with an area of one acre or less. These inlets are typically used on commercial sites where high loads of sediments and oil are generated, such as gas stations, commercial stores, and small parking lots.

Maintenance requirements consist of cleaning the chambers at least twice a year to remove pollutants. The cleaning process includes pumping out the contents of each chamber into a tank truck. If the entire contents are pumped out as a slurry, they are then transferred to a sewage treatment system. If the runoff is separated from the sediments by onsite siphoning, the sediments can be trucked to a landfill for final disposal. These maintenance operations can be costly. In addition, onsite siphoning creates a risk for groundwater contamination.

The cost-effectiveness of this method with regard to the amount of pollutant removed cannot be evaluated, because the pollutant removal capacity of water quality inlets is not well known.

Potential Limitations of Water Quality Inlets

The pollutant removal efficiency of a water quality inlet is believed to be limited because of design constraints such as small wet storage volume, short detention times, and the potential for resuspension of particles.

The construction of a water quality inlet involves the construction of a concrete structure, therefore, the construction activities should be closely monitored. Precast models are also available and can be easily installed.

Underdrains and Stormwater Filter Systems

These types of systems are not recommended because of the high maintenance associated with the filter systems.

Coagulation Injection Systems

Coagulation is a treatment process that typically uses an alum injection system to reduce colloidal or fine suspended matter in stormwater. The alum is applied upstream of a treatment pond by means of an injection system. The pond must be designed to provide sufficient detention time to allow the alum and coagulated particles to settle out.

There are both benefits and concerns when using an alum injection system. Benefits are significant reductions in solids and some nutrients. Concerns are the added capital/operating costs and the alum sludge that is accumulated over time.

Aeration

Aeration is a mechanical means of increasing DO in a waterbody. Aeration can be done in several ways. The most common methods of aeration are diffusers, spray systems, and mechanical aerators which introduce oxygen to the waterbody.

Aeration does have power costs associated with the operation of the mechanical equipment.

Storage/Treatment Facilities (e.g., oil and grease skimmers)

Oil and grease skimmers are a cost-effective method of prohibiting oil and grease toxics from flowing into receiving waterbodies. Oil and grease skimmers are easily installed and maintained.

Recommended Detention Design Criteria

Control of flooding and nonpoint pollution loadings in a given area can be achieved by retrofitting BMPs to existing upstream development and by controls on new development. In areas where there are severe siting constraints for locating structural BMPs, BMP design criteria must be established with a certain degree of flexibility to allow innovative management techniques. Existing structural BMP design guidelines have been devised primarily to address guidance for developing areas.

Recommended design criteria for new developments encourage detention facilities that combine attributes of both wet detention and dry detention BMPs. Design guidelines currently recommended are:

- Wet detention permanent pond storage volume must provide for an average hydraulic residence time of at least 14 to 21 days. This volume may be determined by a calculation of the runoff volume during the wettest two-week period during an average year.
- A bleed-down, or live storage volume, should be provided for the first 0.25 to 0.5 inches of runoff. This bleed-down storage is to be provided in addition to the permanent pool storage.
- Wet detention pond outlets are to be designed to draw down the bleed-down storage pool such that no more than one-half specified stormwater treatment volume may be discharged in the first 24 to 60 hours following a storm event.

- Side slopes should be 6:1 or flatter to provide a littoral shelf from the side of the facility out to a point 2 to 3 feet below the permanent pool elevation. Side slopes above the littoral zone should be no steeper than 4:1.

- Maximum permanent pool depths of 8 to 12 feet below the invert of the extended detention pond drawdown structure are recommended to minimize the potential for thermal stratification and re-release of nutrients from bottom sediments due to potential anaerobic conditions.

- Inlet structures should be designed to dissipate the energy of waters entering the facility and to prevent short-circuiting.

- Facilities that receive stormwater from contributing areas with greater than 50 percent impervious surface or that are a potential source of oil and grease contamination must include a baffle, skimmer, and grease trap to prevent these substances from being discharged from the facility.

- Wetland mitigation or vegetated littoral zones must be provided. Native plant species should be planted on 3-foot centers up to a depth of 3 feet below the permanent pool. The littoral zone planting should attain an 85 percent coverage within 3 years of planting.

By maximizing the distance between the inlet and outlet point of a detention pond, the greatest opportunity for suspended solids settling is obtained. Therefore, a minimum length to width ratio of 3:1 is recommended. A length to width ratio of 4:1 to 7:1 is preferred (Wanielista, 1990). Note that length is defined by the distance from the inflow point to the outflow point and width is defined as the surface area divided by the length. To avoid short-circuiting, diversion barriers should be incorporated into the pond design. These barriers may be created by small islands, peninsulas, or concrete baffles.

Maintenance of Structural Controls

Inspections

Inspections should be performed at regular intervals to assure that the detention pond is operating as designed. Semiannual inspection should be considered at a minimum with additional inspections following storm events. For the inspection following a major storm, the inspector should visit the site at the end of the specified drawdown period to ensure that the extended detention device is draining properly. Some inspections can be arranged to coincide with scheduled maintenance visits in order to minimize site visits and to ascertain that maintenance activities are performed satisfactorily. At the time of all site visits, the inspector should check the accumulations of debris and sediment. The weir or controlling structure and side slopes of the basin should be checked to ensure that they do not show signs of erosion, settlement, slope failure, or vehicular damage. Vegetated littoral zones should be inspected to ensure that water level elevations are appropriate to enhance vegetative growth, acceptable survival rates for planted species are maintained, and vegetative cover is above acceptable limits.

Routine Maintenance

Routine or preventive maintenance refers to procedures which are performed on a regular basis in order to keep the pond sightly and in proper working order. Routine maintenance should include debris removal, silt/sediment removal, and clearing of vegetation around the extended detention control device to prevent clogging. For detention ponds, it is recommended that silt removal be performed every five to seven years.

Erosion and Structural Repair

Areas of erosion and slope failure should be filled and compacted, if necessary, and reseeded (or sodded) as soon as possible. Eroded areas near the inlet or outlet should be revegetated and, if necessary, be filled, compacted, and revegetated or lined with rip rap. Damaged side slopes and embankments should be repaired using fill dirt of adequate permeability. Any major damage to outlet structures should be repaired as soon as possible.

Access to detention ponds is necessary for excavating equipment, trucks, mowers, and personnel for routine maintenance and erosion repair and for the removal of sediment accumulation. Where access is particularly difficult or impractical, ponds should be over-designed to allow for additional sediment accumulation.

Sediment Removal and Disposal

Sediment removal is a very important maintenance activity for detention ponds because these facilities are designed to remove pollutants by sedimentation. Sediments collect at the bottom of the basin reducing storage volume and increasing the likelihood of clogging the orifices of the extended detention outlet structure. Dry extended detention ponds may have to be cleaned out more frequently than wet detention ponds for aesthetic reasons.

Sediment deposition should be regularly monitored. Sediments removed from detention ponds, especially in highly urbanized areas may contain high levels of toxics (e.g., heavy metals, organics). In addition to monitoring sediment deposition rates, core samples from detention ponds every few years could be used to monitor the buildup of pollutants. If bottom sediment concentrations approach levels which would restrict disposal onsite or in local landfills, then clean-out may be required more frequently than every four years.

Under existing EPA regulations (40 CFR 261), material cleaned from a detention pond should periodically be screened with the Extraction Procedure (EP) toxicity test. This test should be carried out on accumulated sediment within the pond. If the sediment fails the test, it is subject to the Resource Conservation and Recovery Act (RCRA) regulations, and must be disposed of in an approved manner at a RCRA-approved facility. If the EP toxicity test is negative, then sediments are subject to state and local solid waste disposal regulations.

For sediment which is not classified as a hazardous waste, two major options of disposal are available: onsite and landfill disposal. The area required for onsite disposal must be determined to assure adequate space for sediment disposal. For detention ponds, sediment removal may be required approximately every 10 years. A regularly scheduled program every four to seven years is recommended. The disposal area should be large enough to stockpile two sediment clean-outs assuming the area can accept a 12-inch depth of wet sediment for each clean-out (MWCOG, 1987). Any onsite disposal areas must be protected with sediment control measures to prevent material from re-entering the watercourses. The disposal area should not be in the 100-year floodplain nor in wetlands (EPA, 1988).

If onsite disposal areas are not available or are inadequate in size, which may be the case for larger detention ponds, then steps must be taken to transport the material to local landfills. Detention pond sediment is typically accepted at landfills by local government departments of solid waste if the material has been sufficiently dried to be a "workable material" and can pass an EP toxicity test.

BMP Pollutant Removal Efficiencies

The following paragraphs provide background discussion for the derivatives of pollutant removal efficiencies for extended dry detention, wet detention, retention, and swale BMPs.

Dry Detention Ponds

Pollutant removal efficiencies for dry detention ponds are based on the settling behavior of the particulate pollutants. **Table C-1** summarizes average pollutant removal efficiencies for dry detention ponds based on settling column data and field monitoring data. Settling column data from NURP studies and from the FHWA study were evaluated to establish the removal efficiencies for TSS and metals (EPA, 1983b; FHWA, 1990). Removal efficiencies for the nutrients were determined by evaluating the results of two field monitoring studies of dry extended detention ponds in the metropolitan Washington, D.C. region (MWCOG, 1987). These efficiencies are applied to the percentage of total annual pollutant wash off captured for treatment in the extended dry detention pond BMP.

Retention Basins

The design of retention systems is generally based on a specified diversion volume. Based on extensive field investigations and simulations using 20 years of rainfall data, average yearly pollutant removal efficiencies were estimated for fixed diversion volumes for onsite (small) watersheds as presented in **Table C-1**.

Wet Detention Ponds

The EPA's NURP study monitored several wet detention ponds serving small urban watersheds in different locations throughout the U.S. (EPA, 1983b). For wet detention ponds with significant average hydraulic residence times (e.g., 2 weeks or greater), average pollutant removal rates were on the order of 40 to 50 percent for total-P and 20 to 40 percent for total-N. For other pollutants that are removed primarily by sedimentation processes, the average removal rates were as follows: 80 to 90 percent for TSS; 70 to 80 percent for lead; 40 to 50 percent for zinc; and 20 to 40 percent for BOD or chemical oxygen demand (COD). Based upon efficiencies reported by the EPA NURP study, the average pollutant removal rates shown in **Table C-1** are recommended for wet detention ponds which achieve an average hydraulic residence time of 2 weeks or greater.

Table C-1
Average Annual Pollutant Removal Rates for Retention and Detention Basin BMPs

Pollutant	*Range of Pollutant Removal Rates (%)*			
	Extended Dry Detention[1]	*Wet Detention*[2]	*Retention*[3]	*Swales*[4]
BOD5	20%-30%	20%-40%	80%-99%	20%-40%
COD	20%-30%	20%-40%	80%-99%	20%-40%
TSS	80%-90%	80%-90%	80%-99%	70%-90%
TDS	0%	20%-40%	80%-99%	0%-20%
Total-P	20%-30%	40%-50%	80%-99%	30%-50%
Dissolved-P	0%	60%-70%	80%-99%	0%-20%
TKN	10%-20%	20%-30%	80%-99%	30%-50%
NO_2+NO_3	0% 30%-40%	80%-99%	30%-50%	
Lead	70%-80%	70%-80%	80%-99%	60%-90%
Copper	50%-60%	60%-70%	80%-99%	40%-60%
Zinc	40%-50%	40%-50%	80%-99%	40%-50%
Cadmium	70%-80%	70%-80%	80%-99%	50%-80%

Notes:

1. Extended dry detention basin efficiencies assume that the storage capacity of the extended detention pool is adequately sized to achieve the design detention time for at least 80% of the annual runoff volume. For most areas of the U.S. extended dry detention basin efficiencies assume a storage volume of at least 0.25 to 0.5 inch of runoff.

2. Wet detention basin efficiencies assume a permanent pool storage volume which achieves average hydraulic residence time of at least two weeks.

3. Retention removal rates assume that the retention BMP is adequately sized to capture at least 80% of the annual runoff volume from the BMP drainage area. For most areas of the U.S., the required minimum storage capacity of the retention BMP will be in the range of 0.25 to 1.0 inch of runoff from the BMP drainage area, but the required minimum storage capacity should be determined for each location.

4. Source: California Storm Water Management Practices Manual (CDM, et al, 1993); Wanielista, 1988.

Shallow Grassed Swales

The design of shallow grassed swales, as discussed previously, provides for infiltration of high frequency, low volume runoff. **Table C-1** shows pollutant removal efficiencies for swales without retention.

Recommended Nonstructural BMPs

Public Information Program

A detailed discussion of the importance of a public information program has been provided in a following section. The following nonstructural controls are recommended as elements of the public information program.

Fertilizer Application Control

Fertilizer application control is a voluntary control mechanism by citizens who use fertilizer as part of their landscaping activities. Fertilizer application controls are implemented through a public information program by making the public aware of the problems associated with overuse of fertilizers. Overuse of fertilizers will cause excessive runoff of nutrients to surface waters thereby wasting money for the homeowner and the responsible entity. Information programs should also be extended to professional fertilizer users.

Pesticide Use Control

Pesticide use control is also a voluntary control by citizens who use pesticides as part of their housekeeping and lawn maintenance activities. Some pesticides are priority pollutants (e.g., Endrin, Lindane, and Silvex), which can be toxic. Overuse of these chemicals can cause excessive runoff to surface waters and entry into the food chain. Many professionals who apply pesticides are using approved pesticides in a safe and proper manner. An information program on pesticide use will help to reduce the amount of pesticides entering the Cow Creek and the Arkansas River.

Solid Waste Management

In certain locations of the study area, problems were noted with trash and other debris flowing into, and obstructing, open channels and culverts. It is recommended that the public be informed of the adverse impacts of littering and poor solid waste management at curbside, and/or that fines be more strictly enforced. This can also include pet droppings and illegal dumping into storm drains, wooded areas, and ditches.

Aquifer Recharge and DCIA Minimization

For those areas designated as probable recharge areas (Hydrologic Group A soils as defined by the SCS and USGS), it is recommended that the first 1 inch of runoff over DCIAs be retained and infiltrated onsite for all new development or construction so the city can maximize remaining recharge areas to ensure long-term protection of potable groundwater supplies. In addition, it is recommended that swale pretreatment for these areas be provided to increase the amount of soil treatment prior to discharge into the aquifer.

Another option would be for the city to minimize the amount of DCIA on a site and promote the use of green buffer zones around paved areas for infiltration.

Street Sweeping

Street sweeping can be an effective method of improving street aesthetics; however, the pollutant removal is not well documented. As further research is performed on street sweeping, including the use of vacuum sweepers, their effectiveness may be further proven. Estimates of pollutant removal efficiency from street sweeping in conjunction with the other structural and nonstructural controls is presented in Section 5.

NPDES Illicit Connections Identification and Removal

The EPA NPDES Phase II rules will likely require the development of an illicit connection elimination program. This type of program can be used to strengthen applicable codes and eliminate these connections which can cause plugs of toxic substances to enter surface waters.

Erosion and Sediment Control on Construction Sites

Erosion and sediment control on construction sites provides for the protection of receiving waters. Proper control during construction can be accomplished with gravel filter weirs, sediment fences, and temporary berms or swales. More stringent control of erosion and sediment during construction is recommended near Cow Creek and the Arkansas River.

Example Analysis of Nonstructural BMPs

This section presents example analyses of nonstructural controls for floodplain regulation and nonpoint source pollutant loads. **Appendix A** provides a detailed approach to regulatory offsite discharge volumes and peak rates of flow to protect downstream areas from flooding.

Flood Control Through Floodplain Storage Protection

In order to assure proper flood hazard management, it is recommended that compensating storage be required of new construction, development, or site alteration so that existing 100-year floodplain storage in the city is maintained; and therefore, offsite flood stages are not increased or flood waters are not moved onto adjacent lands by the development. The following paragraphs offer background information on this issue.

The proper management of riverine floodplain storage is an important factor in the cost of stormwater management infrastructure and in providing sound levels of flood protection. Often, the effects of lost floodplain storage on routed flows tributary to the regulatory floodway are not considered in floodway analyses. For example, the same flows are typically used for zero encroachment and full encroachment conditions; however, the flows delivered to the floodway could increase due to loss of floodplain storage. This storage may have been included in the generation of the peak flows via tributary flood routing or inherently accounted for in regression equations derived from stream gage data.

As urban development increases, the loss of historical floodplain storage, coupled with increased impervious area and other factors, may endanger public safety and cause flooding of existing infrastructure. These effects are especially pronounced in flat, coastal communities where riverine floodplains are influenced by tides.

The hydraulic effects of floodplain storage reduction must be properly accounted for when assessing the full effects of urbanization on flood stages. Non structural management controls (e.g., compensating 100-year floodplain storage filling) are recommended to optimize development versus flood protection, given equal environmental safeguards. The optional solution is a combination of structural and nonstructural controls which maximizes the use of existing infrastructure without causing flooding at critical locations in the system. The ultimate implementation strategy should be tested with an assessment of benefits versus costs assuming that environmental benefits/costs can be truly appraised. Also, in some areas, one foot of flood stage increase can cause significant flood damage. For this reason, it is recommended that the regulatory floodway be the top width of the existing channel with no stage increase for the future land use 100-year, 24-hour storm, including the maintenance overbanks. CDM has found it prudent in many cases for communities to regulate floodway and floodplain alterations on a case-specific basis using the outlined techniques.

Water Quality Protection by Nonpoint Source Pollutant Load Control

To achieve water quality goals, it is often necessary to balance structural and nonstructural controls. An example of this might be a water supply watershed where multiple jurisdictions are involved. A downstream jurisdiction that obtains drinking water from a reservoir may be more willing to implement stringent nonstructural controls to reduce nonpoint pollution loads to its water supply. Another jurisdiction located upstream may prefer higher density development with structural controls to spur economic development.

In order to be successful, a stormwater management plan must be comprehensive (e.g., include all program goals and all upstream jurisdictions) and must factor in local preferences to stormwater management controls. In many cases, a balanced approach combining both structural and nonstructural controls will be required. To be defensible, a stormwater management plan involving both structural and nonstructural controls must also demonstrate that stormwater pollution loadings discharged under the recommended alternative are equivalent to preconditions and will achieve the required water quality benefits. While it is preferable to base stormwater management decisions on receiving water quality impacts, in many cases projections of stormwater loading changes under various alternatives are sufficient for preliminary water quality evaluations. Water quality goals may be expressed as maintaining existing water quality that is assumed to be achieved if stormwater pollution loadings are not increased. Deterioration or improvement in water quality is assumed to be associated with increased or reduced stormwater pollution loads, respectively.

Nonstructural BMPs would include restrictions on land use such as density controls or limits on the maximum percent imperviousness of urban development. Public land acquisition is also a mechanism that has been used to minimize urban development primarily within water supply reservoir watersheds. Land acquisition programs typically begin with buffer zones surrounding a reservoir. These types of nonstructural controls have been proven to be effective as a result of numerous applications in water supply watersheds. In comparison with structural stormwater BMPs, these nonstructural controls have the following advantages:

1. There is less uncertainty about the long-term viability of a land use control program because compared to structural BMPs, more data are available on the long-term reductions in nonpoint pollution loads achieved by density restrictions and the maintenance of undeveloped land.

2. Unlike high density development relying upon structural BMPs, land use controls do not generate higher stormwater pollution loadings that must be treated in a facility located downstream.

3. There are no maintenance requirements associated with land use controls, unlike structural BMPs that must be continually maintained to ensure long-term effectiveness.

4. Pollution loadings of toxics tend to be highly correlated to urban areas with high levels of impervious surfaces. Land use controls have less risk of toxic loadings due to the lower levels of imperviousness typically associated with these BMPs.

5. There is a higher factor of safety associated with land use controls since pollutants are controlled at their source.

The major disadvantages of nonstructural BMPs to local governments are the tax base reductions. In evaluating trade-offs between the application of land use controls versus higher density development with structural stormwater BMPs, potential tax base reductions should be compared with the additional costs of providing services (e.g., roads, schools, water/sewer) to higher density urban development. For example, in the case of the Occoquan Reservoir watershed in northern Virginia, Fairfax County concluded that the reduced tax base associated with a 5-acre minimum lot "down zoning" was more than offset by the savings in providing county services that would be required to serve 1-acre, single family developments in the same area (Fairfax County Office of Comprehensive Planning, 1982).

Nonstructural controls would also include programs to eliminate illicit connections and illegal dumping. These types of programs are required under the EPA NPDES stormwater regulations for large cities (> 250,000 population) and medium cities (>100,000 population). However, there is currently little data available to quantify the effectiveness of these programs.

Buffer zones are nonstructural BMPs that have been demonstrated to be fairly ineffective for providing water quality protection from stormwater pollution loadings. This is because urban development discharges stormwater to confined drainageways (e.g., sewers, swales) which will tend to bypass or short-circuit most buffer zones.

In some areas, "cluster development" is considered a nonstructural alternative. Clustering concentrates development on a small portion of a development tract, leaving the remainder as permanent open space. To provide water quality benefits, cluster development should be associated with a nonpoint pollution loading target. For example, the nonpoint pollution loading target might be associated with a level of development throughout the basin that will maintain the desired water quality goal. A cluster development might be designed such that the combined percent imperviousness of the developed and undeveloped portions are equal to an underlying limitation on impervious cover. In many cases, onsite structural BMPs will be required to serve as an additional factor of safety to prevent the discharge of slug loadings from the developed portions of the site.

Table C-2 presents an example comparison of structural versus nonstructural BMPs for developing watersheds using the CDM WMM. WMM was used to develop annual nonpoint source pollutant loads based upon local hydrology, land use, and soils using EMCs. It can also account for point source loads, septic tank loads, and in stream transport. Using a watershed that is 90 percent undeveloped (10 percent developed) as a baseline, the estimated percent increase in runoff and average annual loads of indicator nutrients (total-P and total-N) and heavy metals (lead and zinc) are presented for various levels of urbanization in the watershed ranging from 20 percent to 100 percent developed. The mix of urban land uses used in this example is typical of many "suburban" areas in the southeast. The example shows that as the level of urban development increases (percent urban development) without BMPs, average annual loads of nutrients increase at roughly the same rate (percent increase), while heavy metals loads increase by about a factor of ten.
As an example of structural BMP controls through a development ordinance, the stormwater pollution loading reductions that can be achieved by wet detention ponds are also presented in **Table C-2**. Other than retention, monitoring studies of structural BMPs have demonstrated that wet detention ponds achieve the highest pollutant removal efficiencies. For the example, structural BMPs can maintain loadings at or near the 90 percent undeveloped levels for urbanization approaching 30 percent to 50 percent of the watershed area. This illustrates that control of nonpoint source pollutant loadings to levels at or below existing levels for undeveloped areas will probably not be possible without the use of land use controls in addition to structural BMPs. Therefore, a decision would need to be made by the community and local regulatory agencies on the trade-off of allowable development versus allowable increases in annual pollutant loads. A receiving water quality model analysis may be necessary to help correlate the potential increase in annual loads versus receiving water impacts.

Table C-2
Comparison of Structural vs. No Structural BMPs for Developing a Watershed Percent Increase in Average Annual Loads Over Undeveloped Conditions

No Structural BMPs Serving Urban Development

Level of Urban Development	Percent DCIA	Runoff	Total-P	Total-N	Lead	Zinc
10%	4.9%	0%	0%	0%	0%	0%
20%	9.3%	10%	10%	10%	100%	100%
30%	13.6%	10%	20%	20%	200%	200%
40%	18.0%	20%	40%	30%	300%	300%
50%	22.4%	20%	50%	40%	400%	400%
60%	26.8%	30%	60%	50%	500%	500%
70%	31.1%	30%	70%	60%	600%	600%
80%	35.5%	40%	80%	70%	700%	700%
90%	39.9%	40%	90%	80%	800%	800%
100%	44.3%	50%	100%	90%	900%	900%

Structural BMPs Serving Urban Development

Level of Urban Development	Percent DCIA	Runoff	Total-P	Total-N	Lead	Zinc	Percent BMP Coverage
10%	4.9%	0%	-10%	-10%	-80%	-50%	8%
20%	9.3%	10%	-10%	0%	-60%	0%	16%
30%	13.6%	10%	0%	0%	-40%	50%	24%
40%	18.0%	20%	0%	10%	-20%	110%	32%
50%	22.4%	20%	0%	10%	0%	160%	40%
60%	26.8%	30%	10%	20%	20%	210%	48%
70%	31.5%	30%	10%	20%	40%	260%	56%
80%	35.5%	40%	20%	30%	60%	310%	64%
90%	39.9%	40%	90%	30%	80%	360%	72%
100%	44.3%	50%	100%	40%	100%	410%	80%

Notes:
1. Undeveloped conditions assume 90% open land.
2. Urban development is assumed as: 50% medium density single-family residential, 10% multi-family residential, 20% commercial/industrial, 10% open/agricultural, 10% wetlands/water.
3. Percent increases/decreases in runoff and pollutant loads are based on the 10% developed area converted to 100% developed in multiples of 10%.

Citizen Participation and Public Information

As part of this Stormwater Master Planning program, the City and CDM implemented a public participation program aimed at identifying stormwater problems and formulating solutions. The program included reaching out to the general public and establishing a Stormwater Management Advisory Committee. These have been further described below.

Past experience with public information programs has shown that obtaining input from the general public can be difficult. Therefore, for this project, a public participation program was designed to address this issue. The process followed allowed the public to participate in the program in three ways, attendance at public meetings, completion of a stormwater questionnaire, and calling a telephone hotline.

Three public meetings where held at City Hall. These meetings, typically held on Thursday Nights, provided an opportunity for the citizens to participate in the process by transferring information on known flooding problems and gaining an understanding of the master planning process. Attendance at the meetings were varied, with the final meeting being the best attended. During these meetings, the citizens provided good detail of flooding problems, including providing photographs and video tapes of recent flood events.

The stormwater questionnaire was the avenue that provided the greatest amount of public participation. Based on the 2,012 returned questionnaire, 155 flooding locations were identified. These locations provided additional detail on the performance of the stormwater system and severity of existing flooding problems. Reported problems typically are frequent and/or excessive ponding in low, flat areas with poor surface drainage and service by storm sewers with inadequate capacity, or lack storm sewers all together. Several areas had adequate storm sewer capacity, but lack sufficient inlet capacity to allow water to enter the system with minimal ponding on the streets. As shown in the table below, Cow Creek has by far the most reported problem areas, followed by the ESD. Together, these systems account for 94 percent of the problems. The flooding locations identified by the survey are presented in **Table C-3.**

Table C-3
Reported Problem Areas by PSWMS

PSWMS	*No. of Reported Problem Areas*
Arkansas River	0
Sand Hills Diversion	2
Cow Creek	96
East Side Ditch	49
GVI Canal	8
Total	155

In addition to returning the questionnaires, the citizens had the option of calling a special stormwater hotline. The hotline was setup to receive complaints and questions concerning the stormwater system. Some residents called the hotline instead of returning the questionnaire. Overall, use of the hotline was minimal during this project.

Due to the limited access to the general public and the need to better understand the stormwater goals of the community, a citizen stormwater advisory committee was established. This committee served to provide direction, discuss and evaluate options, and provide general feedback on acceptable solutions to the stormwater program. This committee met five times as part of this project.

Citizen Participation / Public Information

As essential component of a comprehensive and successful stormwater management program is citizen participation. This is important, as activities which occur on private property can greatly affect the ability of the City to operate and maintain the stormwater system, thus causing flooding and water quality problems. Some of the more common activities which can cause a significant impact are disposing of yard waste, trash, oils, anti-freeze, and paints in the stormwater system. These activities not only impact aesthetics, but can also clog the stormwater pipes and ditches, causing flooding, and impact water quality.

In order to inform the citizens of the City of Hutchinson of their role in managing the stormwater management system, the City should expand on its existing public information program. Common public information and citizen participation programs include: information brochures, utility bill inserts, catch basin stensiling, and public service annoucements. In addition, the City has an opportunity to use informational signage in some of the parks which parallel the Cow Creek. This type of signage could inform users, how activities in their neighborhoods affect flooding and water quality of the creek.

In addition to routine activities, the implementation of this stormwater master plan will require a coordinated public information program. In order to achieve public support for the improvements, a relationship between the improvements and their daily routines will need to be established. Many people may not support the program, as they do not experience flooding on or near their property. However, improvements throughout the system will reduce the impact of large storm events on other activities, such as traveling to and from work and reducing the cost of damage to public facilities. In addition to obtaining community support for the stormwater improvements, a public information program may also need to address the funding mechanism chosen to finance the improvements.

The goals of the stormwater program should be defined in advance to ensure the message is consistent and effective. An example of public information goals are presented below:

- Developing a strategy to show the citizens what benefits they will gain
- Promoting the importance of flood control and water quality improvements on the watershed and city
- Providing opportunities for public input to the solutions
- Creating a win-win solution for landowners

BMP Implementation Considerations

In determining the best stormwater management facility or combination of facilities for a site, several factors, such as the following, need to be considered:

- Physical constraints or requirements of the site such as permeability of the soil, the location of the wet season high water table, and the amount of land available on the site to construct the facility

- Permitability of the facility or facilities

- Needed benefits to solve problems and guide future development in a given area

- The benefits provided by the facility such as control of peak discharge for flood control, reduction in the total volume of discharge, groundwater recharge, erosion control, wetlands management, reduction of pollutant loads to receiving waters, and/or optimized maintenance

Table C-4 provides a list of requirements and benefits that can be used as a guide in the selection of a stormwater BMP type.

Appendix D
Cost Estimates

Table D-1
Conceptual Cost Estimate
Alternative 2
Stormwater Master Plan
City of Hutchinson, Kansas

Item	Unit	Qty	Unit Price	Extension
COW CREEK				
Primary System:				
10'x3' RCB	feet	32,850	$450	$14,782,500
8'x3' RCB	feet	7,250	$400	$2,900,000
6'x3' RCB	feet	6,750	$350	$2,362,500
Channel Improvements	feet	11,800	$45	$531,000
Bridge Expansion	feet	160	$800	$128,000
General:				
Inlets (2 per 400 feet)	each	234	$2,500	$585,625
SUBTOTAL				$21,289,625
SANDHILL REACH				
Primary System:				
10'x3' RCB	feet	0	$450	$0
8'x3' RCB	feet	0	$400	$0
6'x3' RCB	feet	0	$350	$0
Channel Improvements	feet	0	$45	$0
Bridge Expansion	feet	0	$1,000	$0
General:				
Inlets (2 per 400 feet)	each	0	$2,500	$0
SUBTOTAL				$0
ESD				
Primary System:				
10'x3' RCB	feet	4,000	$450	$1,800,000
8'x3' RCB	feet	2,800	$400	$1,120,000
6'x3' RCB	feet	0	$350	$0
Channel Improvements	feet	12,800	$45	$576,000
Bridge Expansion	feet	640	$1,000	$640,000
General:				
Inlets (2 per 400 feet)	each	34	$2,500	$85,000
SUBTOTAL				$4,221,000
GVI				
Primary System:				
10'x3' RCB	feet	0	$450	$0
8'x3' RCB	feet	600	$400	$240,000
6'x3' RCB	feet	1,500	$350	$525,000
Channel Improvements	feet	0	$45	$0
Bridge Expansion	feet	240	$1,000	$240,000
General:				
Inlets (2 per 400 feet)	each	11	$2,500	$26,250
SUBTOTAL				$1,031,250

Subtotal	$26,541,875
Construction Contingency	$6,635,469
Probable Construction Cost Estimate	$33,177,344
Engineering Design	$3,317,734
Construction Services	$2,654,188
Administration Cost	$663,547
Conceptual Cost Estimate (1998 $)	$39,800,000

Table D-2
Conceptual Cost Estimate
Alternative 3
Stormwater Master Plan
City of Hutchinson, Kansas

Item	Unit	Qty	Unit Price	Extension
COW CREEK				
Primary System:				
7'x3' RCB	feet	32,850	$375	$12,318,750
6'x3' RCB	feet	7,250	$350	$2,537,500
4'x3' RCB	feet	6,750	$250	$1,687,500
Channel Improvements	feet	11,800	$45	$531,000
Bridge Expansion	feet	160	$800	$128,000
General:				
Inlets (2 per 400 feet)	each	234	$2,500	$585,625
SUBTOTAL				$17,788,375
SANDHILL REACH				
Primary System:				
7'x3' RCB	feet	0	$400	$0
6'x3' RCB	feet	0	$350	$0
4'x3' RCB	feet	0	$250	$0
Channel Improvements	feet	0	$45	$0
Bridge Expansion	feet	0	$800	$0
General:				
Inlets (2 per 400 feet)	each	0	$2,500	$0
SUBTOTAL				$0
ESD				
Primary System:				
7'x3' RCB	feet	4,000	$400	$1,600,000
6'x3' RCB	feet	2,800	$350	$980,000
4'x3' RCB	feet	0	$250	$0
Channel Improvements	feet	12,800	$45	$576,000
Bridge Expansion	feet	640	$1,000	$640,000
General:				
Inlets (2 per 400 feet)	each	34	$2,500	$85,000
SUBTOTAL				$3,881,000
GVI				
Primary System:				
7'x3' RCB	feet	0	$400	$0
6'x3' RCB	feet	600	$350	$210,000
4'x3' RCB	feet	1,500	$250	$375,000
Channel Improvements	feet	0	$45	$0
Bridge Expansion	feet	240	$1,000	$240,000
General:				
Inlets (2 per 400 feet)	each	11	$2,500	$26,250
SUBTOTAL				$851,250

Subtotal	$22,520,625
Construction Contingency	$5,630,156
Probable Construction Cost Estimate	$28,150,781
Engineering Design	$2,815,078
Construction Services	$2,252,063
Administration Cost	$563,016
Conceptual Cost Estimate (1998 $)	$33,800,000

Table D-3
Conceptual Cost Estimate
Alternative 4
Stormwater Master Plan
City of Hutchinson, Kansas

Item	Unit	Qty	Unit Price	Extension
COW CREEK				
Primary System:				
Property Acquisition	acre	47	$222,000	$10,434,000
Demolition	acres	47	$20,000	$940,000
Excavation (live Storage)	AF	188	$24,000	$4,512,000
Pond Excavation	AF	100	$24,000	$2,400,000
Inlet and Outlet Structures	each	26	$10,000	$260,000
Restoration	acre	47	$12,500	$587,500
General:				
Inlets (2 per 400 feet)	each	10	$2,500	$25,000
SUBTOTAL				$19,158,500
SANDHILL REACH				
Primary System:				
Property Acquisition	acre	0	$222,000	$0
Demolition	acres	0	$20,000	$0
Excavation (live Storage)	AF	0	$24,000	$0
Pond Excavation	AF	0	$24,000	$0
Inlet and Outlet Structures	each	0	$10,000	$0
Restoration	acre	0	$12,500	$0
General:				
Inlets (2 per 400 feet)	each	10	$2,500	$25,000
SUBTOTAL				$25,000
ESD				
Primary System:				
Property Acquisition	acre	22	$222,000	$4,884,000
Demolition	acres	22	$20,000	$440,000
Excavation (live Storage)	AF	88	$24,000	$2,112,000
Pond Excavation	AF	50	$24,000	$1,200,000
Inlet and Outlet Structures	each	12	$10,000	$120,000
Restoration	acre	22	$12,500	$275,000
General:				
Inlets (2 per 400 feet)	each	10	$2,500	$25,000
SUBTOTAL				$9,056,000
GVI				
Primary System:				
Property Acquisition	acre	2.5	$222,000	$555,000
Demolition	acres	3	$20,000	$50,000
Excavation (live Storage)	AF	9	$24,000	$216,000
Pond Excavation	AF	5	$24,000	$120,000
Inlet and Outlet Structures	each	2	$10,000	$20,000

Restoration	acre	3	$12,500	$31,250
General:				
Inlets (2 per 400 feet)	each	0		$0
SUBTOTAL				$992,250
Subtotal				$29,231,750
Construction Contingency				$7,307,938
Probable Construction Cost Estimate				$36,539,688
Engineering Design				$3,653,969
Construction Services				$2,923,175
Administration Cost				$730,794
Preliminary Cost Estimate (1998 $)				$43,800,000

Table D-4
Conceptual Cost Estimate
Alternative 5
Stormwater Master Plan
City of Hutchinson, Kansas

Item	Unit	Qty	Unit Price	Extension
COW CREEK				
Primary System:				
10'x4' RCB	feet	14,000	$450	$6,300,000
8'x3' RCB	feet	4,700	$400	$1,880,000
6'x3' RCB	feet	4,950	$350	$1,732,500
Channel Improvements	feet	11,800	$45	$531,000
Bridge Expansion	feet	160	$800	$128,000
General:				
Inlets (2 per 400 feet)	each	118	$2,500	$295,625
SUBTOTAL				$10,867,125
SANDHILL REACH				
Primary System:				
10'x3' RCB	feet	0	$450	$0
8'x3' RCB	feet	0	$400	$0
6'x3' RCB	feet	0	$350	$0
Channel Improvements	feet	0	$45	$0
Bridge Expansion	feet	0	$1,000	$0
General:				
Inlets (2 per 400 feet)	each	10	$2,500	$25,000
SUBTOTAL				$25,000
ESD				
Primary System:				
10'x3' RCB	feet	0	$450	$0
8'x3' RCB	feet	3,220	$400	$1,288,000
6'x3' RCB	feet	0	$350	$0
Excavation (live Storage)	AF	150	$16,200	$2,430,000
Pond Excavation	AF	90	$16,200	$1,458,000
Inlet and Outlet Structures	each	2	$10,000	$20,000
Restoration	acre	40	$12,500	$500,000
Channel Improvements	feet	12,800	$45	$576,000
Bridge Expansion	feet	640	$1,000	$640,000
General:				
Inlets (2 per 400 feet)	each	16	$2,500	$40,250
SUBTOTAL				$6,952,250
GVI				
Primary System:				
6'x3' RCB	feet	500	$360	$180,000
Bridge Expansion	feet	240	$1,000	$240,000
General:				
Inlets (2 per 400 feet)	each	3	$2,500	$6,250

SUBTOTAL	$426,250
Subtotal	$18,270,625
Construction Contingency	$4,567,656
Probable Construction Cost Estimate	$22,838,281
Engineering Design	$2,283,828
Construction Services	$1,827,063
Administration Cost	$456,766
Conceptual Cost Estimate (1998 $)	$27,400,000

Appendix E
Literature Cited

Appendix E
Literature Cited

Sharpley, Andrew N., S.J. Smith, O.R. Jones, W.A. Berg and G.A. Coleman. 1992. The Transport of Bioavailable Phosphorus in Agricultural Runoff. J. Environ. Qual. 21:30-35.

Lacock, B. Personal Communication June 18, 1998.

Dixon, L.K. 1996. Literature Compilation and Data Synthesis for Atmospheric Deposition to the Tampa Bay Watershed. MML Technical Report Number 486. Prepared for Tampa Bay National Estuary Program. September 25, 1996.

Dixon, L.K., S. Murray, J.S. Perry, P.J. Minotti, M.S. Henry and R.H. Pierce. 1996. Assessment of Bulk Atmospheric Deposition to the Tampa Bay Watershed. Final Report MML Technical Report Number 488. Prepared for Tampa Bay National Estuary Program. September 25,1 996.

Reckow, K.H., J.P. Hartigan, and S. Coffey. 1988. *Lake Nutrient Budget Development for State Level Applications*. National Conference on Enhancing States' Lake Management Programs, Northeastern Illinois Planning Commission. Chicago, Illinois. May, 1988.

EPA. 1983. *Final Report of the Nationwide Urban Runoff Program*. United States Environmental Protection Agency. Office of Water. Washington, DC.

FHWA, 1990. Pollutant Loadings and Impacts from Highway Stormwater Runoff. Volume III: Analytical Investigation and Research Report. U.S. Department of Transportation. Federal Highway Administration . Publication No. FHWA-RD-88-008. April, 1990.

EPA, 1992. Compendium of Watershed-Scale Management Models for TMDL Development (EPA 841-R-92-002)

Walker, W.W. 1987. Phosphorus Removal by Urban Runoff Detention Basins. Lake and Reservoir Management: Volume III. North American Lake Management Society. Washington, DC. Pp 314-326.

Hartigan, J.P. 1988. Basis for Design of Wet Detention Basin BMPs. In Design of Urban Runoff Quality Controls. Proceedings of ASCE conference on Current Practice and Design Criteria for Urban Quality Control. Potosi, MI. July 10-15, 1988.

MWCOG, 1987. Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs. Metropolitan Washington Council of Governments. July, 1987.

Driscoll, E.D. 1983. Performance of Detention Basins for Control of Urban Runoff Quality. Prepared for 1983 International Symposium on Urban Hydrology, Hydraulics and Sediment Control. University of Kentucky. Lexington, KY. 1983.

Wanielista, Final Report on efficiency Optimization of Wet Detention Ponds for Urban Stormwater Management. University of Central Florida, 1989.

NVPDC, 1983. Washington Metropolitan Area Urban Runoff Demonstration Project. Northern Virginia Planning District Commission. Annandale, VA. April, 1983.

FDOT, 1987. Drainage Manual-Drainage Design Office. Florida Department of Transportation. Tallahassee, Fl.

FEMA FIS for Reno County, Kansas and Incorporated Counties.

SWMM User's Manual.

National Weather Service Technical Paper 40 (TP40).

United States Department of Agriculture (USDA) Soil Conservation Service (SCS) Soil Survey for Reno County, March 1966.

CDM, et al, 1993. California Storm Water Management Practices Manual.