COMPREHENSIVE DRAINAGE STUDY

FOR THE CITY OF EVANS

VOLUME I
CITY OF EVANS MASTER DRAINAGE PLAN

ROCKY MOUNTAIN CONSULTANTS, INC.
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MARCH 1997

ROCKY MOUNTAIN CONSULTANTS, INC. Rec'd 1/10/98

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March 11, 1997

Mr. Earl Smith
City of Evans
3700 Golden St.
Evans, CO 80620

Re: City of Evans Master Drainage Plan

Dear Earl:

Enclosed is the Comprehensive Drainage Study for the City of Evans. The study has been prepared in two volumes. Volume I is the Master Drainage Plan for the City of Evans. It contains information on the drainage basins within the city and its Urban Growth Area, the existing drainage facilities within these basins, a complete hydrologic analysis of these basins, potential drainage problem areas, and recommended solutions to the drainage problems. All calculations and reference studies are included in Appendix 1-4 of Volume I.

Volume II is the Drainage Criteria Manual for the City of Evans. It contains the criteria and policies to be used in the design of stormwater drainage systems, including policies on the Evans Town Ditch and recommendations for funding of drainage system improvements.

We appreciate the cooperation and assistance that you and the city staff have given us throughout the project.

Please do not hesitate to call if you have any questions.

Sincerely,

ROCKY MOUNTAIN CONSULTANTS, INC.

Robert C. Brand, P.E.
Principal

Julie A. Stansloski, E.I.T.
Project Engineer

Enclosures
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COMPREHENSIVE DRAINAGE STUDY FOR CITY OF EVANS

VOLUME I
CITY OF EVANS MASTER DRAINAGE PLAN

Submitted By:

Rocky Mountain Consultants
825 Delaware Avenue Suite 500
Longmont, CO 80501

MARCH 1997

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EXECUTIVE SUMMARY

Purpose

Considering the continued growth of the City of Evans, it has become increasingly important for the City to provide adequate storm drainage facilities for its existing developments as well as for the new developments. It is the purpose of the drainage master plan to be used as a planning tool in meeting the City's existing and future stormwater management needs for growth over the next twenty years. This master drainage plan will serve as a guideline for future improvements to the stormwater drainage system.

Both the City of Evans and its Urban Growth Area (UGA) are included in the master plan. The study area is bordered by the City of Greeley to the north, 71st Ave. to the west, and the South Platte River to the south. The drainage area encompasses approximately 8800 acres with about 1725 acres of that within the current city limits.

Key Issues

Key issues that are addressed in this report include:

Existing Drainage Conditions
- What are the drainage basin and subbasin boundaries for the study area?
- What are the existing, or historic, stormwater flow rates?
- What drainage facilities exist to convey stormwater?
- Are the existing facilities adequate for conveyance of existing stormwater flows?

Developed (Future) Drainage Conditions
- What are the future stormwater flow rates for fully developed conditions?
- Will existing facilities be adequate for conveyance of future stormwater flows?

Potential Problem Areas
- Where are the areas most likely to flood?
- What is the magnitude of the City's flooding problems?

Recommended Improvements
- What facilities will need to be added or modified to adequately convey future flows?
- What are the estimated costs of the recommended facilities?

Stormwater Drainage Fees
- How will the City pay for the recommended improvements?
- What is a reasonable and adequate charge for drainage system improvements, operation, and maintenance?

Drainage Criteria
- What are the guidelines and requirements for drainage system design within the City of Evans and its UGA?
- What are the submittal and design requirements for new developments?

Stormwater Conveyance System Analysis

Stormwater flowrates were calculated based on the 5-year rainfall event (the minor storm), and the 100-year rainfall event (the major storm). Flowrates were calculated for the existing conditions based on existing land use and for the fully developed conditions based on the City of Evans future growth plan for the next 20 years as outlined in the 1996 Comprehensive Plan.

The flowrates for the fully developed condition were routed through the appropriate drainage structures to analyze the sufficiency of the existing storm sewers or channels. Where the drainage systems are inadequate for conveyance of stormwater flows, conceptual designs were recommended for system improvements. The costs of the improvements were estimated.

Stormwater Conveyance System Evaluation

Based on hydraulic modeling of the stormwater conveyance systems, several areas were identified that need improvements to either: 1) prevent flooding of roadways and adjacent properties during the minor storm event, or 2) prevent downstream erosion and flooding as the upstream areas develop. Recommended improvements are presented in Volume I, Section VI.

The stormwater drainage problems within the City and its UGA are minor. There are currently no immediate risks of major property damage or loss of life. Although the drainage problems are minor, stormwater will hinder traffic flow and inundate adjacent properties at various locations, and the problems should be addressed. These problems will increase as development continues. Stormwater improvements will be required in the future to protect life and property. The main problem areas include:

Intersection of 37th St. and Highway 85 - stormwater collects at this intersection due to the under design of the storm sewer and detention area. This causes a hindrance to traffic flow on a major north-south roadway.

Intersection of 31st St. and Highway 85 - stormwater that exceeds the storm sewer capacity collects at this intersection. The stormwater ponds along the west side of Highway 85, which hinders traffic flow near the intersection and floods parking lots of nearby businesses.

"Old Town" Section East of the Railroad and South of 37th St. - this area has a flat terrain which prevents stormwater from flowing to the 37th St. storm sewer. Therefore, the stormwater "ponds" in the low areas causing flooding of local streets and lawns.

Evans Town Ditch Overflows - during the 100-year storm it is estimated that approximately 680 cfs will overflow from the Evans Town Ditch at Valmont and 11th Avenue. This discharge will greatly increase the runoff in adjacent basins. Furthermore, it may cause erosion or embankment failure of the ditch.

Recommended Stormwater Drainage System 20-year Capital Improvement Plan

The estimated costs for the recommended stormwater system improvements are presented in Volume I, Section VII. Summarized costs of the improvements that are recommended over the next 20 years are shown in Table ES-1.

Table ES-1
Recommended Stormwater 10-Year CIP

Description	Estimated Capital Cost (in 1996 Dollars)
Improvements Within the Current City Limits	$2,443,240
Improvements in the UGA	$6,257,902
Total Improvements	$8,701,142

Drainage Fees

It is recommended that the funding for the improvements come from two primary sources, a monthly stormwater fee and a development fee to be paid on new developments in conjunction with the building permit fee. Financing for the stormwater improvements shall be set by the Evans City Council.

I. INTRODUCTION

I. INTRODUCTION

The City of Evans is responding to the need to plan for future growth and development in order to manage growth to protect the community's character, preserve the quality of its environment, and provide for adequate public facilities before additional development occurs. The Drainage Master Plan is one facet of the planning process.

A. Objectives

The project objectives are to provide Evans with a comprehensive storm water management plan which will guide the City in dealing with growth and development and in protecting its citizens and their property from storm water flood damage.

The Drainage Master Plan incorporates and builds upon work previously done either by City staff or for the City by consultants, including the City of Evans Comprehensive Plan, the 23rd Avenue Drainage Basin Storm Runoff Control, the Final Drainage Report for 17th Avenue Drainage Basin, the 17th Avenue Basin and Pond Study, the Water/Wastewater Master Plan, and the Water Rights Study, Evans Town Ditch.

B. Scope of Project

1. Mapping

The City of Greeley, Weld County, Arnold Analytical, Aerometric Engineering, Colorado Aerial Photo Service, Earth Science Information Center, Intrasearch, and USGS were contacted to determine the availability of existing topographic data for the current City limits and the City's Urban Growth Area as published in the 1996 Comprehensive Plan. Previous studies for the City were also reviewed for available mapping. The only complete mapping of the area currently available is the USGS map at a scale of 1" = 2000 feet with 10-foot contours.

Following this inventory of potential base mapping sources, RMC met with City of Evans staff to decide which base mapping to use. It was agreed that for purposes of the Drainage Master Plan, the 10-foot contour USGS maps would provide adequate base maps. The mapping includes current streets, existing storm sewer systems, basin boundaries, and USGS contour mapping.

2. Study Area

The study area includes the City of Evans and its Urban Growth Area as defined by the Evans 1996 Comprehensive Plan. The study area was divided into 17 basins based on topography and existing drainage systems. For purposes of hydraulic analysis, the basins were further divided into subbasins.

3. Existing Drainage Inventory

All studies noted above were reviewed. The City of Evans' files were searched for any available information and an inventory of existing facilities prepared. All channels, detention facilities and storm sewer systems were included.

4. Hydrologic Analysis

Hydrologic analysis was performed to evaluate the adequacy of existing storm sewer systems, to locate potential flooding areas, to formulate alternative designs for drainage improvements, and to provide a basis for future drainage criteria.

5. Existing Drainage Problems

Several areas of drainage and flooding problems were identified.

6. Conceptual Design

Alternatives were developed to reduce flooding and provide adequate drainage for existing and future conditions.

7. Estimated Costs for Alternative Improvements

Costs were estimated for the recommended drainage system improvements.

8. Drainage Criteria

Drainage criteria for the City of Evans has been prepared and is set forth in Volume II of this study.

9. 17th Avenue Groundwater Investigation

A discussion of groundwater flooding problems that may be related to the 17th Avenue Detention Pond is included as Appendix 1 of Volume II.

10. Storm Water Management Policy

A storm water management policy has been developed and is set forth in Volume 2 of this study. The information used to formulate the policy is Appendix 2 of Volume II and includes discussions of:

a. Consideration of the Evans Town Ditch from a water rights perspective, drainage perspective, and future development perspective. A discussion of Evans Town Ditch costs which may be attributable to drainage is also included.

b. Options and considerations to assist the City Council in adopting a policy regarding development fees and monthly fees.

The Technical appendices to Volume I contain the runoff modeling using the Colorado Urban Hydrograph Procedure (CUHP) to compute runoff rates and generate storm hydrographs for each subbasin; and the Stormwater Management Model used to route the CUHP through part of the 31st Street and 37th Street basins. Also included in the Technical Appendices to Volume I are the 23rd Avenue Basin Drainage Study, the 17th Avenue Drainage Basin Study, and the 17th Avenue Basin and Pond Study.

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II. STUDY AREA

II. STUDY AREA

A. General

The City of Evans Master Drainage Plan study area is located in Weld County, Colorado. The study includes the City of Evans and its Urban Growth Area (UGA) as defined by the City of Evans 1996 Comprehensive Plan. The area is bordered by the city of Greeley to the north and the South Platte River to the south and east. The majority of the UGA is west of the existing city. The drainage area is estimated to encompass 8800 acres. Storm runoff flows in a general south-southeast direction through various drainageways and eventually discharges into the South Platte River. Surface elevations within the study area range from 4920 feet to 4650 feet. Approximately 25 percent of the total area is developed with the majority of the development within the city limits. The current city limits encompass approximately 1725 acres.

B. Basins and Subbasins

The study area was divided into 17 basins based on topography and existing drainage systems. Figure 1 shows the drainage basins for the existing city and the UGA, and Figure 2 is an enlargement of the drainage basins within the City. The drainage basins are also outlined in Figures 1 and Figure 2 of the Technical Appendix. For hydraulic calculations and basin analysis, the basins were further divided into subbasins as determined by topography, existing drainage systems, flowpaths, street flows, and land use. The subbasins used for hydraulic analysis are presented in Figures 3 and 4. The drainage subbasins are also presented in Figure 3 and Figure 4 of the Technical Appendix. Unless otherwise stated the basins were analyzed independent of one another. That is, it is assumed that the runoff from a basin stays within that basin and does not overflow into adjacent basins.

An overview and brief description of the basins and their drainage characteristics is given below. A more detailed hydraulic analysis of the basins is included in the conceptual design section of this study. The conceptual design section also includes more detailed maps showing the features described below.

1. Urban Growth Area West Basin

The UGA West basin encompasses approximately 1085 acres on the far west side of the UGA. Roughly 694 acres of the basin are in Weld County, outside of the UGA. The basin extends from the Loveland and Greeley Canal on the north to the Evans Town Ditch (ETD) on the south. The land is agricultural and undeveloped. There are currently no plans to develop this basin. Average overland slope is 2 percent. There is a well defined natural drainageway that runs predominantly south-southeast down the center of the basin. The northern portion of the drainageway is in two branches. The drainage discharges into the ETD just east of where the ditch begins. There is a ponding area east of the drainage path. This pond was not modeled as a detention area in the analysis since its capacity as a detention facility is unknown.

2. <u>65th Avenue Basin</u>

At an estimated 122 acres, the 65th Avenue basin is the smallest basin in the UGA. It is bounded by 65th Avenue on the west side and the ETD on the south. This area is undeveloped with no current plans for development. The average overland slope is 2.3 percent. There is a natural drainage path that extends the length of the basin. The basin discharges into the ETD. There appears to be a small ponded area on the north section of the drainageway. Since this is a naturally ponded area, the possible detention caused by this ponding was omitted for calculation purposes.

3. <u>Rehmer Lake Basin</u>

Rehmer Lake Basin includes approximately 745 acres within the UGA and about 35 acres outside the UGA. Land use is primarily agricultural with a low density housing development in the southeast . The area is planned to remain primarily undeveloped with only the rest of the southeast corner to be developed as a low density residential area. Average slope of the basin is 2 percent. The basin's primary drainage facility consists of natural drainage channels, Rehmer Lake, and a natural detention area within Dos Rios Subdivision. The capacities of the lake and detention area are unknown, thus their contribution to detention storage cannot be determined. Therefore, they were omitted in the hydraulic calculations. The channel discharges into the ETD.

4. <u>Urban Growth Area Central Basin</u>

The UGA Central basin encompasses approximately 566 acres. The land is currently undeveloped but the lower half of the basin is planned for low density residential developments. The average slope is estimated at 1.9 percent. Two drainage channels drain the upper 80 percent of the basin. As these two channels merge the natural channel becomes undefined. A recent study by landmark Engineering entitled "Preliminary Drainage Report for Dos Rios Estates 2nd Filing" analyzed and designed the drainage system through the lower section of the basin. Therefore, no additional analysis was performed on the lower sections of the basin.

5. <u>Ashcroft Draw Basin</u>

Encompassing over 3500 acres, the Ashcroft Draw basin is the largest basin in the study area. The Ashcroft Draw Basin is predominantly located in the UGA with about 470 acres in the City of Greeley, about 730 acres in Weld County, and about 2300 acres in Evans' UGA. The Loveland and Greeley Canal form the northern border for the basin. The basin extends along the Ashcroft Draw down to the ETD. Land use is mixed within the basin. Much of the north and east portions of the basin are agricultural and undeveloped. Currently Arrowhead and Hill-n-Park subdivisions are the primary developments in the area. Planned land use is for some additional medium and low density residential developments, with some local business and industrial areas. The rest of the basin will remain agricultural or green belt areas. The average slope throughout the basin is 1.5 percent. The Ashcroft Draw Basin was divided into six subbasins based on land use and stormwater flowpaths. The Ashcroft Draw is a major natural drainage channel that extends the full length of the basin. Another drainage channel merges with the Ashcroft Draw at Arrowhead Lake. Overflow from the lake discharges through a box culvert and continues down the Ashcroft Draw, under the ETD, and to the South Platte River. There appears to be a small irrigation ditch in the north section of the basin. This ditch is solely for irrigation, and has minimum stormwater conveyance capabilities, therefore it was omitted in the analysis.

6. Urban Growth Area East Basin

The UGA East basin is approximately 290 acres. There is currently little development in the basin. There are plans for medium density residential and heavy industrial development in the north and south sections of the basin. Overland slope averages 1.4 percent. There is no well defined drainage path existing in this basin. Runoff flows overland through an indistinct swale to the ETD.

7. 23rd Avenue Basin

The 23rd Avenue basin encompasses approximately 1082 acres. It includes areas in the UGA and the Cities of Evans and Greeley. The majority of the basin is currently agricultural with some development in the northern part of the basin. The basin is planned for commercial and residential development. The 23rd Avenue Basin was divided into 3 subbasins for analysis. Currently, a natural channel drains the northern half of the basin. The channel discharges to some existing ponds. The rest of the basin runoff flows overland to the ETD. The land below the ETD flows to the South Platte River. The 23rd Avenue drainage basin was analyzed in a previous study by Rocky Mountain Consultants titled, "23rd Avenue Drainage Basin Storm Runoff Control". A copy of this study is included in Appendix 2.

8. 17th Avenue Basin

This drainage basin collects runoff from approximately 183 acres. The land is 50 percent developed with plans for further residential development. The 17th Avenue Basin was divided into five subbasins for analysis. The stormwater system was redesigned and installed in 1996. For a detailed analysis of the basin, refer to Appendix 3 for a copy of the "Final Drainage Report for 17th Avenue Drainage Basin" written by Rocky Mountain Consultants. The stormwater sewer system for this basin carries the runoff under the ETD and into the existing ETD overflow ditch which flows to the South Platte River. Further discussion of the stormwater sewer conveyance system is presented in the Existing Facilities section of this report.

9. <u>17th Avenue Detention Pond Basin</u>

The 17th Avenue Detention Pond drainage basin is approximately 223 acres. The watershed is currently developed with residential areas, commercial areas, school areas, and open space. For runoff analysis, the basin was divided into eight subbasins. The upper two-thirds of the basin are in the city of Greeley. Various surface and underground storm drainage systems exist within the basin. The basin discharges into a detention pond located within the city of Evans at the northwest corner of 17th Avenue and 34th Street. This basin was analyzed and redesigned in the "17th Avenue Basin and Pond Study" by Rocky Mountain Consultants in 1996. A copy of the study is included in Appendix 4.

10. <u>Evans Town Ditch Basin</u>

This drainage basin encompasses approximately 285 acres. About 36 acres are in the city of Greeley, the remainder of the basin is within the city limits of Evans. The basin is predominantly residential with some local businesses. This basin was divided into 14 subbasins for stormwater runoff modeling and channel design. The ETD Basin has three storm sewer systems that discharge into the ETD. More detailed information on the ETD storm sewer systems is presented in the Existing Facilities section of this report under the 11th Avenue South, 15th Avenue, and 37th Street West storm sewers.

The ETD Basin was not modeled as a completely independent basin. During both the 5-year and the 100-year storms, the 31st Street Basin will overspill into the ETD Basin. Excess street flow from the 31st Street Basin will continue down 11th Avenue into the ETD Basin. These excess flows were taken into account in the stormwater analysis. Also, during the 5- and 100-year storms the ETD will overspill into the 37th Street and Southeast Platte basins. Therefore, the location and amount of overspill from the ETD Basin is estimated based on the "Water Facilities and Related Future Estimations" 1985 report by Western Technical Services, Inc., then routed to the corresponding downstream basins.

11. <u>Industrial Parkway Basin</u>

This basin encompasses approximately 80 acres of industrial development on the southwest side of Highway 85 within the city limits of Evans. The south part of the basin is in the 100-year floodplain of the South Platte River. The southern boundary of the basin is the ETD overflow ditch which drains directly into the South Platte River. There are currently no storm sewers in the basin. Stormwater drains overland to the south into the overflow ditch.

12. <u>Southeast Platte Basin</u>

This basin of approximately 129 acres drains directly into the South Platte River. The basin has some existing industrial developments and is intended for further industrial development. The Southeast Platte Basin has no existing storm drainage facilities. Stormwater is conveyed overland and in localized ditches toward the South Platte River. The runoff becomes somewhat channelized by Highway 85 and the western frontage road as it approaches the river. This basin was not modeled independently. For the 5- and 100-year storms, estimated overflow from the ETD is incorporated into the calculations.

13. River Bend Basin

The River Bend subdivision forms its own drainage basin. The drainage area is approximately 18 acres in the south of Evans, east of the Union Pacific Railroad. The basin is a low density residential development. The runoff is sufficiently routed through curb and gutter systems to the south of the basin where it drains to a ditch and eventually overspills into the Riverside Pond or the South Platte River.

14. Riverside Park Basin

The Riverside Park Basin encompasses about 127 acres in the southeast corner of Evans. The land use in this basin is primarily residential and open space with some mixed use and industrial areas. The basin was divided into two subbasins based on land use and stormwater flow. The Riverside Park Basin is characteristically flat. The general slope of the basin is less than 1 percent. The majority of the roads are unpaved roads without curb and gutter. There is no well defined drainage path. Runoff will flow in a general east to southeast direction to the South Platte River or to a local irrigation ditch that extends east from the end of 42nd Street. From this ditch, some of the runoff may be diverted into the Riverside Pond, but most will flow to the South Platte River.

15. 37th Street Basin

The 37th Street Basin is the primary watershed for the eastern section of the city of Evans. It includes over 270 acres, all within Evans' city limits. The basin includes residential, commercial, and industrial developments. Only a small portion of the basin is open for further development. This area is planned for commercial uses. For storm flow analysis and modeling, the basin was divided into 10 subbasins. Runoff from this basin generally drains toward 37th Street. However, many of the subbasins east of the railroad tracks are relatively flat and do not drain well. At 37th Street the runoff enters the storm sewer system and proceeds east to the South Platte River. Further discussion of the 37th Street east storm sewer is provided in the Existing Facilities section of this report. During the 5- and 100-year event, excess runoff from the ETD Basin will overflow into the 37th Street Basin. This overflow is considered in the flow analysis.

16. <u>31st Street Basin</u>

The 31st Street Basin is approximately 225 acres. The basin extends along the north side of Evans from about 15th Avenue to Trinidad Avenue. About 56 acres of the basin are in the City of Greeley. There are various residential and commercial developments in the basin. Based on stormwater flowpaths, the basin was divided into seven subbasins for analysis. The primary storm conveyance facility is the 31st Street sewer system, including the 11th Avenue branch. Further information on the storm sewer is presented in the Existing Facilities section of this report. For the 5-year and 100-year event, the 31st Street Basin was not modeled independent of all other basins. At the corner of 11th Avenue and 31st Street, the excess street flow was divided. Half of it is routed to the ETD Basin and half remains in the 31st Street system.

17. <u>East Platte Basin</u>

This basin includes 86 acres in the northeast side of Evans. The area is bordered by the ETD on the south and extends east to the South Platte River. Residential and industrial developments are planned for this basin. Currently the area is undeveloped except for the wastewater treatment plant. The basin has a gradual slope to the east. There are currently no drainage facilities in the basin. Runoff flows east until it reaches the South Platte River.

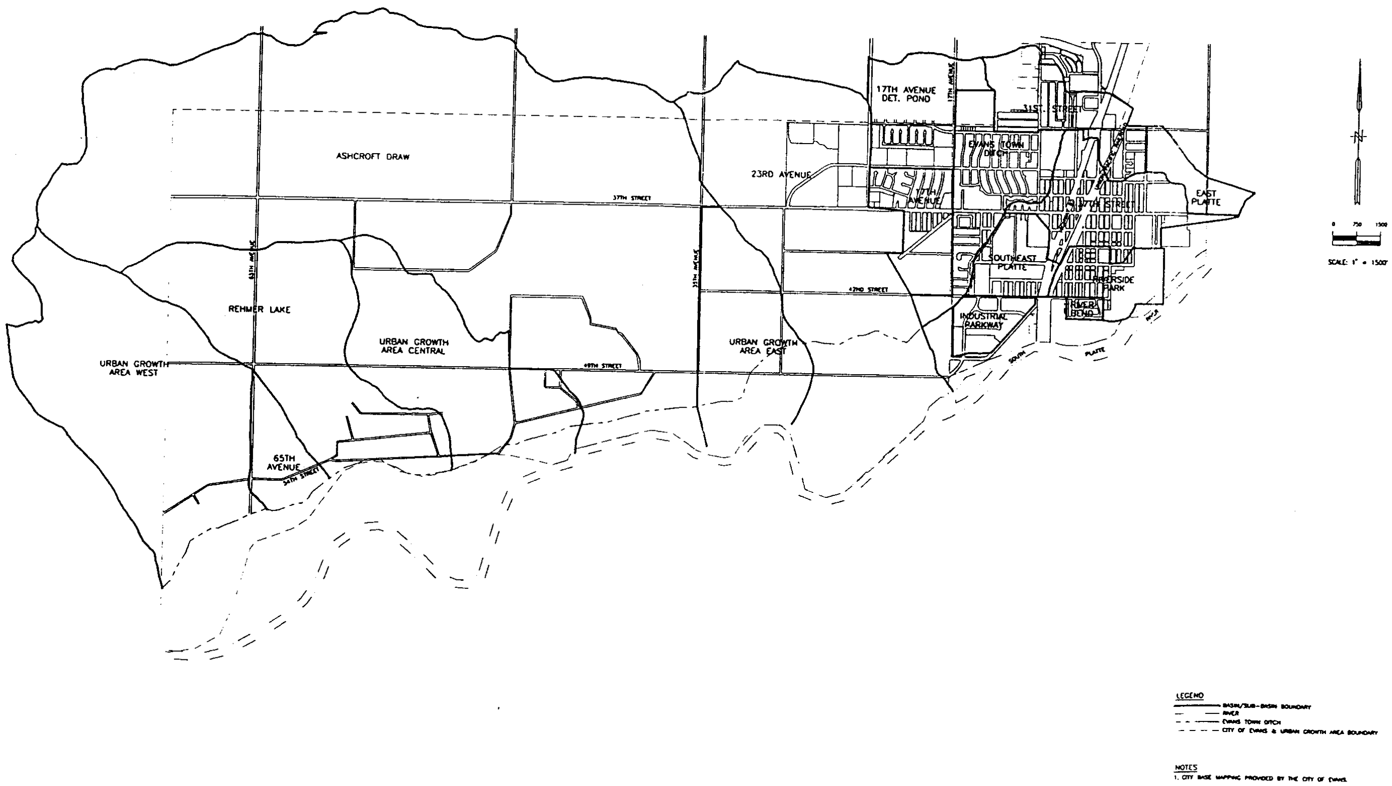
C. Areas Outside the Existing Basins

There area two areas within the city of Evans that were excluded from analysis as described below:

(1) The incorporated area just north of the 31st Street Basin drains north and becomes part of the city of Greeley's drainage system.

(2) The areas within the city limits that are east and southeast of the study area, along the South Platte River, and the areas in the UGA that lie between the ETD and the South Platte River. These areas are in the 100 year floodplain of the river where further development is discouraged or they discharge directly into the South Platte River with no distinct drainageway.

Figure 1



DRAINAGE BASINS
CITY AND URBAN GROWTH AREA
CITY OF EVANS MASTER DRAINAGE PLAN

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DATE: OCT. 1996
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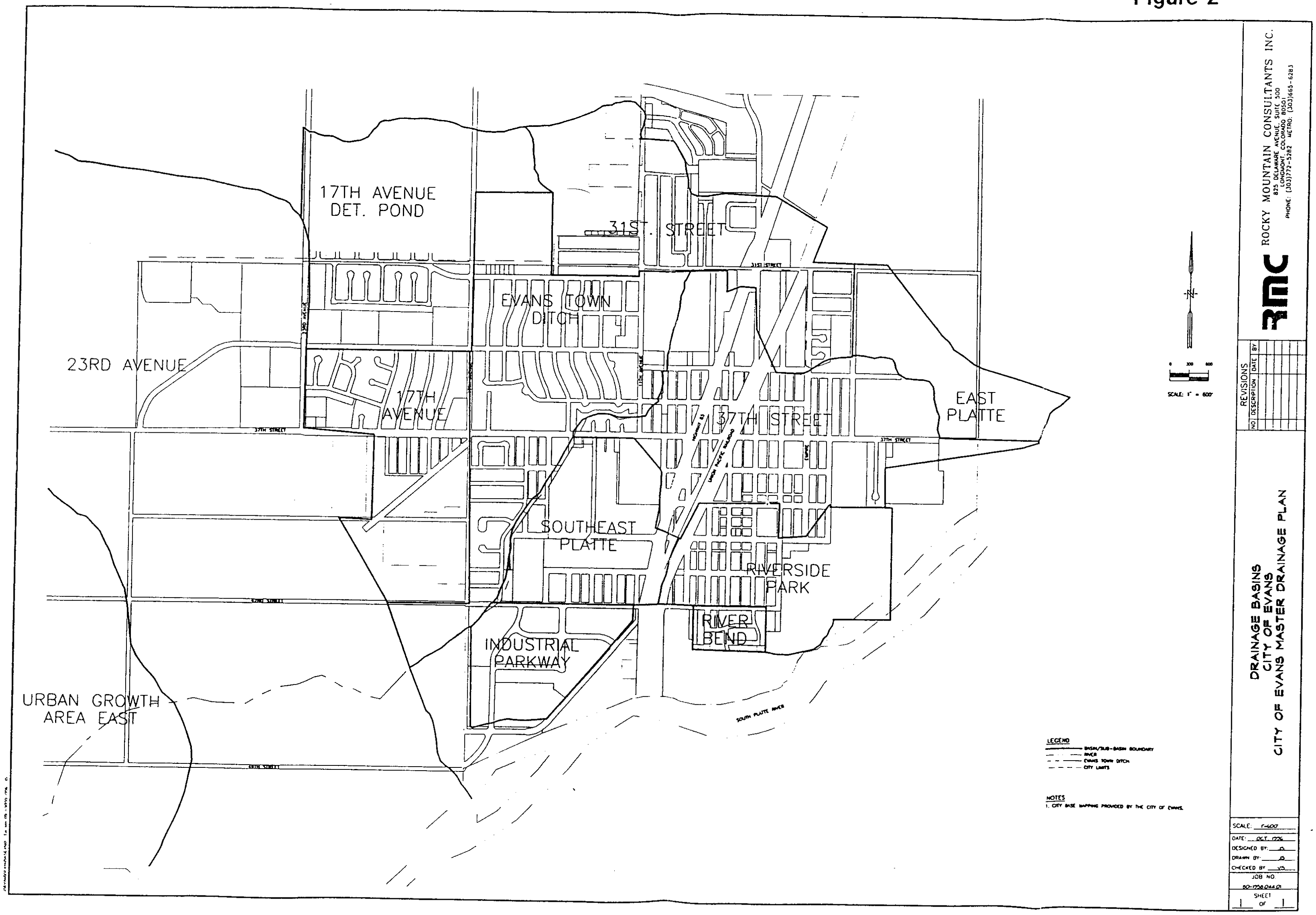
Figure 2


17TH AVENUE
DET. POND
31ST. STREET
EVANS TOWN
DITCH
23RD AVENUE
17TH
AVENUE
37TH STREET
EAST
PLATTE
SOUTHEAST
PLATTE
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PARK
RIVER
BEND
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DRAINAGE BASINS
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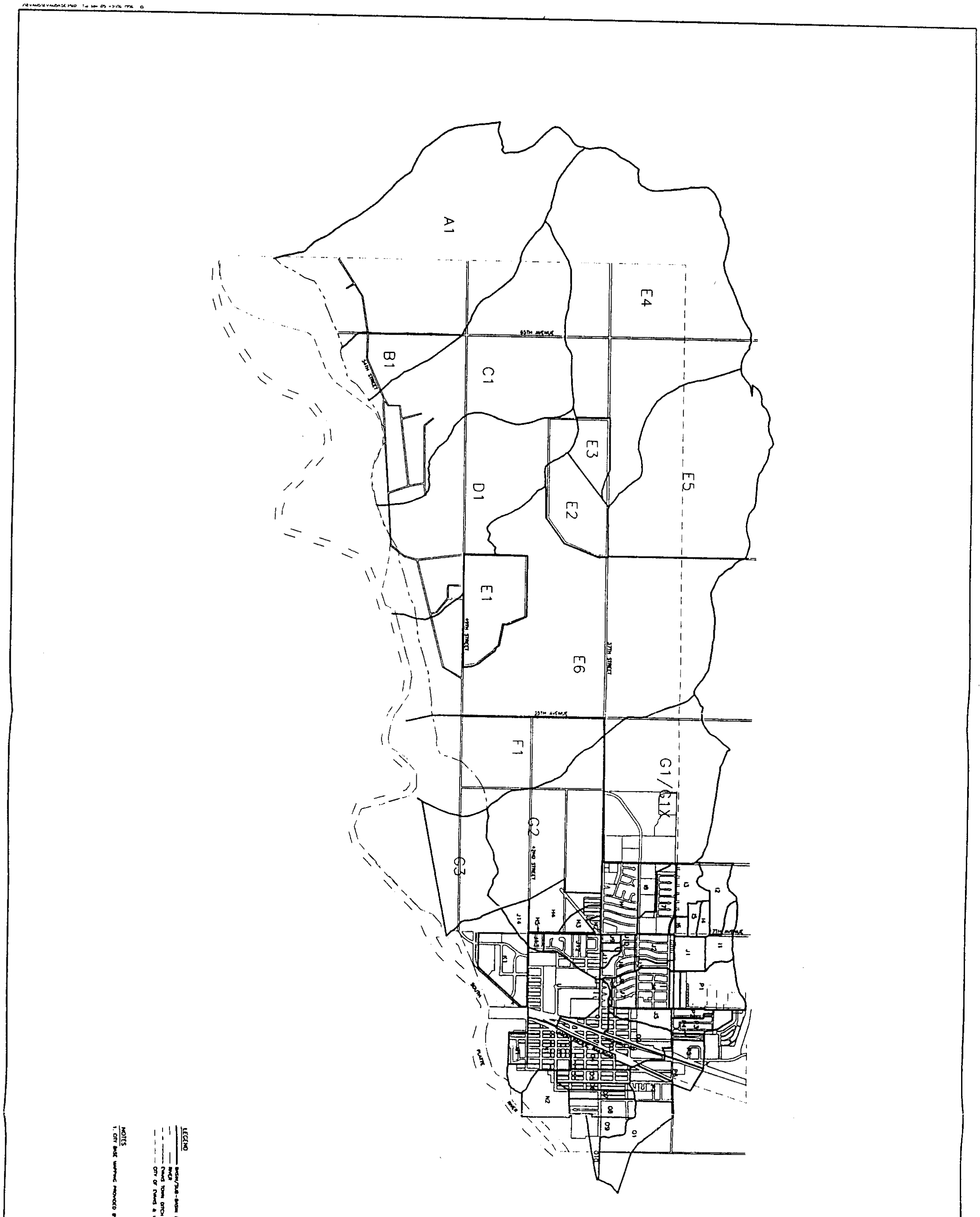

Figure 3

SUB-BASINS USED FOR HYDRAULIC ANALYSIS
CITY AND URBAN GROWTH AREA
CITY OF EVANS MASTER DRAINAGE PLAN

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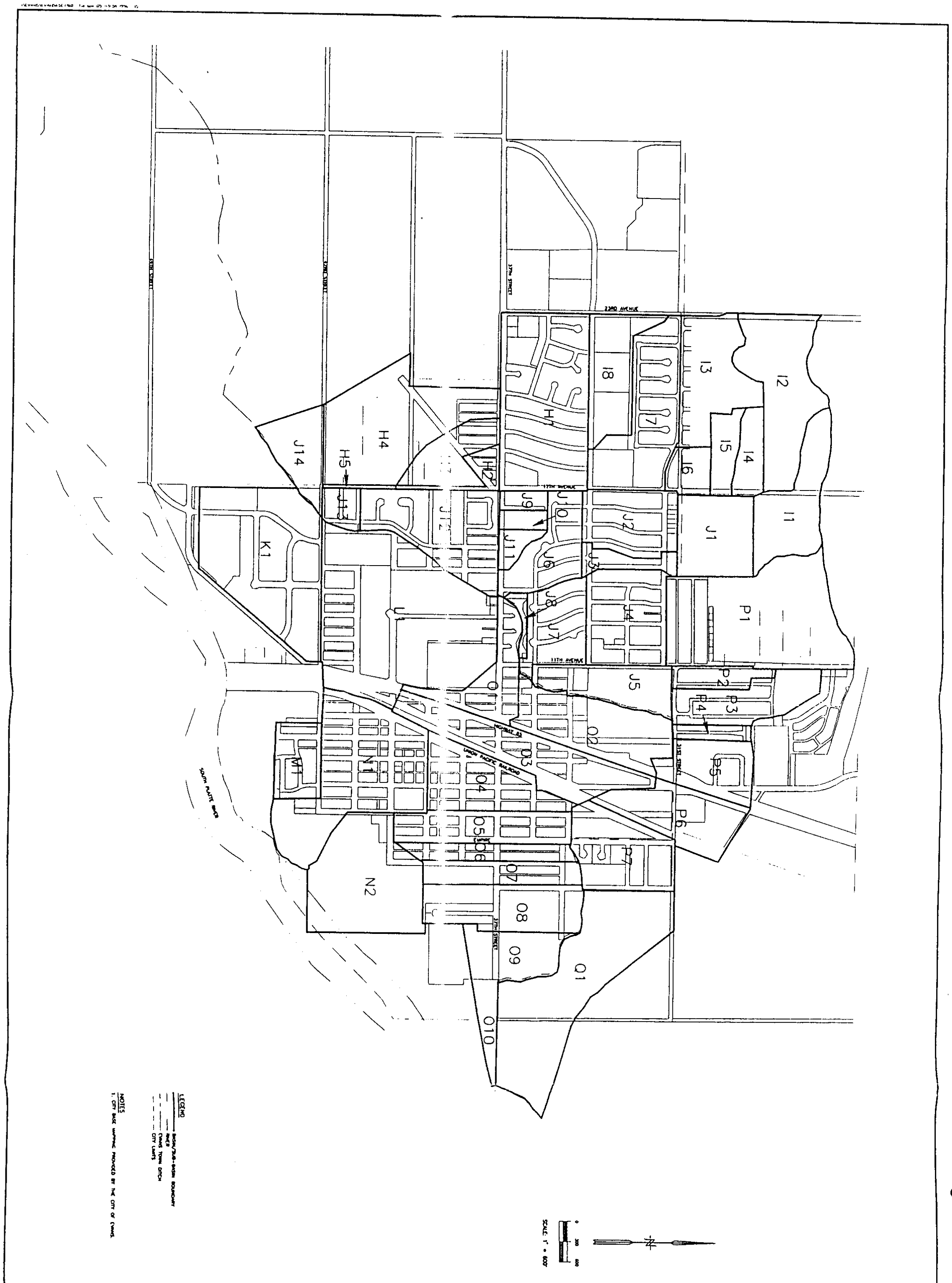
Figure 4



SUB-BASINS USED FOR HYDRAULIC ANALYSIS
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III. EXISTING DRAINAGE FACILITIES

III. EXISTING DRAINAGE FACILITIES

As part of the master planning efforts the existing storm drainage facilities were inventoried. The inventory and evaluation involved (1) review of subdivision and storm sewer construction plans, (2) field inspection to verify the plans and note additional facilities, and (3) evaluation of the hydraulic capacities of existing systems.

Drainage facilities in the UGA are natural channels, natural and man-made detention areas, and culvert road crossings. These facilities provide adequate flood relief in the undeveloped areas during minor and major storms with the possible exception of some undersized road crossings. Drainage facilities within the City include channels, detention ponds, and storm sewer systems to alleviate flooding problems during frequent storms. Table 1 summarizes the data for drainage facilities within the city. A brief description of the facilities within the City of Evans is provided in the following paragraphs.

A. CHANNELS

The only open channels within the city that were considered in the analysis are the main branch of the ETD, and the channel that drains to Riverside Pond and the South Platte River. Although there are other minor ditches running throughout the city, they are primarily irrigation ditches with very limited capacities. These will not effectively reduce stormwater runoff, therefore their effects as a stormwater conveyance system are negligible.

1. <u>Evans Town Ditch</u>

The Evans Town Ditch is a major irrigation ditch that consists of an unlined open channel and pipe distribution system. The ditch originates from the Big Thompson River in the UGA. The ditch divides at 42nd Street and Belmont Avenue. The southern division of the ditch will be omitted as a drainage facility for purposes of this study since it is composed of primarily underground pipe and small ditches with limited capacities. The northern division of the ditch, the main ditch channel, winds through town and then eventually empties into the South Platte River at 37th Street. The ditch goes underground at 31st Street and receives no stormwater runoff beyond that point. Information on hydraulic capacities of the ditch and ditch structures was obtained from the "Preliminary Engineering Report - Water Facilities and Related Future Estimations" written by WTS for the City of Evans in 1985 for use in the determination of potential ditch overtopping. The capacities of the ditch range from 547 cfs at the ditch headgate to 18 cfs at the most restrictive section of the ditch.

1. <u>Riverside Park Ditch</u>

This irrigation ditch was modeled because it conveys stormwater from parts of the Riverside Park Basin. Some of the water flowing in the ditch is diverted to the Riverside Pond. The ditch discharges into the South Platte River.

B. DETENTION FACILITIES

Only detention facilities that provide effective reduction of peak discharge during minor and major storm events were considered in this study. Storage-discharge relationships were estimated based on construction drawings or other information provided by the City of Evans. It was assumed in the hydraulic analysis that local detention facilities were designed correctly for given releases during a 100-year storm without overtopping of the pond embankments. The only regional detention facility in the City of Evans is the 17th Avenue Detention Pond, which has been analyzed in a previous study. The Riverside Pond acts partially as a downstream regional detention pond before releasing to the South Platte River, however it does not affect any conveyance systems or prevent flooding since it is downstream in the basin.

1. Green Meadows Subdivision Detention Pond #1

This is a local detention pond at Belmont and 39th Street. The maximum stormwater storage before overtopping is 0.62 acre-feet. A 24" CMP discharges from the pond into the ETD at a maximum rate of 10 cfs. It was assumed that the detention pond is sized so that no overtopping will occur during the 100-year storm event. If it does occur it will inundate the road and yards within the Green Meadows Subdivision. It will not enter the ETD due to the elevated ditch bank.

2. Green Meadows Subdivision Detention Pond #2

This is a local detention pond at Belmont and 41st Street. The stormwater storage volume available is 0.64 acre-feet. Discharge from the pond into the ETD is controlled by a 12-inch CMP outlet. The maximum discharge capacity of the pipe is approximately 6 cfs. It was assumed that the detention pond is sized so that no overtopping will occur during the 100-year storm event. If it does occur it will inundate the road and yards within the Green Meadows Subdivision. It will not enter the ETD due to the elevated ditch bank.

3. 32nd Street and 15th Avenue Detention Pond

Little information could be found on this pond. It was noted in the 1977 "West Evans Drainage Study" by Zoyiopoulos & Associates and was located in the field. The area draining to the pond was based on area drainage flows as determined by field reconnaissance. The maximum storage volume is 4.0 acre-feet with a maximum discharge of 2.0 cfs as noted in the West Evans Drainage drawings. This was assumed to be adequate storage to prevent overtopping in the 100-year storm For calculation purposes it was assumed the pond discharges to 32nd Street and flows toward 11th Avenue.

4. Platte Valley Subdivision Detention Pond

This local detention pond has little drainage area. The maximum storage capacity is 1 acre-foot. A 30-inch CMP discharges from the pond to the ETD at a maximum discharge capacity of 42.4 cfs. However, the 100-year runoff from the area draining to the pond is 11 cfs. Therefore 11 cfs was used for hydraulic calculations.

5. 37th Street Detention Areas

This area consists of a West and an East around Highway 85 at the 37th Street intersection. These areas are part of the 37th Street storm sewer system. Capacity of these detention areas was not able to be determined from available data. Maximum discharge from the East pond into the sewer system was estimated at 8.5 cfs.

C. STORM SEWER SYSTEMS

There are currently six major storm conveyance systems in Evans. A map of existing storm sewers can be found in Figure 5. For hydraulic calculations, the slope was assumed based on local topography, street slopes, or adjacent sewer slopes when no sewer construction plans were available.

1. 31st Street Storm Sewer

This system includes a branch that travels south along 11th Avenue where it connects into the 31st Street sewer. From 11th Avenue the storm sewer continues east along 31st Street and discharges just east of the Union Pacific Railroad into a ditch that flows to the State Farm Ditch. The sewer diameter ranges from 18-inches to 48-inches with capacities from 9 cfs to 97 cfs respectively. The purpose of this storm system is to provide stormwater conveyance for the areas north of 31st Street and the northwest section of the City of Evans adjacent to 11th Avenue during frequent storm events. Also included in the 31st Street storm sewer system is a 24 inch section that extends from 32nd Street, north along Empire Street and discharges into the same ditch leading to the State Farm Ditch.

2. 11th Avenue South Storm Sewer

This storm sewer is a 15 inch to 24 inch diameter RCP paralleling 11th Avenue and discharging directly into the ETD. It conveys runoff from subdivisions south of 31st Street and west of 11th Avenue. Maximum capacity of the system is 30 cfs.

3. <u>15th Avenue Storm Sewer</u>

This system conveys runoff from the area between 15th Avenue and east of 17th Avenue to the 37th Street West storm sewer. The sewer diameters range from 24 inch to 36 inch with capacities of 28 cfs to 45 cfs, respectively.

4. <u>37th Street West Storm Sewer</u>

Due to recent modifications to the 17th Avenue storm sewer, all flows west of 17th Avenue are assumed to stay in the 17th Avenue system. Therefore, it is assumed that the 37th Street West system originates at the intersection of 37th Street and 17th Avenue. The 37th Street west storm sewer extends along 37th Street east from 17th Avenue to 15th Avenue. It then extends south down Valmont to discharge into the ETD. This system carries runoff from adjacent subdivisions to the ETD. The sewer diameters range from 27 inch to 60 inch and have maximum capacities from 37 cfs to 307 cfs respectively.

5. <u>17th Avenue Storm Sewer</u>

This sewer system drains much of the area west of 17th Avenue. It consists of a main branch extending along 17th Avenue and a minor branch along 37th Street. Analysis involving this storm sewer was performed in a recent study titled "17th Avenue Drainage Basin" and will not be reanalyzed in the master plan. A copy of the 17th Avenue study is included in Appendix 3. Summarized information on the sewer system is included in Table 1.

6. <u>37th Street East Storm Sewer</u>

This system begins just west of Highway 85. It conveys stormwater through a series of detention areas around Highway 85 and then extends east along 37th Street. It outfalls directly into the South Platte River. The sewer ranges in diameter from 24 inches to 42 inches with a maximum capacity range of approximately 9 cfs to 43 cfs respectively. The purpose of this system is to prevent flooding of the areas surrounding 31st Street and transport runoff to the South Platte River during the initial storm. It serves as the primary stormwater conveyance for the City east of the railroad tracks.

Table 1. Inventory of Existing Facilities

Facility Name and/or Type	Location	Sewer Diamter (in)	Maximum Discharge Capacity (cfs)
31st St. Storm Sewer	Along 11th Ave., 30th St. to -----	18	9
	Along 11th Ave., --- to Pleasant Acres	27	26
	Along 11th Ave., Pleasant Acres to 31st St.	30	47
	Along 11th Ave., 32nd St. to 31st St.	18	9
	Along 31st St., 11th Ave. to High St.	30	62
	Along 31st St., High St. to Lakeside St.	30	78
	Along 31st St., Lakeside St. to Denver St.	36	144
	Along 31st St., Denver St. to Hwy. 85	42	76
	Along 31st St., Hwy 85 to ditch outfall	48	97
	Along 31st St., Hway 85 to ditch outfall	18	7
	Along Empire St., 32nd St. to ditch outfall	24	15
11th Ave. South Storm Sewer	Along 11th Ave., 34th St. to ETD outfall	24	30
15th Ave. Storm Sewer	Along 34th St., Belmont to 15th Ave.	27	24
	Along 15th Ave., from 34th St.	24	28
	Along 15th Ave., to 36th St.	27	39
	Along 15th Ave., from 36th St.	27	51
	Along 15th Ave., to 37th St. storm sewer	36	45
37th St. West Storm Sewer	Along 37th St., 17th Ave. to the private drive	24	32
	Along 37th St., private drive to west side of Centennial	27	36
	Along 37th St., Centennial School to Burlington	33	62
	Along 37th St., Burlington St. to Valmont	42	64
	Along Valmont to ETD outfall	60	307
17th Ave. Storm Sewer	Parralleling Marigold Ct., 36th St. to 37th St.	24	9
	Along 37th St., to Marigold St.	24	15
	Along 37th St., Marigold St. to Myrtle St.	24	15
	Along 37th St., Myrtle St. to Montrose St.	24	17
	Along 37th St., Montrose St. to 17th Ave. storm sewer	24	38
	Along 17th Ave., 34th St. to 37th St.	21	22
	Along 17th Ave., 37th St. to 38th St. Rd.	30	39
	Along 17th Ave., 38th St. Rd. to 39th St.	36	46
	Along 17th Ave., 39th St. to 40th St.	42	69
	Along 17th Ave., 40th St. to 41st St.	48	92
	Along 17th Ave., 41st St. to 42nd St.	60	183
	From 17th and 42nd to Overflow ditch outfall	60	195
37th St. East Storm Sewer	Along 37th St., St. Vrain St. to Hwy. 85	30	48
	Along Hwy. 85, 37th St. to 24" cmp	30	48
	Along Hwy. 85, Detention Pond West to 24" cmp	30	59
	Crossing Hwy. 85, connecting detention areas	24	9
	Along 37th St., Hwy. 85 to Union Pacific railroad	27	26
	Along 37th St., Railroad to Golden St.	27	12
	Along 37th St., Golden St. to Pueblo St.	30	16
	Along 37th St., Pueblo St. to Trinidad St.	30	34
	Along 37th St., Trinidad St. to east of Soco Pkwy.	33	30
	Along 37th St., Soco Pkwy. to Wastewater Plant	36	36
	Along 37th St., Wastewater Plant to South Platte outfall	42	43

Table 1. Inventory of Existing Facilities

Green Meadows Detention Ponds	Green Meadows Subdivision, Belmont and 39th St.	---	10
	Green Meadows Subdivision, Belmont and 41st St.	---	6
32nd and 15th Detention Pond*	Northeast corner of 32nd St. and 15th Ave. intersection	---	2
Platte Valley Detention Pond**	Platte Valley Subdivsion, between 15th and 11th Aves.	---	42
37th Street Detention Ponds	37th St. and Hwy. 85, East and West Ponds	---	9

NOTES:

The slope was estimated based on street slopes or topography. Discharge capacity will depend on actual street slope.

* Detention Pond Information from the "West Evans Drainage Study " by Zoyiopoulos & Associates.

** Discharge from the pond is 42 cfs, but 100-year runoff for the area draining to the pond is only 11 cfs.

IV. HYDROLOGIC ANALYSIS

IV. HYDROLOGIC ANALYSIS

A. General

Hydrologic analysis was performed to develop runoff flow rates and hydrograph data at various hydrologic points of interest within the study area. This information was then used to evaluate existing storm sewer systems, analyze potential flooding areas, formulate alternative designs for drainage improvements, and provide a basis for future drainage criteria.

The 5-year storm data was used for the initial storm analysis and the 100-year storm data was used for the major storm analysis. Methods for analysis and basin parameters were based on either the City of Greeley Storm Drainage Criteria Manual (GSDCM) or the Urban Storm Drainage Criteria Manual (USDCM).

B. Rainfall Data

Rainfall data used in the analysis was taken from the GSDCM one-hour point rainfall values. The one-hour point rainfall values for Greeley are based on the NOAA Atlas for Colorado. These same values are applicable also to the city of Evans and its UGA due to its close proximity with the City of Greeley. These values are duplicated below in Table 2.

Table 2. One-hour Point Rainfall Values - Greeley, CO

ONE-HOUR POINT RAINFALL (INCHES)				
2-year	5-year	10-year	50-year	100-year
1.04	1.49	1.76	2.51	2.78

C. Soil Characteristics

The soils in the study area are in the hydrologic group B as defined by the Soil Conservation Service and the Soil Survey Maps of Weld County. Type B soils are sandy loams with moderate infiltration rates, (type A soils have the fastest infiltration rates and type D have the slowest). The Urban Drainage and Flood Control District (UDFCD) analyzed runoff data for each hydrologic soil group and established standard values for infiltration and decay coefficients to be used with CUHP. These values are presented in the USDCM Vol. I and are reproduced below in Table 3.

Table 3. Recommended Horton's Equation Parameters to be Used with CUHP Analysis

SCS Hydrologic Soil Group	Infiltration (in/hr) Initial	Infiltration (in/hr) Final	Decay Coefficient
A	5.0	1.0	0.0007
B	4.5	0.6	0.0018
C	3.0	0.5	0.0018
D	3.0	0.5	0.0018

D. Basin Imperviousness

The percent impervious values used in the runoff modeling were based on land use and the impervious percentage for each type of land use as defined by the USDCM, see Table 4 for the values used. When a subbasin included various land uses, a weighted average (an average based on the "sub" area's percentage of the total area,) was calculated to determine the percent impervious value to be used. The existing, or historical, land use was determined from aerial surveys, current maps, and field reconnaissance surveys. The planned, or developed, land use was based on the City of Evans 1996 Comprehensive Plan.

E. Runoff Modelling

1. Colorado Urban Hydrograph Procedure

The Colorado Urban Hydrograph Procedure (CUHP) was used to compute runoff rates and generate storm hydrographs for each subbasin. Only a portion of rainfall runs off the land to the drainageways. Much of the rain is intercepted by vegetation, infiltration into the ground, storage in surface depressions, and surface retention. CUHP is a method for determining the amount of actual storm runoff that will result from the design rainfall. CUHP takes into account soil infiltration, imperviousness, depression losses, and soil classification. The input parameters for each subbasin are outlined in Table 5. Storm hydrographs were generated for the 5- and 100-year return periods. Summarized results of the CUHP analysis for historic peak flows at seclected design points and developed peak flows at the same points are given in Tables 6 and 7. Detailed calculations are in Appendix 1. The calculated historic flowrates were used only as a guideline for determining the detention release criteria. They were not used for design. The developed peak flows were used for hydraulic calculations in the design of alternative improvements.

Based on the City of Greeley Storm Drainage Criteria Manual (GSDCM) recommendations, subbasins less than 90 acres in size were modeled using the CUHP rational method. For these subbasins a time of concentration was calculated based on Equation 3-4 of the Urban Storm Drainage Criteria Manual (USDCM).

Both historic and developed flow rates were calculated for the 5- and 100-year storms. The majority of land within the city of Evans is already developed. Therefore, within the city the historic flow rates were the same as the developed flow rates except for the Southeast Platte, Riverside Park, and East Platte basins. Many of the historical basin boundaries in the UGA were slightly different than the developed basin boundaries due to planned streets and developments. Therefore, the study areas will vary in the UGA.

2. Stormwater Management Model

The personal computer version of the UDFCD Stormwater Management Model (SWMM) was used to route the CUHP storm hydrographs through part of the 31st Street and 37th Street basins. The SWMM model routes hydrographs through a drainageway system based on the kinematic wave approach utilizing the Manning's equation. The SWMM calculated flowrate at each location along the drainageway accounts for variations in the time to peak of the flows. Therefore, the resulting flows are more accurate than if the peaks were simply added together as the storm travels through the drainageway. The 31st and 37th Street storm sewers have long branches that collect runoff from 6 to 8 subbasins along its length. Due to the length of the system and the narrow subbasins, the resulting flow rate would be much higher if the flows were added than if they are properly routed with the SWMM model. The other watersheds have fewer subbasins draining to a single sewer system, have relatively square drainage areas, or have less extensive systems, therefore the flows are added as runoff travels through the drainageway. These numbers will result in slightly higher flowrates and a conservative analysis but are sufficiently accurate for this study. Detailed output from the SWMM analysis is in Appendix 1. A summary of the results is given in Table 8.

For the SWMM analysis, the storm sewer systems were modeled with a Manning's value, n, of 0.016. Overflow elements were defined as a trapezoidal section representative of the street with an "n" value of 0.020 as recommended by the SWMM User's Manual.

Table 4

RECOMMENDED RUNOFF COEFFICIENTS AND PERCENT IMPERVIOUS

LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	FREQUENCY 2	5	10	100
Business:					
Commercial Areas	95	.87	.87	.88	.89
Neighborhood Areas	70	.60	.65	.70	.80
Residential:					
Single-Family	*	.40	.45	.50	.60
Multi-Unit (detached)	50	.45	.50	.60	.70
Multi-Unit (attached)	70	.60	.65	.70	.80
1/2 Acre Lot or Larger	*	.30	.35	.40	.60
Apartments	70	.65	.70	.70	.80
Industrial:					
Light Areas	80	.71	.72	.76	.82
Heavy Acres	90	.80	.80	.85	.90
Parks, Cemetaries:	7	.10	.18	.25	.45
Playgrounds:	13	.15	.20	.30	.50
Schools:	50	.45	.50	.60	.70
Railroad Yard Areas	20	.20	.25	.35	.45
Undeveloped Areas:					
Historic Flow Analysis-	2	(See "Lawns")			
Greenbelts, Agricultural					
Offsite Flow Analysis (when land use not defined)	45	.43	.47	.55	.65
Streets:					
Paved	100	.87	.88	.90	.93
Gravel (Packed)	40	.40	.45	.50	.60
Drive and Walks:	96	.87	.87	.88	.89
Roofs:	90	.80	.85	.90	.90
Lawns, Sandy Soil	0	.00	.01	.05	.20
Lawns, Clayey Soil	0	.05	.15	.25	.50

NOTE: These Rational Formula coefficients may not be valid for large basins.

Table 5. CUHP Input Parameters

Basin ID	Area (acres)	Catchment Length (mi)	Centroid Distance (mi)	% Imper. (dev.)	Elevation Change	Catchment Slope (ft/ft)	Time of Concentration (min)	Retention		Infiltration Rate		Horton's Decay Coeff.
								Pervious (in)	Impervious (in)	Initial	Final	
A1	1085.05	1.96	1.24	2	200	0.0193		0.4	0.05	4.5	0.6	0.0018
B1	121.56	0.82	0.319	2	100	0.0231		0.4	0.05	4.5	0.6	0.0018
C1	780.27	2.01	1.012	10	210	0.0198		0.4	0.05	4.5	0.6	0.0018
D1	566.62	1.52	0.888	8	150	0.0187		0.35	0.05	4.5	0.6	0.0018
E1	208.27	1.4	0.78	50	120	0.0162		0.35	0.05	4.5	0.6	0.0018
E2	135.44	0.7	0.417	42	70	0.0189		0.35	0.05	4.5	0.6	0.0018
E3	75.68	0.91	0.553	42	90	0.0187	36.69	0.35	0.05	4.5	0.6	0.0018
E4	1205.02	2.17	1.521	2	160	0.014		0.4	0.05	4.5	0.6	0.0018
E5	664.01	1.25	0.674	2	140	0.0212		0.4	0.05	4.5	0.6	0.0018
E6	1218.3	2.77	1.488	23	200	0.0137		0.35	0.05	4.5	0.6	0.0018
F1	289.76	1.01	0.499	53	104	0.0195		0.35	0.1	4.5	0.6	0.0018
J1	31.76	0.44	0.16	42	28	0.012	22.91	0.35	0.05	4.5	0.6	0.0018
J2	31.27	0.39	0.197	42	24	0.0116	21.44	0.35	0.05	4.5	0.6	0.0018
J3	8.79	0.3	0.128	42	22	0.0139	18.80	0.35	0.05	4.5	0.6	0.0018
J4	38.44	0.48	0.226	44	28	0.011	24.08	0.35	0.05	4.5	0.6	0.0018
J5	22.52	0.42	0.205	47	21	0.0095	22.32	0.35	0.05	4.5	0.6	0.0018
J6	26.57	0.43	0.228	42	30	0.0132	22.61	0.35	0.05	4.5	0.6	0.0018
J7	29.84	0.4	0.172	46	20	0.0095	21.73	0.35	0.05	4.5	0.6	0.0018
J8	3.09	0.064	0.034	2	1	0.003	11.88	0.35	0.05	4.5	0.6	0.0018
J9	4.92	0.19	0.075	56	15	0.015	15.57	0.35	0.05	4.5	0.6	0.0018
J10	4.86	0.14	0.079	51	18	0.0244	14.11	0.35	0.05	4.5	0.6	0.0018
J11	5.98	0.2	0.097	42	12	0.0114	15.87	0.35	0.05	4.5	0.6	0.0018
J12	48.43	0.34	0.12	42	12	0.0067	19.97	0.35	0.05	4.5	0.6	0.0018
J13	6.29	0.23	0.106	42	2	0.0016	16.75	0.35	0.05	4.5	0.6	0.0018
J14	21.83	0.21	0.272	42	7	0.0063	16.16	0.35	0.05	4.5	0.6	0.0018
K1	79.97	0.65	0.291	85	35	0.0102	29.07	0.4	0.1	4.5	0.6	0.0018
L1	128.62	0.75	0.385	83	20	0.005	32.00	0.4	0.1	4.5	0.6	0.0018
M1	17.83	0.34	0.143	42	10	0.0056	19.97	0.35	0.05	4.5	0.6	0.0018
N1	58.88	0.68	0.225	42	16	0.0044	29.95	0.35	0.05	4.5	0.6	0.0018
N2	67.7	0.41	0.227	27	11	0.0051	22.03	0.4	0.05	4.5	0.6	0.0018
O1	24.58	0.52	0.072	60	20	0.0073	25.25	0.35	0.1	4.5	0.6	0.0018
O2	43.64	0.49	0.228	68	20	0.0077	24.37	0.35	0.1	4.5	0.6	0.0018
O3	46.57	0.24	0.095	65	8	0.0063	17.04	0.35	0.1	4.5	0.6	0.0018
O4	32.02	0.26	0.042	51	1	0.0007	17.63	0.35	0.1	4.5	0.6	0.0018
O5	23.22	0.36	0.066	42	2	0.001	20.56	0.35	0.05	4.5	0.6	0.0018
O6	19.08	0.28	0.046	47	7	0.0047	18.21	0.35	0.05	4.5	0.6	0.0018
O7	19.98	0.3	0.097	50	10	0.0063	18.80	0.35	0.05	4.5	0.6	0.0018
O8	35.94	0.36	0.13	50	11	0.0058	20.56	0.35	0.05	4.5	0.6	0.0018
O9	26.7	0.32	0.107	65	1	0.0006	19.39	0.4	0.1	4.5	0.6	0.0018
O10	5.48	0.23	0.112	80	1	0.0008	16.75	0.4	0.1	4.5	0.6	0.0018
P1	85.83	0.72	0.376	53	58	0.0152	31.12	0.35	0.05	4.5	0.6	0.0018
P2	10.4	0.3	0.133	46	20	0.0126	18.80	0.35	0.05	4.5	0.6	0.0018
P3	27.41	0.44	0.218	54	40	0.0172	22.91	0.35	0.05	4.5	0.6	0.0018
P4	6.07	0.22	0.096	70	28	0.0241	16.45	0.35	0.1	4.5	0.6	0.0018
P5	24.04	0.32	0.182	70	27	0.016	19.39	0.35	0.1	4.5	0.6	0.0018
P6	32.83	0.36	0.023	72	11	0.0058	20.56	0.35	0.1	4.5	0.6	0.0018
P7	38.63	0.31	0.092	57	6	0.0037	19.09	0.35	0.05	4.5	0.6	0.0018
Q1	86.31	0.87	0.488	65	2	0.0004	35.52	0.35	0.05	4.5	0.6	0.0018

Subasin drainage already calculated for G, H, and I in previous studies. Copies of the studies are included in the Appendices.

Table 6. Historic Peak Flows for Selected Design Points

Basin Name	Basin ID	Design Point Description	Area (acres)	5-Year Peak Flows (cfs)	100-Year Peak Flows (cfs)
Urban Growth Area West	*A1	Drainage channel at ETD outfall	858.58	121	827
65th Avenue	*B1	Drainage channel at ETD outfall	209.37	49	301
Rehmer Lake	*C1	Drainage channel at ETD outfall	765.84	101	678
Urban Growth Area Central	*D1	Drainage channel at ETD outfall	663.91	136	733
Ashcroft Draw	*E1-E3,E6	Ashcroft Draw at ETD crossing	1539.03	104	1477
Ashcroft Draw	*E4	Ashcroft Draw at the Arrowhead Lake inlet	1204.78	104	763
Ashcroft Draw	*E5	Minor drainage channel at the Arrowhead Lake inlet	637.28	114	742
Urban Growth Area East	*F1	Drainage channel at ETD outfall	289.76	72	378
Evans Town Ditch	J1	32nd Street at 15th Avenue	31.76	40	110
Evans Town Ditch	J2	34th Street at Belmont	31.27	40	111
Evans Town Ditch	J3	34th Street at 15th Avenue	8.79	12	34
Evans Town Ditch	J4	34th Street at 11th Avenue	38.44	48	130
Evans Town Ditch	J5	ETD at 31st Street	22.52	30	80
Evans Town Ditch	J6	37th Street at 15th Avenue	26.57	33	93
Evans Town Ditch	J7	ETD at 11th Avenue crossing	29.84	41	109
Evans Town Ditch	J8	Detention area between ETD and 36th Street	3.09	2	11
Evans Town Ditch	J9	37th Street at the privated drive east of 17th Avenue	4.92	10	23
Evans Town Ditch	J10	37th Street at west corner of Centennial School	4.86	9	24
Evans Town Ditch	J11	37th Street at Burlington	5.98	9	24
Evans Town Ditch	J12	39th Street at Belmont	48.43	65	180
Evans Town Ditch	J13	41st Street at Belmont	6.29	9	26
Evans Town Ditch	J14	ETD at 42nd Street crossing	21.83	32	89
Industrial Parkway	K1	ETD Overflow ditch at Brantner crossing	79.97	148	303
Southeast Platte	L1	Highway 85 at 42nd Street	128.62	132	366
River Bend	M1	43rd Street discharge point	17.83	24	66
Riverside Park	N1	Riverside Pond inlet and discharge pipe	58.88	62	173
Riverside Park	N2	Irrigation ditch at the South Platte River outfall	67.7	28	178
37th Street	O1	37th Street at St. Vrain	24.58	36	87
37th Street	O2	36th Street at Idaho	43.64	74	167
37th Street	O3	37th Street at the railroad	46.57	92	213
37th Street	O4	37th Street at Boulder	32.02	51	132
37th Street	O5	37th Street at Golden	23.22	30	84
37th Street	O6	37th Street at Empire	19.08	29	77
37th Street	O7	37th Street at Pueblo	19.98	31	79
37th Street	O8	37th Street at Trinidad	35.94	53	137
37th Street	O9	37th Street just past Soco Parkway	26.7	49	114
37th Street	O10	37th Street at the wastewater treatment plant	5.48	12	25
31st Street	P1	31st Steet at 11th Avenue	85.83	106	264
31st Street	P2	31st Street at High	10.4	15	40
31st Street	P3	31st Street at Lakeside	27.41	41	102
31st Street	P4	31st Street at Denver	6.07	12	27
31st Street	P5	31st Street at Highway 85 - west side	24.04	48	107
31st Street	P6	31st Street between Highway 85 and the railroad	32.83	64	140
31st Street	P7	32nd Street at Empire	38.63	66	159
East Platte	Q1	Study area boundary	86.31	66	213

*Basins A thru F may have slightly different boundaries than the developed basins due to additional streets and developments.
Basins G, H, and I were analyzed in previous studies. Copies of these studies are included in the Appendices.

Table 7. Developed Peak Flows for Selected Design Points

Basin Name	Basin ID	Design Point Description	Area (acres)	5-Year Peak Flows (cfs)	100-Year Peak Flows (cfs)
Urban Growth Area West	*A1	Drainage channel at ETD outfall	1085.05	130	917
65th Avenue	*B1	Drainage channel at ETD outfall	121.56	30	176
Rehmer Lake	*C1	Drainage channel at ETD outfall	780.27	138	729
Urban Growth Area Central	*D1	Drainage channel at ETD outfall	566.62	121	581
Ashcroft Draw	*E1	Hill-n-Park discharge into the Ashcroft Draw	208.27	225	586
Ashcroft Draw	*E2	Arrowhead subdivision at Ashcroft Draw outfall	135.44	170	463
Ashcroft Draw	*E3	Arrowhead subdivision at the Arrowhead Lake inlet	75.68	71	197
Ashcroft Draw	*E4	Ashcroft Draw at the Arrowhead Lake inlet	1205.02	118	856
Ashcroft Draw	*E5	Minor drainage channel at the Arrowhead Lake inlet	664.01	122	790
Ashcroft Draw	*E6	Ashcroft Draw at the ETD	1218.3	336	1273
Urban Growth Area East	*F1	Drainage channel at ETD outfall	289.76	445	1124
Evans Town Ditch	J1	32nd Street at 15th Avenue	31.76	40	110
Evans Town Ditch	J2	34th Street at Belmont	31.27	40	111
Evans Town Ditch	J3	34th Street at 15th Avenue	8.79	12	34
Evans Town Ditch	J4	34th Street at 11th Avenue	38.44	48	130
Evans Town Ditch	J5	ETD at 31st Street	22.52	30	80
Evans Town Ditch	J6	37th Street at 15th Avenue	26.57	33	93
Evans Town Ditch	J7	ETD at 11th Avenue crossing	29.84	41	109
Evans Town Ditch	J8	Detention area between ETD and 36th Street	3.09	2	11
Evans Town Ditch	J9	37th Street at the privated drive east of 17th Avenue	4.92	10	23
Evans Town Ditch	J10	37th Street at west corner of Centennial School	4.86	9	24
Evans Town Ditch	J11	37th Street at Burlington	5.98	9	24
Evans Town Ditch	J12	39th Street at Belmont	48.43	65	180
Evans Town Ditch	J13	41st Street at Belmont	6.29	9	26
Evans Town Ditch	J14	ETD at 42nd Street crossing	21.83	32	89
Industrial Parkway	K1	ETD Overflow ditch at Brantner crossing	79.97	148	303
Southeast Platte	L1	Highway 85 at 42nd Street	128.62	220	456
River Bend	M1	43rd Street discharge point	17.83	24	66
Riverside Park	N1	Riverside Pond inlet and discharge pipe	58.88	62	173
Riverside Park	N2	Irrigation ditch at he South Platte River outfall	67.7	59	211
37th Street	O1	37th Street at St. Vrain	24.58	36	87
37th Street	O2	36th Street at Idaho	43.64	74	167
37th Street	O3	37th Street at the railroad	46.57	92	213
37th Street	O4	37th Street at Boulder	32.02	51	132
37th Street	O5	37th Street at Golden	23.22	30	84
37th Street	O6	37th Street at Empire	19.08	29	77
37th Street	O7	37th Street at Pueblo	19.98	31	79
37th Street	O8	37th Street at Trinidad	35.94	53	137
37th Street	O9	37th Street just past Soco Parkway	26.7	49	114
37th Street	O10	37th Street at the wastewater treatment plant	5.48	12	25
31st Street	P1	31st Steet at 11th Avenue	85.83	106	264
31st Street	P2	31st Street at High	10.4	15	40
31st Street	P3	31st Street at Lakeside	27.41	41	102
31st Street	P4	31st Street at Denver	6.07	12	27
31st Street	P5	31st Street at Highway 85 - west side	24.04	48	107
31st Street	P6	31st Street between Highway 85 and the railroad	32.83	64	140
31st Street	P7	32nd Street at Empire	38.63	66	159
East Platte	Q1	Study area boundary	86.31	116	264

*Basins A thru F use the drainage criteria of 1cfs/acre release for the 100-year storm, for future developments. Therefore, the values calculated by CUHP are not used for the conceptual design analysis.

Basins G, H and I are analyzed in previous studies. These studies are included in the Appendices.

Table 8. SWMM Analysis Results

SUMMARY OF SWMM ANALYSIS RESULTS			
Description	EPA SWMM	Peak Discharge (cfs)	
	Node	5-year	100-year
37th Street East Storm Sewer			
37th St. at the west side of the railroad	1	11	11
37th St. and Golden St.	2	60.3	139.1
37th St. and Empire St.	3	86.6	219.2
37th St. and Pueblo St.	4	111.1	288.7
37th St. and Trinidad St.	5	132.1	342.8
37th St. just east of Soco Parkway	6	160.2	455.7
37th St. at the Wastewater Treatment Plant	7	179.6	522.9
31st Street Storm Sewer			
31st St. and 11th Avenue	1	77.62	160
31st St. and High St.	2	89	193.9
31st St. and Lakeside St.	3	123.3	291.6
31st St. and Denver St.	4	132.6	307.9
31st St. at the west side of Highway 85	5	159.4	392.7

V. EXISTING DRAINAGE PROBLEMS

V. EXISTING DRAINAGE PROBLEMS

It is not the intent of this study to address flooding problems for specific streets or subdivisions. The identification of potential flooding is based on calculated runoffs and the capacities of the existing systems. The results are used to determine generalized areas within a drainage basin where flooding may occur.

The drainage problems that exist within Evans and its UGA are relatively mild and few. There are some locations within the city that will experience localized flooding during even the frequent storms. However, this flooding will be more of a nuisance than a threat to life and property. At this time, Evans drainage system does not require costly and immediate improvements to prevent major property damage or unsafe conditions during a minor storm. As the city and its UGA develop further, the drainage systems will require some modifications or replacements to promote safe and efficient transport of stormwater.

A. Potential Problem Areas

The majority of Evans' storm drainage systems are inadequately sized to convey the 5-year storm. A discussion of the potential problems within each basin and possible solutions is given in the Conceptual Design section of this report. However, there are four areas that experience the predominant flooding problems which create a hindrance to traffic flow and residential access. These areas are outlined below.

1. <u>37th Street at the Highway 85 Intersection</u>

The flooding of the intersection of 37th Street and Highway 85 is a frequent nuisance. A major storm sewer system begins west of the highway and travels east down 37th street to the South Platte River. There are several reasons the storm sewer system is not adequate at the intersection with Highway 85:

(a) The intersection is not sufficiently crowned to prevent stormwater inundation of the highway.

(b) Three detention areas are located at the intersection, however these ponds do not have sufficient access for the areas' drainage or are not adequately sized. The West Pond between the west service road and Idaho Street is surrounded by an embankment that allows stormwater to enter from the north only. Therefore, it may not be utilized to its full potential.

(c) Two 30 inch sewers, one from the West Pond detention area and one from the 37th Street storm sewer, converge at a 24 inch cmp that conveys the runoff among the detention areas and on east through the 37th Street sewer system. Due to the lower capacity of the

24 inch, the system's capacity will be exceeded by approximately 145 cfs in the 5-year event and 405 cfs in the 100-year event. This excess will overflow into the streets and prevent further draining of the pond and western 37th Street system.

(d) 37th Street has a relatively steep slope as it comes into Highway 85. Between Highway 85 and the railroad the land levels out. This does not provide for adequate runoff from the area and causes sump areas to develop around the intersection.

(e) Projected overflows from the ETD add to the runoff congregating at the intersection.

Flooding of Highway 85 can cause a considerable hindrance to traffic flow since Highway 85 constitutes a major north-south traffic route for Evans and Greeley. Residences in the area are far enough away from the flooding areas that they should not be affected by the problems. Some local businesses, especially on the west side of the intersection, may be in danger of some parking lot flooding. The problems will be magnified during the 100-year storm and may include some flooding of the local businesses.

2. <u>31st Street at the Highway 85 Intersection</u>

Stormwater flow that exceeds the 31st Street storm sewer capacity will flow in the street toward Highway 85. Street flooding may occur as the excess runoff ponds along the west side of Highway 85. The storm sewer capacities are adequate to handle the 5-year flows until the sewer reaches the Denver Street catchment. At this point a decrease in sewer slope causes a sudden decrease in the system capacity. Excess flows, about 62 cfs in the 5-year storm, are then carried by the street to Highway 85 where another 33 cfs from subbasin drainage is flowing. The intersection is slightly crowned so that most runoff in excess of the storm sewer capacity will be detained on the west side of Highway 85. West of Highway 85 this may cause local flooding of nearby business parking lots and a hindrance to traffic flow in the adjoining streets. During the 100-year storm these problems will be of a larger magnitude. They may include flooding of local businesses and may temporarily prevent traffic flow at the intersection.

3. <u>The "Old Town" Section of Evans</u>

The areas within Riverside Park Basin and the southeast section of 37th Street Basin have extremely flat terrain. There is little or no slope in these areas to provide efficient drainage of stormwater. Also, there are no well defined flow paths in the area. Stormwater that does not infiltrate into the ground will collect at the low spots until it evaporates. Due to the flat terrain, the stormwater ponding encroaches on numerous lawns and streets. In the 100-year storm there is potential for flooding of local residences and streets.

4. <u>Evans Town Ditch Overflows</u>

During the 100-storm it is estimated that approximately 680 cfs will spill out of the ETD into adjacent basins, the largest amounts overspilling at Valmont and at 11th Avenue. These discharges greatly increase the flowrates for the adjacent basins, Southeast Platte and 37th Street. Overflow of the ditch in such large quantities may cause erosion or embankment failure of the ditch. It may also cause localized flooding around inlets and street culverts where stormwater enters the ditch or enters systems leading to the ditch. Analysis of the 5-year event indicates small amounts of overspill out of the ETD, but these amounts should not create any significant flooding problems around the ditch areas.

VI. CONCEPTUAL DESIGN

VI. CONCEPTUAL DESIGN

A. Basis for Conceptual Design

As part of the master drainage study, alternative improvements were developed to reduce flooding and provide adequate drainage for existing and future conditions. The following improvement alternatives are for **planning purposes only**. Further detailed analysis should be completed and incorporated into the final design of any improvements. Hydraulic analysis and conceptual design were completed for each basin and are included in the report. The following alternatives were considered for the conceptual design of drainage system improvements:

- Construction of open channel drainageways with a linear park system which includes bike paths, open space, and park areas.

- Improvement of natural drainage channels

- Construction of roadside ditches

- Installation or replacement of underground storm sewer systems

- Use of the ETD as a storm drainage system

- Construction of regional detention facilities

The improvements were designed to meet the GSDCM recommended criteria when possible. The channel designs and restrictions for ditches, open channels, and storm sewers were also based on the GSDCM. These design criteria are based on allowable depths, velocities, and street flows.

For hydraulic calculations the professional edition of Flowmaster for Windows was utilized. Flowmaster is a computer program that calculates flows and pressures based on the Manning's equation. The Manning's "n" values used were (1) n=0.013 for Reinforced Concrete Pipe; (2) n=0.024 for Corrugated Metal Pipe; and (3) n= 0.030 for all open channels and natural drainageways. Representative cross-sections of natural channels were estimated from USGS maps and modeled on Flowmaster. These cross-sections represent the channel only at specific locations and will vary along the channel. Detailed analysis of individual channels is recommended prior to any modifications.

For conceptual design in the UGA it was assumed that storm drainage from future developments will be restricted to detention with 1cfs/acre maximum discharge during the 100-year storm and the 5-year existing flowrate discharge during the 5-year storm. The historic flow rates for the UGA were used to determine this drainage criteria for future developments in this area. The developed flow rates used for hydraulic modeling in the UGA were based on the assumption that all future developments would adhere to the adopted drainage criteria of detention and release at 1cfs/acre for the 100-year storm. The drainage criteria for the City of Evans is presented in Volume II of this report.

B. Conceptual Design of Alternative Improvements

Wherever practiced, RMC recommends the development of linear parks along all open channels including the natural channels and the ETD. These parks would follow the channel and include bike paths, picnic areas, and open space. This will add ambiance and provide access to natural areas for residents of Evans as it grows. The easement widths noted on Figures 7 thru 19 include ample space for the 100-year storm flows and the proposed linear parks. An example of a storm drainage / linear park system is shown in Figure 6.

The amount of runoff will increase in the channel as it flows downstream, therefore the need for erosion and control structures will increase downstream. So, for all open channels improvements, RMC recommends that as development of the basin occurs the drainage channel improvements be made first at the channel outfall. As development continues, the improvements should be made progressively upstream.

With some exceptions noted herein, it is recommended that use of the ETD as a future stormwater conveyance system should be prohibited. The ditch was originally designed for the purpose of irrigation only. Modifications have been made and storm flows currently enter the ditch from the existing city. Allowing stormwater runoff to enter the ditch may cause embankment failure where the ditch overflows or clog ditch structures with trash carried by the runoff.

Preliminary storm drainage system locations, flow rates, easement widths, and sections for each basin are shown on Figures 7 thru 19.

For most of the UGA, improvements to the existing natural channel are the most economical and efficient options for the basin. Past experience has shown that natural channels should be utilized when possible because: (1) stormwater drainage systems perform better and have fewer problems when they follow the existing natural drainageways, (2) improvements to a natural channel are minimal compared to construction of a new one, and (3) existing channels often exceed the capacities of the 100-year storm without further construction.

Alternative hydraulic structures are recommended for road crossings near the design points of the channels in the UGA. Some of the crossings may have existing structures that adequately convey the 100-year storm under the road. The recommended structures are for conceptual purposes only. They suggest the minimum size and capacity that should be installed if they do not exist currently.

TYPICAL CHANNEL SECTION

DETENTION POND/PARK

CITY OF EVANS
STORM CHANNEL/PARK
LONGMONT, CO

RMC
FIGURE: 6

Analysis of the UGA natural drainageways assumed no base flows exist in the channel prior to the storm.

Within the city it was determined that it is most reasonable and economically feasible to design the storm sewer improvements for the 5-year developed storm flows rather than the 100-year storm. Except where noted, a 5-year design will simultaneously meet the standards for the GSDCM allowable street flows during the 100-year storm. The 5-year developed flows were used for the design and analysis.

1. <u>Urban Growth Area West Basin</u>

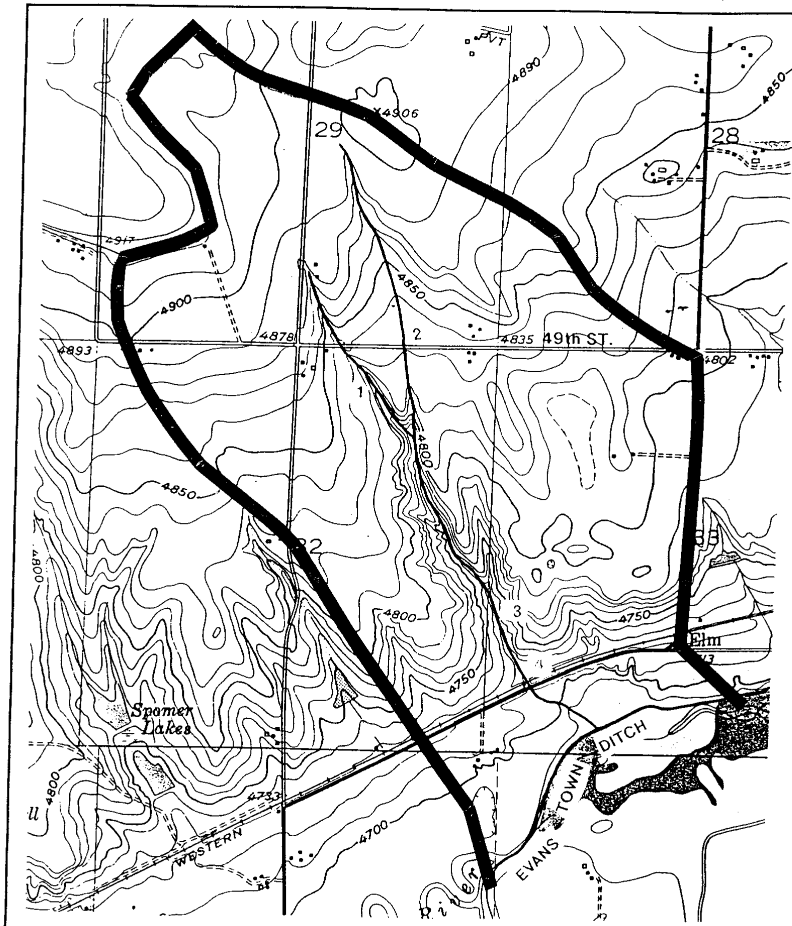
It is recommended that the natural channel continue to be used as the primary drainage system for this basin. The channel's capacity was modeled downstream just above the ETD. It was modelled as an irregular channel with a cross-section based on USGS mapping. It is more than adequate for conveying the 100-year storm. At the calculated 100-year runoff rate of 1085 cfs, the channel is flowing at a depth of less than 4 feet.

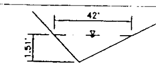
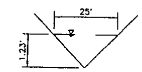
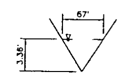
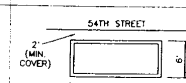
Use of the existing channel as a storm drainage system will require minimal modifications. Due to excessive velocities, it will be beneficial to install erosion and velocity control structures at various locations along the channel along with energy dissipation structures to prevent supercritical flows. An outlet design similar to that in the "17th Avenue Drainage Basin" study may also be advantageous to prevent erosion and to properly size the ETD outfall to prevent localized flooding. A 10 foot x 6 foot box culvert is recommended for the channel road crossing at 54th Street to prevent ponding behind the road embankment. Figure 7 shows the channel cross-section used in analysis and preliminary culvert sizing.

The channel drains into the ETD near its diversion from the Big Thompson River and near an overflow structure. The ditch parallels the Big Thompson River and lies within the river's floodplain at this location. Therefore, a drainageway crossing the ditch to discharge into the Big Thompson River is not deemed necessary for this basin.

2. <u>65th Avenue Basin</u>

RMC recommends the natural channel be utilized for storm drainage. The natural channel's capacity was modeled downstream just above the ETD as an irregular channel with a cross section based on USGS mapping. At a runoff rate of 122 cfs for the 100-year storm, the flow depth in the existing channel is approximately 1 foot. Modifications would include various erosion and velocity control structures. Some drop structures or energy dissipation structures may also be necessary due to the supercritical flows. Although the natural channel is adequate, it may be beneficial to install an open channel along the natural drainageway in the south section of the basin to streamline the flows. An alternative GSDCM Type C open channel design was modeled that will meet the GSDCM criteria. This channel consists of a concrete lined channel section and a wider grass lined channel. A typical cross-section is shown in Figure 20. The



STRUCTURE #	DESCRIPTION	LENGTH/ SIZE	EASEMENT WIDTH ①	FLOWRATE (CFS) & VELOCITY (FT/S)		SECTION
				5 YEAR	100 YEAR	
1	NORTH DRAINAGE CHANNEL SECTION 1	2600'	150'	Q = 22 V = 3.4	Q = 181 V = 5.8	
2	NORTH DRAINAGE CHANNEL SECTION 2	3800'	125'	Q = 14 V = 4.7	Q = 120 V = 8.0	
3	SOUTH DRAINAGE CHANNEL	4500'	175	Q = 130 V = 5.66	Q = 1085 V = 9.62	
4	BOX CULVERT @ 54TH ST.	50'	-	Q = 130 V = 13.8	Q = 1085 V = 27.42	

① RECOMMENDED EASEMENT WIDTHS INCLUDE AMPLE SPACE FOR THE 100 YR. FLOWS PLUS SOME ADDITIONAL SPACE FOR A LINEAR PARK.

N

NOT TO SCALE

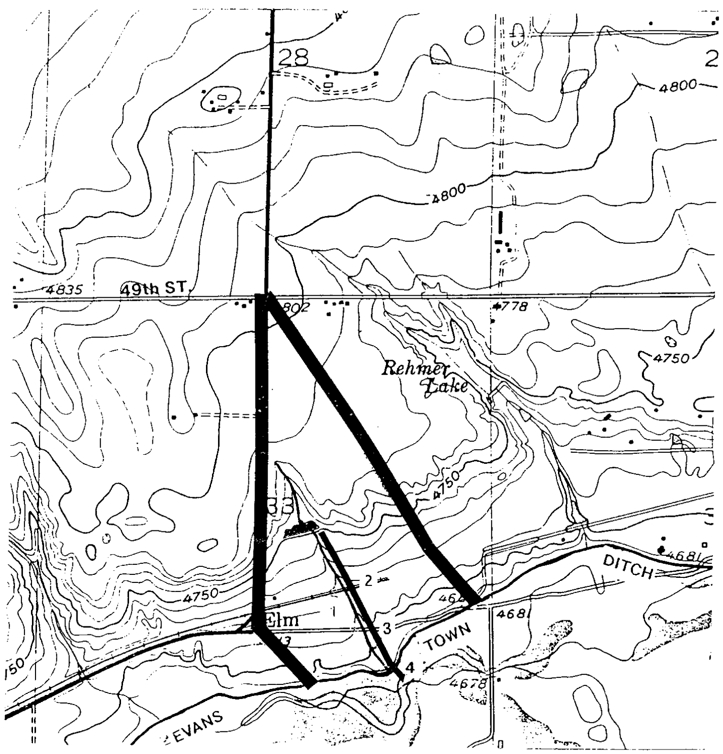
BASEMAP TAKEN FROM USGS MAPPING.

JOB NO. 80-1958.044.00

CITY OF EVANS
PRELIMINARY DRAINAGE SYSTEM
SIZE AND LOCATION
URBAN GROWTH AREA WEST

RMC

FIGURE: 7



N

NOT TO SCALE

BASEMAP TAKEN FROM USGS MAPPING.

STRUCTURE #	DESCRIPTION	LENGTH/ SIZE	EASEMENT WIDTH [1]	FLOWRATE (CFS) & VELOCITY (FT/S) 5 YEAR [2]	100 YEAR	SECTION
1	EXISTING DRAINAGE CHANNEL	2700'	150'	Q = 30 V = 3.09	Q = 122 V = 4.38	56'; 0.99'
2	PROPOSED OPEN CHANNEL SECTION	1700'	75'	Q = 30 V = 4.29	Q = 122 V = 4.2	33'; 4:1; 2%; 1.5'; 2:1; 3'
3	BOX CULVERT @ 54TH ST.	50'	-	Q = 30 V = 9.48	Q = 122 V = 15.3	54TH STREET; 2' (MIN. COVER); 4'; 6'
4	STORM PIPE CROSSING ETD	90'	-	Q = 30 V = 7.[illegible]	Q = 122 V = 10.4	48"; CMP S=2.2%

① RECOMMENDED EASEMENT WIDTHS INCLUDE AMPLE SPACE FOR THE 100 YR. FLOWS PLUS SOME ADDITIONAL SPACE FOR A LINEAR PARK.

② THE 5 YR. DEVELOPED FLOWRATES WERE USED FOR ANALYSIS SINCE THERE WAS LITTLE CHANGE FROM HISTORIC TO DEVELOPED CONDITIONS EXCEPT FOR THE BASIN AREAS.

JOB NO. 80-1958.044.00

CITY OF EVANS
PRELIMINARY DRAINAGE SYSTEM
SIZE AND LOCATION
65TH AVENUE BASIN

RMC

FIGURE: 8

channel will increase in width and depth from north to south as runoff is collected. The minimum right-of-way required at the outfall is approximately 45 feet. Channel length would be about 2500 feet.

For channel hydraulic structures, a 6 foot x 4 foot box culvert will allow 100-year flow under 54th Street with 2 feet of freeboard during maximum flow. A 48-inch corrugated metal pipe (cmp) culvert crossing the ETD to discharge into the Big Thompson River is also proposed. Figure 8 shows preliminary improvement designs and a representative channel cross-section.

3. Rehmer Lake Basin

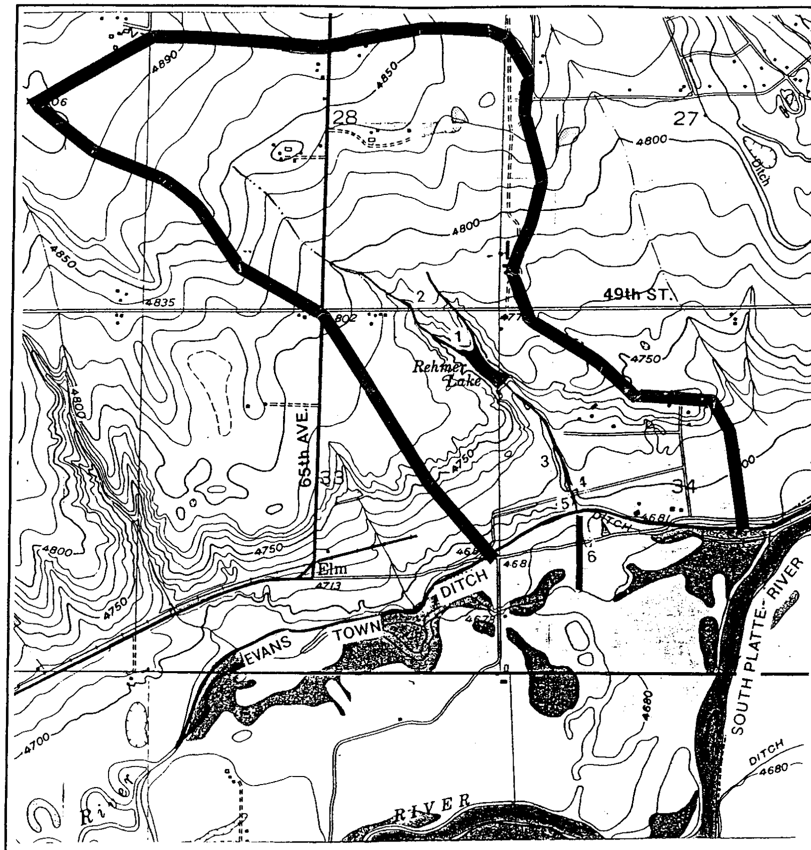
The Rehmer Lake Basin was modeled in two places, at a point just upstream of the lake inlet and at one just above the ETD. Both channels were modeled with irregular cross sections based on USGS mapping. No decree information or construction drawings were available on the lake. The information used was estimated from the USGS maps. Therefore, no detention or estimated release rates were included in the analysis. As development occurs, Rehmer Lake's detention capabilities should be analyzed.

Upstream of Rehmer Lake the existing channel is in two branches. The westerly branch was modeled as a major drainageway and the easterly branch as a minor drainageway. However, the results of the modelling indicated such shallow depths that all runoff was placed in the major drainageway. With a maximum 100-year flow of 455 cfs, this channel flows at a depth of about 6 inches. Continued use of these channels for stormwater drainage is recommended. They will require minimal improvements. Due to the steep slopes, some locations have supercritical flows that may require energy dissipation structures. Preliminary sizing of the 49th Street road crossing results in a 7 foot x 5 foot box culvert. Similar storm channel structures will be required at all road crossings. As development occurs, the channel into Rhemer Lake may require sizing and erosion protection.

It is also recommended that the existing channel below Rehmer Lake be used as the stormwater drainage system. At a 100-year design flowrate of 780 cfs the flow depth of the existing channel is less than 4 feet. An equivalent open channel will greatly exceed the maximum velocity requirements and cost significantly more.

During the 100-year storm it is possible that ponding behind the road embankment in Dos Rios subdivision would eventually overtop the road, cause embankment failure, or wash out the road. An 8 foot x 6 foot box culvert would adequately convey runoff under the Dos Rios subdivision road and prevent excessive ponding behind the road embankment.

The channel currently discharges to the ETD. As the drainageway is developed, two 72-inch cmps would adequately convey runoff across the ETD. The cmp discharges into a proposed open channel which conveys runoff to the Big Thompson River floodplain. An 8' x 6' box culvert will adequately convey the storm under 54th Street. Figure 9 summarizes preliminary



N

NOT TO SCALE

BASEMAP TAKEN FROM USGS MAPPING.

STRUCTURE #	DESCRIPTION	LENGTH/ SIZE	EASEMENT WIDTH [1]	FLOWRATE (CFS) & VELOCITY (FT/S) 5 YEAR [2]	100 YEAR	SECTION
1	NORTH DRAINAGE CHANNEL	3000'	250'	Q = 80 V = 2.81	Q = 455 V = 5.6	155'; 0.53'
2	BOX CULVERT @ 49TH ST.	50'	-	Q = 80 V = 14.7	Q = 455 V = 25.6	49TH ST.; 2' (MIN. COVER); 7'; 5'
3	SOUTH DRAINAGE CHANNEL	2300'	100'	Q = 138 V = 6.91	Q = 780 V = 10.6	38'; 2.0'
4	BOX CULVERT @ COMPO RD.	50'	-	Q = 138 V = 15.0	Q = 780 V = 25.3	COMPO RD.; 2' (MIN. COVER); 8'; 6'
5	STORM PIPE CROSSING ETD	90'/EA.	-	Q = 69/PIPE V = 10.0/PIPE	Q = 390/PIPE V = 14.8/PIPE	2 - 72"ø PIPE; 72"; 72"; CMP S=2.6%
6	PROPOSED OPEN CHANNEL SECTION	500'	100'	Q = 138 V = 5	Q=780 V = 8.9	37'; 4:1; 2%; 2.5'; 2:1; 3'

① RECOMMENDED EASEMENT WIDTHS INCLUDE AMPLE SPACE FOR THE 100 YR. FLOWS PLUS SOME ADDITIONAL SPACE FOR A LINEAR PARK.

② THE 5 YR. DEVELOPED FLOWRATES WERE USED FOR ANALYSIS SINCE THERE WAS LITTLE CHANGE FROM HISTORIC TO DEVELOPED CONDITIONS EXCEPT FOR THE BASIN AREAS.

JOB NO. 80-1958.044.00

CITY OF EVANS
PRELIMINARY DRAINAGE SYSTEM
SIZE AND LOCATION
REHMER LAKE BASIN

RMC

FIGURE: 9

sizing and design configurations for the channel improvements, illustrates sample cross sections, and gives flow rate and easement information.

4. Urban Growth Area Central Basin

The existing drainageway is formed by two channels. These channels were modeled as irregular cross sections based on USGS mapping. Just above Dos Rios subdivision, these channels merge and then shortly thereafter they fade out. The area below the existing channels is part of the Dos Rios Estates Second Filing. A drainage system has already been designed for this section of the basin in the "Preliminary drainage report for Dos Rios Estates 2nd Filing" by Landmark Engineering. The study by Landmark Engineering is thorough, therefore no further analysis was done on the south section of this basin.

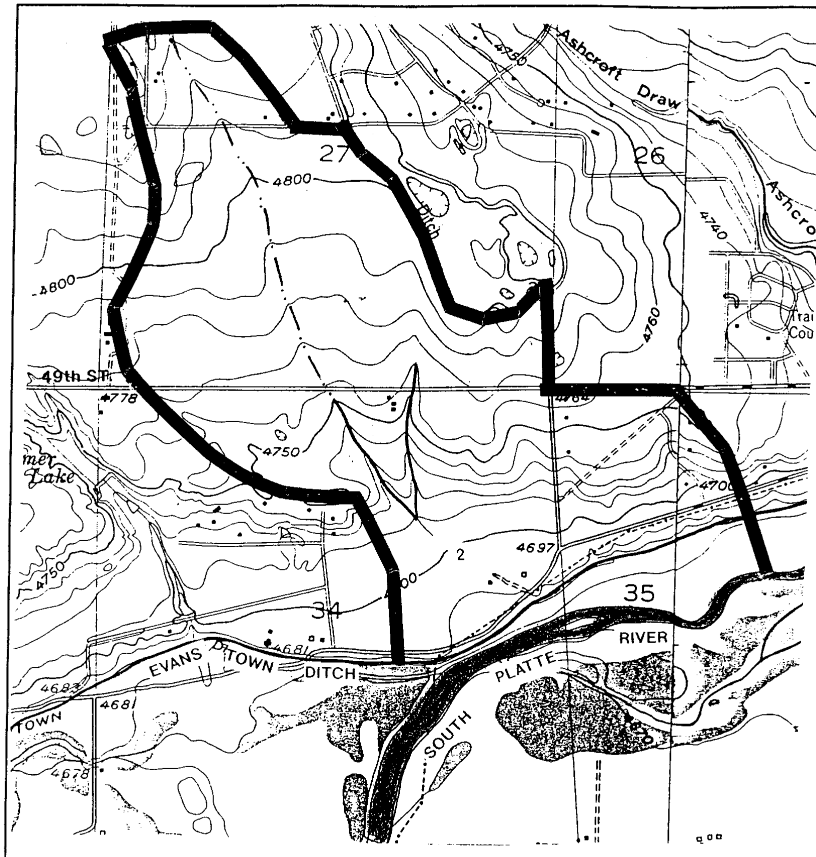
For drainage above Dos Rios, it is recommended that the existing natural drainageways be utilized. As development occurs, the channels may require some energy dissipators to prevent supercritical flows. The calculated maximum flow depths in the channels would not exceed 1 foot. An estimated cross section of the existing channel is shown in Figure 10.

5. Ashcroft Draw Basin

The current developments within the Ashcroft Draw basin are Hill-n-Park and Arrowhead. Hill-n-Park discharges into the Ashcroft Draw below Arrowhead Lake. The Hill-n-Park discharge used for calculations is the CUHP calculated discharge rather than the 1cfs/acre previously noted since the area is already developed with a pre-existing drainage plan. The Arrowhead subdivision discharges directly into the lake. The drainage in this area will not be restricted to 1 cfs/acre either since the subdivision precedes the criteria.

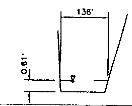
No decrees or construction plans were available on the Arrowhead Lake. The information used for calculations is estimated from the USGS maps and field observation. The regional detention capabilities of the lake should be investigated with future developments. The lake outlet is a 36 foot x 2 foot box culvert which discharges to the south into the Ashcroft Draw. The maximum calculated discharge capacity of the outlet is approximately 750 cfs. Therefore, for the downstream calculations, 750 cfs was used as the discharge flow rate resulting from all upstream subbasins. It was assumed that the lake is sufficient to detain and release the existing 100-year runoff without overtopping. There are currently no problems with flooding of the area. Any future developments just south of the lake outlet should be aware of the discharge flows.

The Ashcroft Draw was modeled at two locations: just above the Arrowhead Lake and at the downstream end prior to crossing the ETD. Another minor channel discharges into the north side of the lake. This channel was also modeled above the lake outfall. The channel cross sections were based on USGS mapping. A small irrigation ditch diverts water from the Ashcroft Draw in the northwest, runs through Arrowhead, and terminates. This ditch does not serve as a stormwater conveyance structure nor will it impact runoff from a 100-year storm, therefore it was



NOT TO SCALE

BASEMAP TAKEN FROM USGS MAPPING.

STRUCTURE #	DESCRIPTION	LENGTH/ SIZE	EASEMENT WIDTH [1]	FLOWRATE (CFS) & VELOCITY (FT/S) 5 YEAR [2]	100 YEAR	SECTION
1	NORTH DRAINAGE CHANNEL MAIN SECTION	2000'	250'	Q = 81 V = 2.6	Q = 378 V = 4.8	
2	DOS RIOS ESTATES [3] STORM DRAINAGE SYSTEM	-	-	-	-	

① RECOMMENDED EASEMENT WIDTHS INCLUDE AMPLE SPACE FOR THE 100 YR. FLOWS PLUS SOME ADDITIONAL SPACE FOR A LINEAR PARK.

② THE 5 YR. DEVELOPED FLOWRATES WERE USED FOR ANALYSIS SINCE THERE WAS LITTLE CHANGE FROM HISTORIC TO DEVELOPED CONDITIONS EXCEPT FOR THE BASIN AREAS.

③ THIS DRAINAGE SECTION HAS BEEN DESIGNED BY LANKMARK ENGINEERING. FOR DETAILED INFORMATION SEE "PRELIMINARY DRAINAGE REPORT FOR DOS RIOS ESTATES 2ND FILING".

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CITY OF EVANS
PRELIMINARY DRAINAGE SYSTEM
SIZE AND LOCATION
URBAN GROWTH AREA CENTRAL

RMC
FIGURE: 10

omitted in the basin analysis. Figure 11 shows representative cross sections, alternative improvements, and layout of the existing channels within the basin.

The Ashcroft Draw is a well-defined major drainageway. Rerouting of stormwater and construction of a replacement open channel would be costly and inefficient. Whereas only minor improvements need to be made to the existing channel. Therefore, no alternatives were proposed for this natural drainage system. Before entering Arrowhead Lake, the Draw will handle 1205 cfs with a flow depth less than 3 feet. Below the lake at the ETD crossing, approximately 2555 cfs flows through the channel at a depth of about 5.5 feet. Recommended improvements to the channel include velocity control structures, erosion protection, energy dissipators, and an 18 foot x 7 foot culvert crossing under 49th Street. The ETD flows in a flume over the Draw. Any excess flow in the ETD at this point will overflow into the Draw. From the ETD the Draw flows south into the South Platte River.

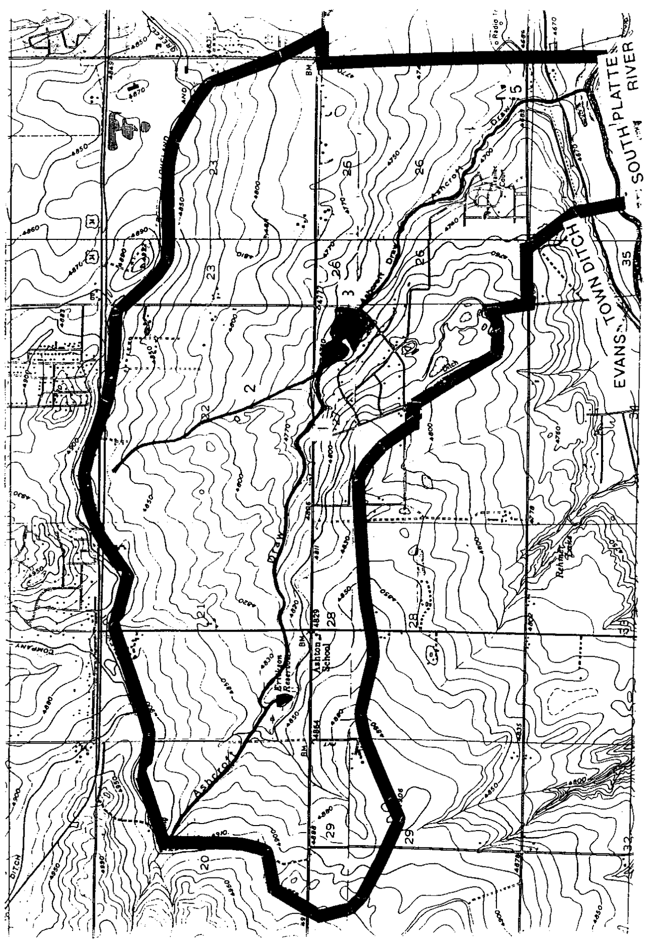
For the minor drainage channel that discharges into the Arrowhead Lake, it is recommended that the existing natural channel be utilized for the future stormwater drainage system. At the design point slightly north of the lake outfall, 664 cfs will flow in the existing channel at a depth of less than 2 feet. The necessity for erosion protection and energy dissipators should be determined to improve and protect the channel.

6. Urban Growth Area East Basin

The UGA East basin currently has no well defined drainageway. Runoff flows in a small swale to the ETD. A preliminary open channel has been designed to convey future runoff. The channel design is based on the GSDCM Type C open channel, see Figure 20. The channel extends approximately 2500 feet, crosses the ETD, extends for another 1000 feet to the South Platte River floodplain. A sample channel cross-section was designed just above the ETD. A 72-inch cmp is proposed to convey runoff across the ETD. The land south of the ETD is in the floodplain of the South Platte River. Due to the flat slopes here, storm runoff is not expected to contribute to the regional storm drainage system, therefore it was not calculated. The recommended 49th Street crossing is a 7 foot x 5 foot box culvert at a 1 percent slope. Additional storm channel structures will be required at other street crossings. Figure 12 presents flow rate and easement width information, sample cross-sections, and channel layout.

7. 23rd Avenue Basin

An open channel storm collection system with linear park was previously designed and is proposed to control storm runoff for the 23rd Avenue drainage basin. Two proposed channels convey the runoff in the north drainage section. The two channels combine at 37th Street. The channel then passes under 37th Street and continues along the natural drainageway to the southeast for about 1400 feet to the proposed 23rd Avenue alignment. The channel then follows the west section line of Section 31. It empties into a detention/settling pond before being piped under the ETD where it is then conveyed to the South Platte River. Figure 13 summarizes the



NOT TO SCALE

BASEMAP TAKEN FROM USGS MAPPING.

STRUCTURE #	DESCRIPTION	LENGTH/ SIZE	EASEMENT WIDTH [1]	FLOWRATE (CFS) & VELOCITY (FT/S) 5 YEAR	100 YEAR	SECTION
1	NORTH DRAINAGE CHANNEL ASCHCROFT DRAW	11,500'	225'	Q = 104 V = 3.8	Q = 1205 V = 7.10	127'; 2.67'
2	NORTH DRAINAGE CHANNEL SECTION 2	5500'	225'	Q = 114 V = 4.1	Q = 664 V = 6.4	125'; 1.67'
3	BOX CULVERT @ ARROWHEAD LAKE DISCHARGE	50'	-	Q = 459 [2]	Q = 750	ARROWHEAD; 2' (MIN. COVER); 36'; 2'
4	SOUTH DRAINAGE CHANNEL ASCHCROFT DRAW	8500'	175'	Q = 1020 V = 9.0	Q = 2555 V = 11.4	82'; 5.47'
5	BOX CULVERT @ 49TH ST.	50'	-	Q = 1020 V = 21.7	Q = 2555 V = 29.1	49TH STREET; 2' (MIN. COVER); 18'; 7'

① RECOMMENDED EASEMENT WIDTHS INCLUDE AMPLE SPACE FOR THE 100 YR. FLOWS PLUS SOME ADDITIONAL SPACE FOR A LINEAR PARK.

② FLOWRATES FOR ARROWHEAD AND HILL-N-PARK AREAS ARE BASED ON DEVELOPED FLOWS.

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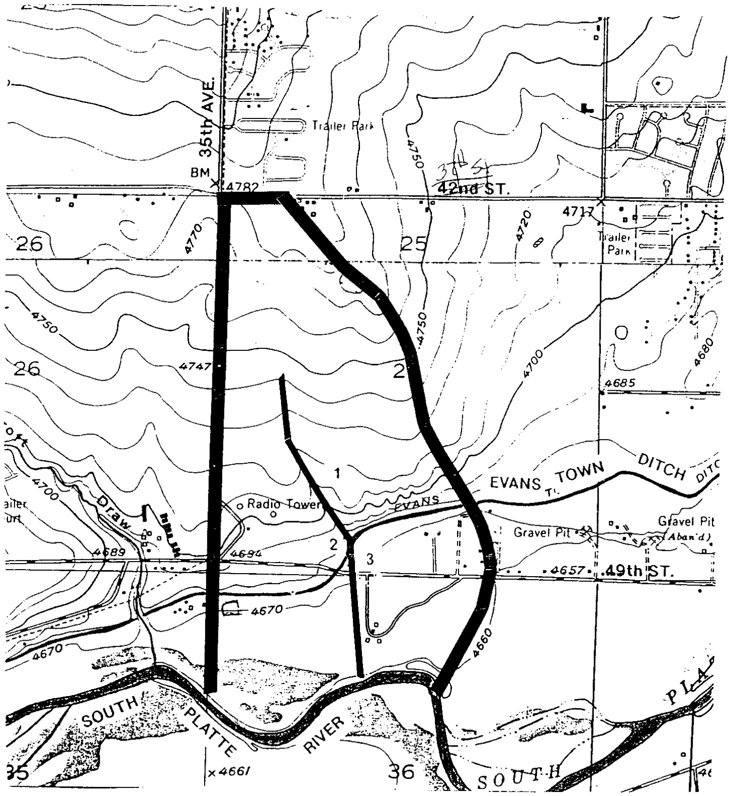
CITY OF EVANS
PRELIMINARY DRAINAGE SYSTEM
SIZE AND LOCATION
ASCHCROFT DRAW BASIN

RMC

FIGURE: 11



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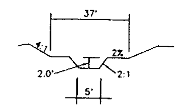
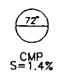
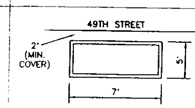
NOT TO SCALE

BASEMAP TAKEN FROM USGS MAPPING.

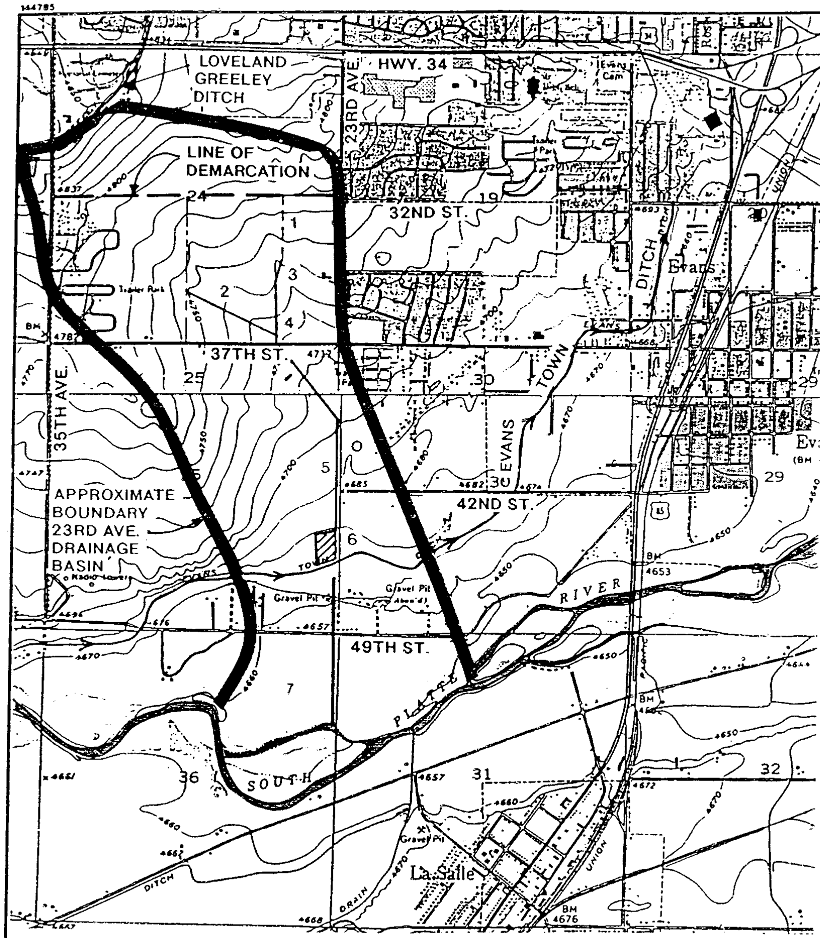
STRUCTURE #	DESCRIPTION	LENGTH/ SIZE	EASEMENT WIDTH ①	FLOWRATE (CFS) & VELOCITY (FT/S) 5 YEAR	100 YEAR	SECTION
1	PROPOSED OPEN CHANNEL	3500'	75'	Q = 72 V = 5.3	Q = 290 V = 5.6	
2	STORM PIPE CROSSING ETD	90'	-	Q = 72 V = 8.[illegible]	Q = 290 V = 10.8	
3	BOX CULVERT @ 49TH ST.	50'	-	Q = 72 V = 9.9	Q = 290 V = 15.2	

① RECOMMENDED EASEMENT WIDTHS INCLUDE AMPLE SPACE FOR THE 100 YR. FLOWS PLUS SOME ADDITIONAL SPACE FOR A LINEAR PARK.

JOB NO. 80-1958.044.00

CITY OF EVANS
PRELIMINARY DRAINAGE SYSTEM
SIZE AND LOCATION
URBAN GROWTH AREA EAST

RMC
FIGURE: 12



NOTE: MAP TAKEN FROM U.S.G.S. TOPOGRAPHY MAPS GREELEY, COLORADO 1989 AND LASALLE. COLORADO 1969

0 1000' 2000'

SCALE: 1"=2000'

STRUCTURE #	DESCRIPTION	LENGTH/ SIZE	EASEMENT WIDTH	FLOWRATE (CFS) & VELOCITY (FT/S)		SECTION
				5 YEAR*	100 YEAR*	
1	STROM DRAIN PIPE FROM GREELEY (48"ø MAX.)	1060'	50'	TO BE DETERMINED	TO BE DETERMINED	
2	NORTH DRAINAGE SECTION CHANNEL 1	2000'	50'	Q = 188 V = 11.6	Q = 756 V = 6.0	20', 3.5', 2.5', 4:1, 1:1, 6', S = 1%
3	NORTH DRAINAGE SECTION CHANNEL 2	2000'	50'	Q = 104 V = 9.7	Q = 416 V = 5.0	20', 2.5', 2', 4:1, 1:1, 6', S = 1%
4	BOX CULVERT @ 37TH ST.	75'	-	Q = 293 V = 11.5	Q = 1170 V = 18.2	37TH STREET, 2' (MIN. COVER), 6', 15'
5	MIDDLE DRAINAGE SECTION CHANNEL	4000'	75'	Q = 415 V = 14.3	Q = 1756 V = 7.6	25', 5', 3.5', 4:1, 1:1, 7', S = 1%
6	DETENTION POND	10 ACRES	10 ACRES	-	-	10', 4:1, 100 YR HWL W/ 1' FREEBOARD
7	STORM PIPE OR CHANNEL	3000'	50'	Q_P = 208/PIPE V_P = 12.7/PIPE Q_C = 415 V_C = 14.3	Q_P = 344.1/PIPE V_P = 12.2/PIPE Q_C = 721 V_C = 4.9	2 - 72"ø PIPE, 72", 72", OR, 25', 3', 3.5', 4:1, 1:1, 7', S = 1%

*NOTE NUMBERS ARE UNDETAINED AND DEVELOPED FLOWRATES AND VELOCITIES

CITY OF EVANS
PRELIMINARY STORM CHANNEL
SIZE & LOCATION
23RD AVE. DRAINAGE BASIN

RMC FIGURE 13

system layout. A detailed analysis and design is presented in the "23rd Avenue Drainage Basin Study" by Rocky Mountain Consultants and is included in Appendix 2.

8. 17th Avenue Basin

Due to recent modifications to the 17th Avenue storm sewer, no additional improvements to the drainage system are needed. The design and implementation set forth by the "17th Avenue Drainage Basin Study" by Rocky Mountain Consultants, Inc. will adequately convey runoff from the fully developed basin, assuming the area south of 37th Street will utilize on-site detention as it develops. A complete copy of the drainage study is included in Appendix 3.

9. 17th Avenue Detention Pond Basin

The recent "17th Avenue Basin and Pond Study" prepared by Rocky Mountain Consultants for the City of Greeley solved the drainage problems of this basin. The regional detention pond that was designed and constructed will adequately contain the 100-year storm with historic discharge rates. No additional modifications are needed to this basin. A complete copy of the drainage study is included in Appendix 4.

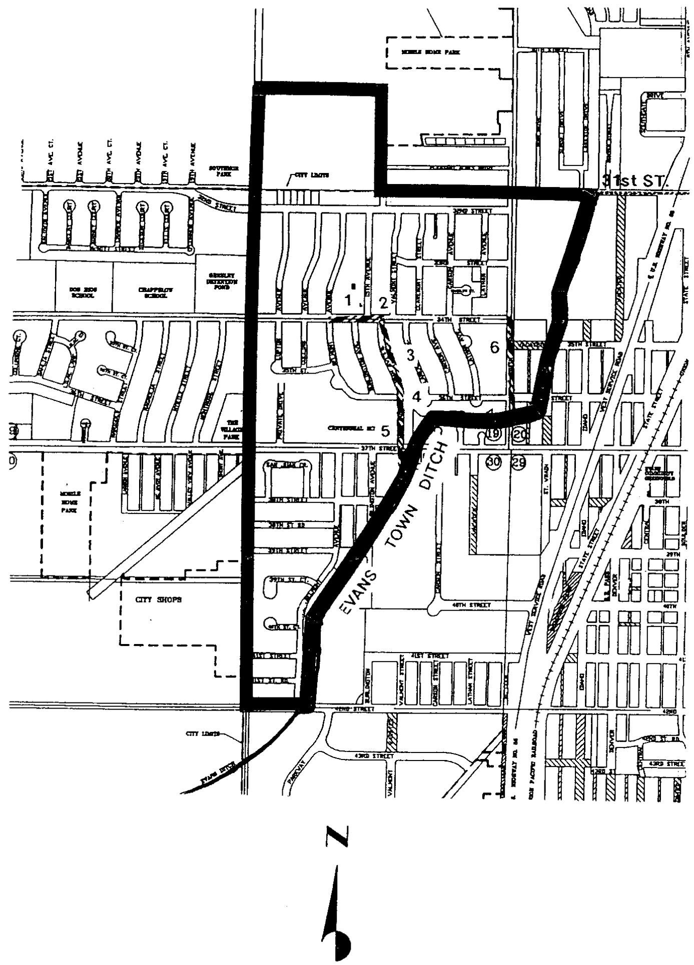
10. Evans Town Ditch Basin

Three storm sewer sections and three detention areas make up the primary stormwater conveyance system in the ETD Basin. Four of these systems currently provide adequate drainage for the basin. Improvements are recommended for the other two systems although they do not cause major flooding problems at this time. Figure 14 presents existing system layouts.

The detention areas for the developments along Belmont Avenue and south of 37th Street are assumed adequate for the 100-year detention-release. Therefore, no changes are necessary in these systems.

The 37th Street West storm sewer does not require any modifications at this time. The 37th Street West sewer capacity exceeds the runoff flows for both the 5-year and the 100-year storms.

Slight modifications to the 15th Avenue and 11th Avenue South storm sewers will increase the efficiency of the existing systems and reduce localized flooding. Both systems were redesigned to meet GSDCM criteria for the 5-year storm, which means storm runoff is conveyed in the sewer system with very minimal street flow. With these improvements implemented, the systems will meet the criteria for allowable street flows during the 100-year storm.



NOT TO SCALE

BASEMAP TAKEN FROM CITY OF EVANS
FACILITY PLAN MAP

STRUCTURE #	DESCRIPTION	LENGTH/ SIZE	EASEMENT WIDTH	FLOWRATE (CFS) & VELOCITY (FT/S) 5 YEAR	100 YEAR	SECTION
1	STORM PIPE 34TH ST. SECTION 1 (BELMONT TO BURLINGTON)	260'	-	Q = 40 V = 7.0	Q = 40 V = 6.3 Q STREET = 71	33" S=0.5%
2	STORM PIPE 34TH ST. SECTION 2 (BURLINGTON 15TH AVE.)	260'	-	Q = 48 V = 6.7 Q STREET = 4	Q = 48 V = 6.7 Q STREET = 97	36" S=0.51%
3	STORM IPE 15TH AVE. SECTION 1 (34TH ST. HALFWAY TO 36TH ST.)	850'	-	Q = 52 V = 11.0	Q = 48.5 V = 9.9 Q STREET = 96.5	30" S=1.4%
4	STORM PIPE 15TH AVE. SECTION 2 (SECTION 1 TO 36TH ST.)	440'	-	Q = 85 V = 15.5	Q = 81 V = 13.6 Q STREET = 157	33" S=2.35%
5	STORM PIPE 15TH AVE. SECTION 3 (36TH ST. TO 37TH ST.)	440'	-	Q = 85 V = 8.2	Q = 91 V = 7.2 Q STREET = 147	48" S=0.4%
6	STORM PIPE 11TH AVE.	1000'	-	Q = 87 V = 13.0	Q = 82 V = 11.6 Q STREET = 166	36" S=1.5%

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CITY OF EVANS
PRELIMINARY DRAINAGE SYSTEM
SIZE AND LOCATION
EVANS TOWN DITCH BASIN

RMC FIGURE: 14

a. 15th Avenue System

For the 5-year storm, the 15th Avenue drainage system greatly exceeds the allowable street flow capacities as set forth by the GSDCM. For conceptual design the slopes were kept at the estimated slope of the existing sewers. Final pipe alignment will determine the actual pipe diameter required. The 34th street branch of the system requires the 27 inch pipes to be replaced with a 33 and 36 inch pipe. The 15th Avenue 24, 27, and 36 inch pipes were replaced with 30, 33 and 48 inch pipes respectively. A summary of the recommended sewer replacements is presented in Figure 14.

b. 11th Avenue South System

This storm sewer discharges directly into the ETD. The estimated capacity of the 24 inch pipe is not sufficient to carry the 5-year storm with the GSDCM allowable street flows. Approximately 59 cfs will flow in the streets. This excess will tend to pond up and cause localized flooding around the catchments. For analysis it was assumed that any excess flows will stay within the ETD Basin. The slopes were kept at the estimated slope of the existing sewers for conceptual design. Replacement of the 24 inch diameter pipe with a 36 inch diameter pipe at 1.5 percent slope will adequately convey the 5-year flowrates and will meet the 100-year allowable street flow criteria. Final pipe alignment will determine the actual pipe diameter required. The 11th Avenue South storm sewer recommendations are summarized in Figure 14.

11. Industrial Parkway

The ETD overflow ditch borders the south side of the Industrial Parkway Basin. Approximately the southern 1/4 of the basin is in the South Platte River floodplain. Problems in this basin, if any, will occur from overtopping of the overflow ditch. A brief study of the ditch and its capacities was done in the 17th Avenue Drainage Basin Study, see Appendix 3 for a copy of the report. Overtopping of the ditch will occur from Industrial Parkway to Brantner Road during the 100-year storm. This may flood parts of the Parkway or Brantner Road and hinder traffic flow due to the flat slope of the land. Improvements may be desired in the Industrial and Brantner Road crossings to prevent overtopping. A detailed study of the ditch and its capacities is recommended if improvements are warranted. However, this potential trouble area is in the 100-year floodplain so it is not recommended that improvements for this area be implemented. Developments should continue to route flows to the overflow ditch. Development within the floodplain is discouraged.

12. Southeast Platte

The Southeast Platte Basin has no well defined drainageway. Existing developments have localized ditches to convey minor storms, but they are not part of a major storm drainage system. Storm runoff flows toward Highway 85 and the South Platte River. Currently much of the land is tall grass that retards excessive runoff. As industrial development occurs, various roads and businesses may experience flooding, especially those along the Highway 85 frontage road where the basin drains. During the 100-year storm, the ETD will overflow some 258 cfs into this basin, adding to the drainage problems. Several options are available for alleviating the street flooding.

Two alternatives involve construction of a major drainage system. These systems were designed to convey the 100-year storm with allowable street flows rather than the 5-year storm due to the excess flows from the ETD overspill during the 100-year storm. The first alternative is to install a reinforced concrete pipe (RCP) to convey the developed 100-year storm runoff with the allowable street flows. The sewer will increase in diameter from north to south. It will discharge into the South Platte floodplain. At the design point at the Highway 85 and 42nd Street intersection, a 78 inch RCP is recommended. This sewer is designed to parallel Highway 85. The sewer would not require additional easements, but may require road modifications. Another alternative is to install a GSDCM Type C open channel along the west frontage road. The channel would include a linear park, but would require a minimum 75 foot easementfor the 100-year flow width and the park area. Preliminary storm channel designs and layout are presented in Figure 15.

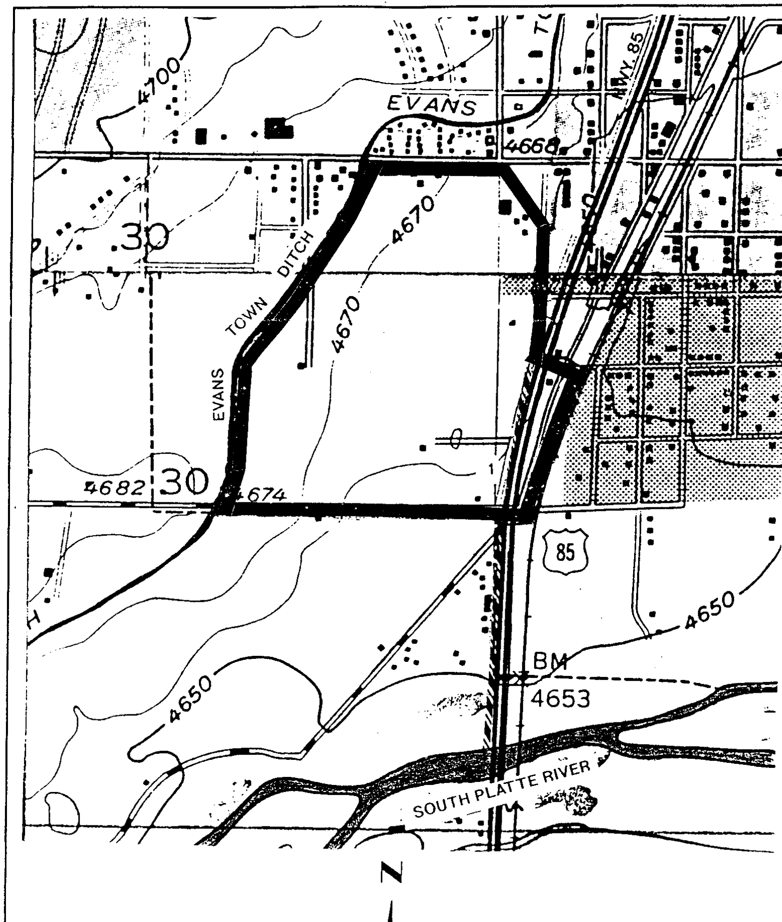
Another solution involve preventing the ETD overflow at Valmont. Preventing ETD overflow will require a detailed analysis of the ETD to determine a plan to enlarge the ditch, detain the overflow, or reroute the storm runoff that flows into the ditch.

13. River Bend Basin

The River Bend Basin consists of only the River Bend Subdivision. There are no existing drainage problems in this area. The curb and gutter drainage system sufficiently conveys the runoff to the cmp outlets and ditches along the south side of the subdivision. A steep ledge bordering the south side of the development ensures that the basin drains to the south. From here most of the runoff will flow overland to the South Platte River or is detained in the flat areas below the ledge. Some of the runoff may flow into the Riverside Pond. This flow will contribute to the pond storage but will not affect the Riverside Pond stormwater runoff rates. The stormwater conveyance system for this basin has been designed and implemented with the subdivision construction. Therefore, no alternative improvements are necessary.

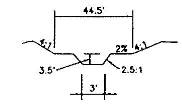
14. Riverside Park Basin

The Riverside Park Basin is characteristically flat with no existing system for stormwater conveyance. The majority of roads are dirt or gravel without roadside ditches. The problems in the basin are caused more by a lack of conveyance than excess flows. The runoff ponds up in the low spots until it floods adjacent properties or finally overflows into the irrigation ditch where it is conveyed to the river or diverted to the Riverside Pond. Installation of a sewer system can be costly with such flat terrain.



NOT TO SCALE

BASEMAP TAKEN FROM USGS MAPPING.

STRUCTURE #	DESCRIPTION	LENGTH/ SIZE	EASEMENT WIDTH [1]	FLOWRATE (CFS) & VELOCITY (FT/S) 5 YEAR	FLOWRATE (CFS) & VELOCITY (FT/S) 100 YEAR	SECTION
1	STORM PIPE OF CHANNEL	2200'	–	Q_P = 225 V_P = 15.3	Q_P = 529 V_P = 16.0 Q STREET = 185	78"
			100'			S=1.02% OR
				Q_C = 225 V_C = 7.0	Q_C = 714 V_C = 7.3	

① RECOMMENDED EASEMENT WIDTHS INCLUDE AMPLE SPACE FOR THE 100 YR. FLOWS PLUS SOME ADDITIONAL SPACE FOR A LINEAR PARK.

JOB NO. 80-1958.044.00

CITY OF EVANS
PRELIMINARY DRAINAGE SYSTEM
SIZE AND LOCATION
SOUTHEAST PLATTE BASIN

RMC

FIGURE: 15

For subbasin N1 it is recommended that a storm sewer system be installed in conjunction with street improvements such as paving and curb-and-gutter installation. A proposed storm sewer system is outlined in Figure 16. The proposed system will discharge into the Riverside Pond. The storm sewer design is based on conveyance of the 5-year storm. This design will subsequently meet GSDCM allowable street flow requirements for the 100-year storm. The storm sewer includes a major branch along Boulder Street from 40th Street to 42nd Street with 36 inch and 48 inch diameter sections. Two minor 30 inch sewers will parallel 40th Street and 41st Street. These will discharge into the major branch. A 54 inch diameter line is recommended to convey the flows to Riverside Pond. The size and capacity of the sewers will vary with slope. For conceptual design the slope was kept to a minimum without causing excessive pipe diameters.

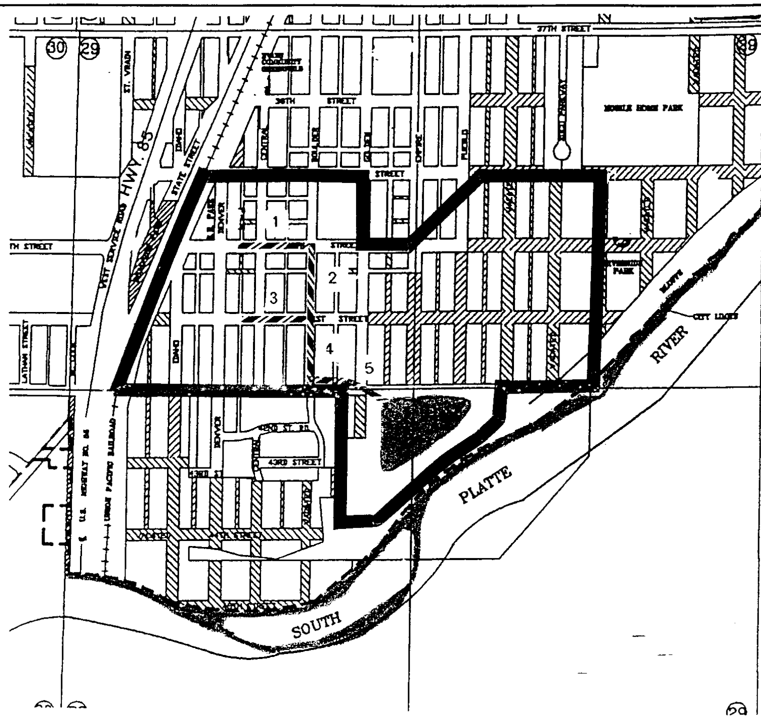
It is recommended that subbasin N2, the eastern section of Riverside Park Basin be developed similar to N1. Developments should be required to provide stormwater conveyance directly to the South Platte River. There are few existing streets in N2, therefore a conceptual system was not designed. The flows will be similar to that in N1 so the pipes will be of similar size. As the drainage system is developed, the runoff from Riverside Park Basin must remain isolated from the 37th Street basin to prevent unnecessary loading of the 37th Street storm sewer system.

15. <u>37th Street Basin</u>

The 37th Street storm sewer system is essentially separated into two systems by the Union Pacific Railroad, the west section and the east section,. Water cannot flow over the railroad track embankment. Therefore, only the runoff that flows in the underground system is conveyed to the eastern section of the storm sewer. Neither drainage system adequately conveys the 5-year storm or the 100-year storm with allowable street flows.

a. The West Section

The 37th Street drainage system on the west side of the tracks does not provide sufficient drainage at the 37th Street and Highway 85 Intersection. This constitutes one of the major problem areas in Evans. The problems and potential causes are discussed in the Existing Drainage Problems section of this report. At the intersection, more than 145 cfs will be flowing in the streets during the 5-year event and more than 405 cfs during the 100-year. These flows will tend to pond around the west frontage road and the highway. The best solution is to increase the detention capacities around Highway 85 and along the railroad. The existing detention ponds should be enlarged, the area draining to the ponds increased, and the outlets redesigned to prevent surcharge of connecting sewers. Modification of the existing system to adequately convey the storm to the east system is not recommended. This would require costly installation under the highway and railroad. Furthermore, the additional flow would further overload the east



STRUCTURE #	DESCRIPTION	LENGTH/ SIZE	EASEMENT WIDTH	FLOWRATE (CFS) & VELOCITY (FT/S) 5 YEAR	FLOWRATE (CFS) & VELOCITY (FT/S) 100 YEAR	SECTION
1	STORM PIPE SECTION 1 40TH ST.	400'	-	Q = 10 V = 5.7	Q = 9 V = 5.2 Q STREET = 20	18" S=0.76%
2	STORM PIPE SECTION 2 BOULDER ST. (40TH ST. TO 41ST ST.)	525'	-	Q = 21 V = 7.1	Q = 20 V = 6.3 Q STREET = 38	24" S=0.76%
3	STORM PIPE SECTION 3 41ST ST.	400'	-	Q = 10 V = 6.0	Q = 9 V = 5.3 Q STREET = 20	18" S=0.8%
4	STORM PIPE SECTION 4 BOULDER ST. (41ST ST. TO 42ND ST.)	550'	-	Q = 41 V = 8.7	Q = 38 V = 7.8 Q STREET = 77	30" S=0.87%
5	STORM PIPE SECTION 5 (42ND ST. TO RIVERSIDE POND)	675'	-	Q = 62 V = 10.0	Q = 62 V = 8.8 Q STREET = 113	36" S=0.86%

N

NOT TO SCALE

BASEMAP TAKEN FROM CITY OF EVANS FACILITY PLAN MAP

JOB NO. 80-1958.044.00

CITY OF EVANS
PRELIMINARY DRAINAGE SYSTEM
SIZE AND LOCATION
RIVERSIDE PARK BASIN

RMC

FIGURE: 16

section of the sewer system. Maximum discharge of the detention areas should be kept to 9 cfs which is the capacity of the downstream sewers. Suggested detention requirements and possible modifications are presented in Figure 17.

b. The East Section

The hydraulic calculations indicate that frequent flooding will occur along 37th Street, east of the railroad tracks. Street flows in excess of 100 cfs were calculated during the 5-year storm. This street flow greatly exceeds allowable street flows as recommended by the GSDCM. However, there are currently no significant problems with flooding in this area. The reason being much of the area draining to the 37th Street sewer is flat and does not sufficiently drain to the sewer system. Instead stormwater is ponded in various low spots and retained until it evaporates. This ponding of stormwater creates problems with localized flooding. For analysis, it was assumed that all areas within the basin drain to the sewer system. As the streets in the basin are further developed, the drainage will pond less, it will flow as designed, and the drainage in the 37th Street system will increase to the calculated values. To adequately convey the design flows for the 5-year storm, the system must be enlarged. For conceptual design the slopes were kept at the estimated slope of the existing sewers. Final pipe alignment will determine the actual pipe diameter required. Figure 17 shows the alternative designs for replacement of the east section of the 37th Street storm sewer.

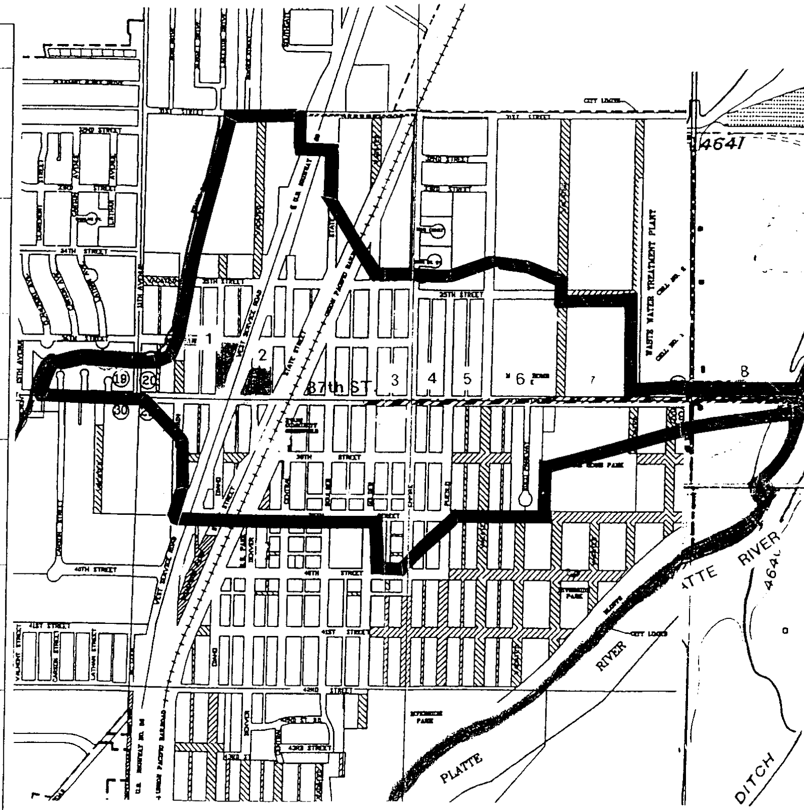
16. 31st Street

Like the 37th Street system, the 31st Street storm sewer can be subdivided into different sections; the main branch along 31st Street, a branch extending up 11th Avenue, and a short branch along the north part of Empire Street. For calculation purposes, it was assumed that half of the street flow from the11th Avenue system flows down 31st and half is routed to the 11th Avenue South system. Only four sewer sections do not meet GSDCM allowable street flows for the 5-year storm.

a. 31st Street Main Branch

A detailed discussion of the 31st Street problems and their causes can be found in the Existing Drainage Problems section of this report. East of Denver Street the sewer system does not sufficiently convey the 5-year storm. It is estimated that approximately 130 cfs during the 5-year storm and 540 cfs during the 100-year storm will congregate around the 31st Street and Highway 85 intersection. Furthermore, about 58 cfs will be confined between the highway and the railroad. Replacement of the 42 and 48 inch pipes with 54 and 60 inch pipes respectively will adequately convey the 5-year storm, meet 100-year allowable street flow requirements, and eliminate the flooding near the intersection. Replacement of the 18 inch pipe draining the area between Highway 85 and the railroad with a 42 inch will reduce the localized flooding in this area. However, both of these would involve installation under the highway and the railroad which could be costly and time consuming. The other alternative is to provide some detention on

STRUCTURE #	DESCRIPTION	LENGTH/ SIZE	EASEMENT WIDTH	FLOWRATE (CFS) & VELOCITY (FT/S)		SECTION
				5 YEAR	100 YEAR	
1	DETENTION POND WEST POND	2 ACRES	2 ACRES	–	–	8' 4:1 11.6 ACRE-FT CAPACITY
2	DETENTION POND EAST POND	2 ACRES	2 ACRES	–	–	6' 4:1 7.3 ACRE-FT CAPACITY
3	STORM PIPE SECTION 1 (GOLDEN ST. TO EMPIRE ST.)	370'	–	Q = 60 V = 5.1	Q = 72 V = 4.6 Q STREET = 67	54" S=0.136%
4	STORM PIPE SECTION 2 (EMPIRE ST. TO PUEBLO ST.)	340'	–	Q = 87 V = 5.5	Q = 96 V = 4.9 Q STREET = 123	60" S=0.136%
5	STORM PIPE SECTION 3 (PUEBLO ST. TO TRINIDAD)	360'	–	Q = 111 V = 10.1	Q = 111 V = 8.8 Q STREET = 178	48" S=0.6%
6	STORM PIPE SECTION 4 (TRINIDAD TO SOCO PKWY.)	650'	–	Q = 132 V = 8.0	Q = 138 V = 7.0 Q STREET = 205	60" S=0.28%
7	STORM PIPE SECTION 5 (SOCO PKWY TO WASTEWATER PLANT)	1050'	–	Q = 160 V = 8.0	Q = 168 V = 7.1 Q STREET = 288	66" S=0.25%
8	STORM PIPE SECTION 6 (WASTEWATER PLANT TO RIVER)	1250'	–	Q = 180 V = 6.6	Q = 167 V = 5.9 Q STREET = 356	72" S=0.155%



NOT TO SCALE

BASEMAP TAKEN FROM CITY OF EVANS FACILITY PLAN MAP

JOB NO. 80-1958.044.00

CITY OF EVANS
PRELIMINARY DRAINAGE SYSTEM
SIZE AND LOCATION
37TH STREET BASIN

RMC

FIGURE: 17

the west side of Highway 85 and on the north side of 31st Street between Highway 85 and the railroad. This alternative would prevent costly installation, but would require location of open space for the pond and land acquisition. Recommended alternatives are summarized in Figure 18.

b. 11th Avenue Branch

It was calculated that this branch will not meet the 5-year storm criteria. Approximately 62 cfs of excess street flow will be at the 11th Avenue and 31st Street intersection. However, these flows do not cause considerable problems and replacement of this section should be of low priority. There were no construction plans or storm drainage information on this sewer. The slopes for this system were assumed based on USGS contour mapping. Therefore, the estimated capacities and recommended alternatives are highly dependent on the installed alignment of the pipe. An alternative is presented to enlarge the 18, 27, and 30 inch sewer to a 30, 36, and 42 inch sewer to properly convey the 5-year storm. Figure 18 summarizes the existing system and the proposed designs.

c. North Empire Branch

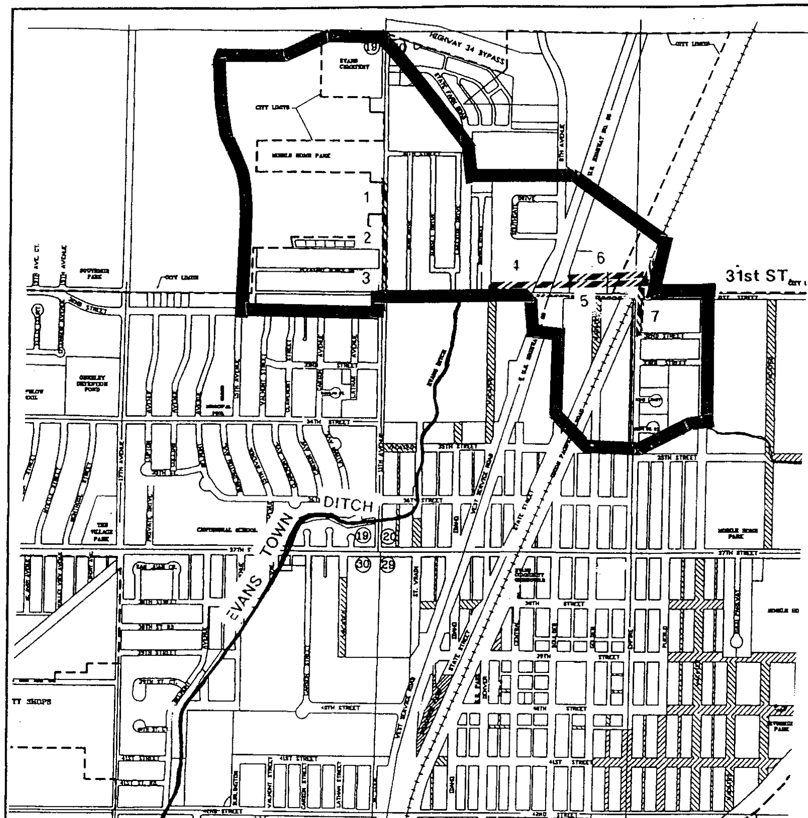
For the north Empire branch, only minor nuisances are expected. During the 5-year storm, approximately 52 cfs will be flowing in the street. Due to the local slopes, the street flows will pond around the catchments. This may cause localized flooding and hinder traffic flow. However, the houses are raised well above the street so residential flooding is unlikely. To prevent the flooding, replacement of the existing 24 inch with a 42 inch sewer is recommended. Preliminary sizing and flow rate information is presented in Figure 18.

17. <u>East Platte Basin</u>

There is no existing drainage path in this basin. Much of the land is low and flat. Some standing water is present in the lowest spots of the open fields. The basin drains overland to the South Platte River. It is recommended that future developments in this area be required to provide stormwater conveyance directly to the South Platte River floodplain through open channels or underground sewers. Once the runoff crosses 1st Avenue, it is in the South Platte floodplain. No distinct conveyance system will be required beyond this point due to the flat slopes and marshy land. Stormwater should not be allowed to be routed into the ETD.

18. <u>Interbasin Solutions</u>

The effectiveness of regional detention was investigated as a solution to some of the city's drainage problems. A problem of regional detention is finding undeveloped land in the city and acquiring the land. Furthermore, regional detention isn't always economical or effective. Detention will only reduce flows for areas downstream in the drainage system, therefore to be effective it must be located in the upper reaches of the basin. When large areas are draining to the detention area, large pipes are required to convey the drainage to the pond.



NOT TO SCALE

BASEMAP TAKEN FROM CITY OF EVANS
FACILITY PLAN MAP

STRUCTURE #	DESCRIPTION	LENGTH/ SIZE	EASEMENT WIDTH	FLOWRATE (CFS) & VELOCITY (FT/S) 5 YEAR	100 YEAR	SECTION
1	STORM PIPE 11TH AVE. SECTION 1 (30TH ST. HALFWAY TO PLEASANT ACRES DRIVE)	520'	-	Q = 37 V = 7.5 Q STREET = 7	Q = 37 V = 7.5 Q STREET = 73	30" S=0.81%
2	STORM PIPE 11TH AVE. SECTION 2 (SECTION 1 TO PLEASANT ACRES DRIVE)	570'	-	Q = 55 V = 7.8 Q STREET = 7	Q = 55 V = 7.8 Q STREET = 99	36" S=0.68%
3	STORM IPE 11TH AVE. SECTION 3 (PLEASANT ACRES TO 31ST ST.)	230'	-	Q = 81 V = 8.4 Q STREET = 7	Q = 81 V = 8.4 Q STREET = 139	42" S=0.65%
4	STORM PIPE 31ST AVE. SECTION 1 (DENVER ST. TO HWY 85)	575'	-	Q = 133 V = 10.0	Q = 139 V = 8.7 Q STREET = 169	54" S=0.5%
5	STORM PIPE 31ST AVE. SECTION 2 (HWY 85 TO DITCH OUTFALL	1200'	-	Q = 159 V = 9.6	Q = 165 V = 8.4 Q STREET = 228	60" S=0.4%
6	STORM PIPE 31ST AVE. SECTION 3 (HWY 85 TO DITCH OUTFALL	900'	-	Q = 64 V = 7.5	Q = 64 V = 6.6 Q STREET = 76	42" S=0.4%
7	STORM PIPE EMPIRE ST.	500'	-	Q = 66 V = 7.5	Q = 64 V = 6.6 Q STREET = 95	42" S=0.4%

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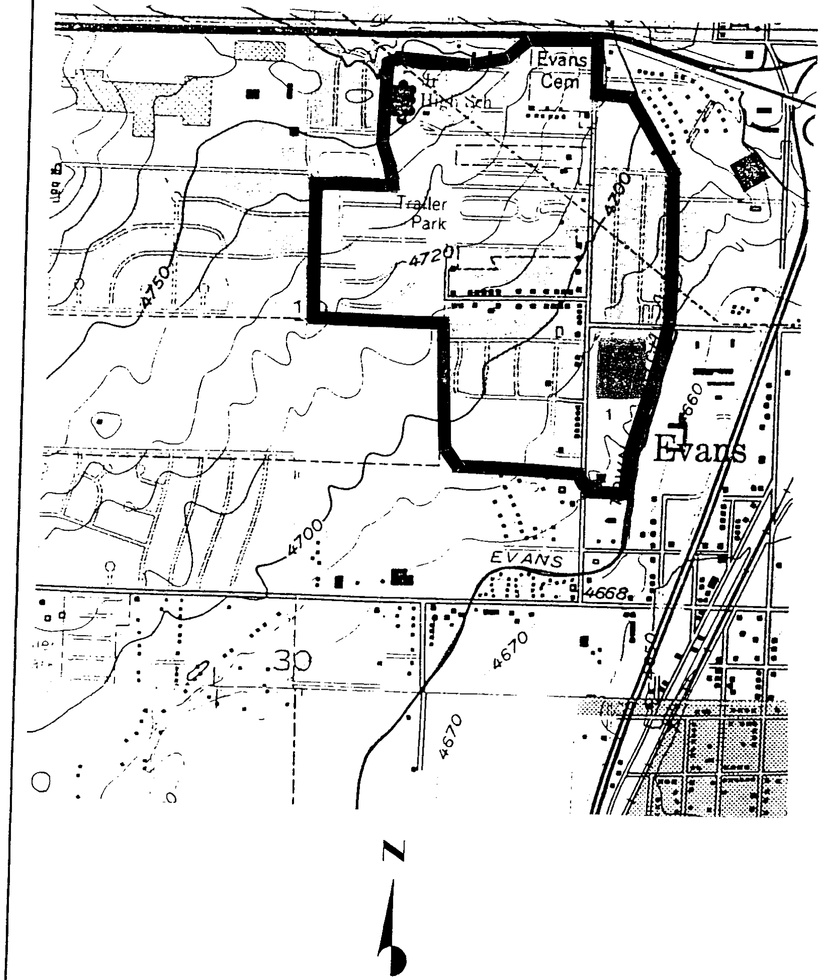
CITY OF EVANS
PRELIMINARY DRAINAGE SYSTEM
SIZE AND LOCATION
31ST STREET BASIN

RMC
FIGURE:
18

Much of the city of Evans is already developed. Therefore, the available areas for regional detention are limited. One regional detention location was analyzed and determined as beneficial.

Use of the open field bordered by 11th Avenue on the west, 31st Street on the north, and the ETD on the East as a regional detention facility would be an asset to the Evans drainage system. This area is currently undeveloped, open space. The field is slightly higher than the surrounding streets, therefore detained discharge into the 31st Street sewer system is feasible. A regional detention pond in this area could collect runoff from parts of the ETD basin and the 31st Street basin with minimal modifications to the storm sewer systems. Figure 19 shows the areas that would drain to the detention pond. Use of the pond will reduce discharge into the ETD, decrease the ETD overflow, reduce the excess flows at the 31st Street and Highway 85 intersection, and eliminate the need for some of the 31st Street system modifications. Preliminary location and sizing for the pond are presented in Figure 19. The recommended detention capability is based on a maximum discharge of 71 cfs. This discharge equals the minimum capacity of the 31st Street storm sewer. No changes would be necessary to the main branches of the 31st Street system with this detention.



NOT TO SCALE

BASEMAP TAKEN FROM USGS MAPPING.

STRUCTURE #	DESCRIPTION	LENGTH/ SIZE	EASEMENT WIDTH	FLOWRATE (CFS) & VELOCITY (FT/S) 5 YEAR	FLOWRATE (CFS) & VELOCITY (FT/S) 100 YEAR	SECTION
1	REGIONAL DETENTION POND	5 ACRES	5 ACRES	– –	– –	29.2 ACRE-FT CAPACITY

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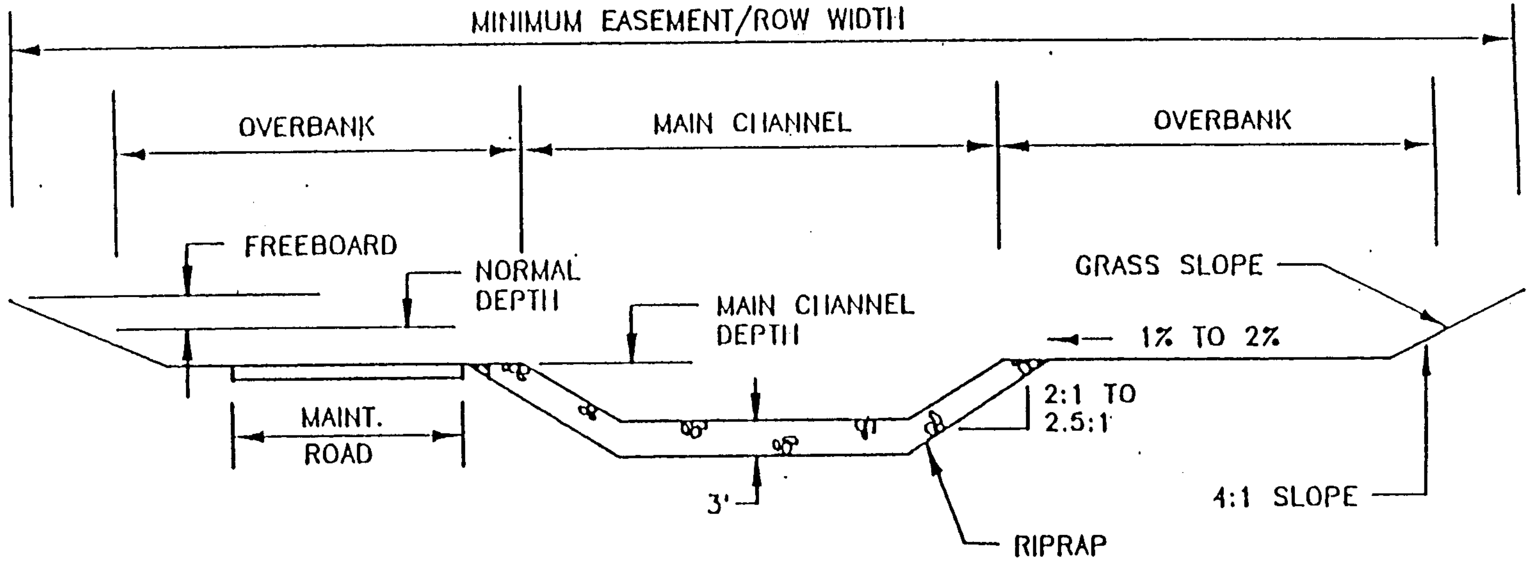
CITY OF EVANS
PRELIMINARY DRAINAGE SYSTEM
SIZE AND LOCATION
REGIONAL DETENTION POND

RMC

FIGURE: 19

Figure 20

TYPE C



NOTE:

1. THIS SECTION IS REQUIRED FOR CHANNELS IN SANDY SOILS.

2. MAIN CHANNEL: CAPACITY TO BE THE EQUIVALENT OF THE [redacted] INITIAL STORM RUNOFF. MAXIMUM 100-YEAR FLOW VELOCITY IS 5 FPS. PROTECT SLOPES WITH RIPRAP. USE A MANNINGS N-VALUE OF 0.03 FOR HYDRAULIC CALCULATIONS.

3. NORMAL DEPTH: FLOW DEPTH FOR 100-YEAR FLOW SHALL NOT EXCEED 5 FEET, NOT INCLUDING THE MAIN CHANNEL DEPTH.

4. FREEBOARD: FREEBOARD TO BE A MINIMUM OF 1 FOOT.

5. MAINTENANCE ACCESS ROAD: MINIMUM WIDTH TO BE 12 FEET. CITY MAY REQUIRE ALL OR PART OF THE ROAD TO BE SURFACED.

6. ROW WIDTH: MINIMUM WIDTH TO INCLUDE FREEBOARD AND MAINTENANCE ACCESS ROAD.

7. OVERBANK: FLOW IN EXCESS OF MAIN CHANNEL TO BE CARRIED IN THIS AREA. AREA MAY BE USED FOR RECREATION PURPOSES.

8. A concrete lining may be used in leiu of the riprap.

N.T.S.

TYPICAL GRASS LINED CHANNEL SECTION FOR SANDY SOILS

VII. ESTIMATED COSTS FOR ALTERNATIVE IMPROVEMENTS

VII. Estimated Costs for Alternative Improvements

Table 9 summarizes the estimated costs for the recommended drainage system improvements. These costs are estimates only. Detailed analysis of the individual basin will be required before improvements are made to that basin. The actual lengths, sewer diameters, and channel depths will depend on installed slopes and may vary from those proposed. These costs are to be used as a guideline for planning, not as final construction estimates.

The estimated costs are based on 1996 dollars. The costs do not include easement aquisition and landscaping.

TABLE 9. RECOMMENDED DRAINAGE SYSTEM IMPROVEMENTS AND ASSOCIATED COST ESTIMATES

LOCATION	DESCRIPTION	LENGTH/ QUANTITY	UNITS	UNIT PRICE	INSTALLED COSTS	CONTINGENCY @35%	SUBTOTALS	TOTALS (PER BASIN)	TOTAL PER ACRE COSTS
Urban Growth Area West Basin									
Velocity and Erosion Control Structures	---	5	EA	$50,000	$250,000	$87,500	$337,500		
54th Street crossing	10' x 6' Box Culvert	50	FT	$679	$33,950	$11,883	$45,833		
Channel Improvements to Existing Channel	---	7,350	FT	$100	$735,000	$257,250	$992,250	$1,375,583	$1,268
65th Avenue Basin									
Velocity and Erosion Control Structures	---	2	EA	$50,000	$100,000	$35,000	$135,000		
65th Avenue to 54th Street	Type C Open Channel	1,700	FT	$596	$1,013,200	$354,620	$1,367,820		
54th Street crossing	6' x 4' Box Culvert	50	FT	$316	$15,800	$5,530	$21,330		
ETD crossing	48" CMP	250	FT	$144	$36,000	$12,600	$48,600	$1,572,750	$12,891
Rehmer Lake Basin									
Velocity and Erosion Control Structures	---	2	EA	$50,000	$100,000	$35,000	$135,000		
49th Street crossing	7' x 5' Box Culvert	50	FT	$389	$19,450	$6,808	$26,258		
Compo Road crossing	8' x 6' Box Culvert	50	FT	$457	$22,850	$7,997	$30,848		
ETD crossing	2 - 72" CMP	180	FT	$216	$38,880	$13,608	$52,488		
ETD to River outfall	Type C Open Channel	500	FT	$761	$380,500	$133,175	$513,675		
Channel Improvements to Existing Channel	---	7,600	FT	$100	$760,000	$266,000	$1,026,000	$1,784,268	$2,288
Urban Growth Area Central Basin									
Velocity and Erosion Control Structures	---	2	EA	$50,000	$100,000	$35,000	$135,000		
Channel Improvements to Existing Channel	---	6,500	FT	$100	$650,000	$227,500	$877,500	$1,012,500	$1,789
Ashcroft Draw Basin									
Velocity and Erosion Control Structures	---	4	EA	$50,000	$200,000	$70,000	$270,000		
49th Street crossing	18' x 7' Box Culvert	50	FT	$1,378	$68,900	$24,115	$93,015		
Channel Improvements to Existing Channel	---	25,200	FT	$100	$2,520,000	$882,000	$3,402,000	$3,765,015	$1,076
Urban Growth Area East Basin									
Velocity and Erosion Control Structures	---	1	EA	$50,000	$50,000	$17,500	$67,500		
42nd Street to ETD	Type C Open Channel	3,500	FT	$844	$2,954,000	$1,033,900	$3,987,900		
ETD crossing	72" CMP	90	FT	$216	$19,440	$6,804	$26,244		
49th Street crossing	7' x 5' Box Culvert	50	FT	$389	$19,450	$6,808	$26,258	$4,107,902	$14,165
23rd Avenue Basin*	Mobilization	---	LS	$60,000	$60,000	$14,400	$74,400		
Upper basin to ETD	Open Channel	8,000	FT	$42	$336,600	$69,720	$406,320		
37th Street crossing	15' x 6' Box Culvert	75	FT	$1,333	$100,000	$22,400	$122,400		
23rd Ave. and ETD	100 acre-ft Detention Pond	---	LS	$207,000	$207,000	$43,800	$250,800		
ETD to River outfall	2- 72" CMP	6,000	FT	$180	$1,080,000	$218,400	$1,298,400	$2,150,000	$1,987
Evans Town Ditch (ETD) Basin									
34th St., Belmont to Burlington	33" Diameter Pipe	260	FT	$165	$42,900	$15,015	$57,915		
34th St., Burlington to 15th Ave.	36" Diameter Pipe	260	FT	$180	$46,800	$16,380	$63,180		
15th St., 34th St. half way to 36th St.	30" Diameter Pipe	850	FT	$150	$127,500	$44,625	$172,125		
15th Ave., to 36th St.	33" Diameter Pipe	440	FT	$165	$72,600	$25,410	$98,010		
15th Ave., 36th St. to 37th St.	48" Diameter Pipe	440	FT	$240	$105,600	$36,960	$142,560		
11th Ave., 34th St. to ETD	36" Diameter Pipe	1,000	FT	$180	$180,000	$63,000	$243,000	$776,790	$2,726

TABLE 9. RECOMMENDED DRAINAGE SYSTEM IMPROVEMENTS AND ASSOCIATED COST ESTIMATES

LOCATION	DESCRIPTION	LENGTH/ QUANTITY	UNITS	UNIT PRICE	INSTALLED COSTS	CONTINGENCY @35%	SUBTOTALS	TOTALS (PER BASIN)	TOTAL PER ACRE COSTS
Southeast Platte Basin									
West Frontage Rd., 40th St. to River	78" Diameter Pipe	2,200	FT	$531	$1,168,200	$408,870	$1,577,070	$1,577,070	$12,225
OR								OR	
West Frontage Rd., 40th St. to River	Type C Open Channel	2,200	FT	$1,074	$2,362,800	$826,980	$3,189,780	$3,189,780	$24,727
Riverside Park Basin									
40th Street	18" Diameter Pipe	400	FT	$54	$21,600	$7,560	$29,160		
Boulder St., 40th St. to 41st St.	24" Diameter Pipe	525	FT	$72	$37,800	$13,230	$51,030		
41st Street	18" Diameter Pipe	400	FT	$54	$21,600	$7,560	$29,160		
Boulder St., 41st St. to 42nd St.	30" Diameter Pipe	550	FT	$90	$49,500	$17,325	$66,825		
42nd St. to Riverside Pond	36" Diameter Pipe	675	FT	$108	$72,900	$25,515	$98,415	$274,590	$2,162
37th Street Basin									
Hwy. 85 and 37th St. - West side	11.6 acre-ft Detention Pond	---	LS	$99,502	$99,502	$34,826	$134,328		
Hwy. 85 and 37th St. - East side	7.3 acre-ft Detention Pond	---	LS	$75,220	$75,220	$26,327	$101,547		
37th St.,Golden St. to Empire St.	54" Diameter Pipe	370	FT	$270	$99,900	$34,965	$134,865		
37th St., Empire St. to Pueblo	60" Diameter Pipe	340	FT	$300	$102,000	$35,700	$137,700		
37th St., Pueblo to Trinidad	48" Diameter Pipe	360	FT	$240	$86,400	$30,240	$116,640		
37th St., Tinidad to Soco Pkwy.	60" Diameter Pipe	650	FT	$300	$195,000	$68,250	$263,250		
37th St., Soco Pkwy. to Wastewater Plant	66" Diameter Pipe	1,050	FT	$330	$346,500	$121,275	$467,775		
37th St., Wastewater Plant to River outfall	72" Diameter Pipe	1,250	FT	$465	$581,250	$203,438	$784,688	$2,140,792	$7,929
31st Street Basin									
11th Ave, 30th half way to Pleasant Acres	30" Diameter Pipe	520	FT	$150	$78,000	$27,300	$105,300		
11th Ave., to Pleasant Acres Drive	36" Diameter Pipe	570	FT	$180	$102,600	$35,910	$138,510		
11th Ave., Pleasant Acres to 31st St.	42" Diameter Pipe	230	FT	$210	$48,300	$16,905	$65,205		
31st St., Denver St. to Hwy. 85	54" Diameter Pipe	575	FT	$270	$155,250	$54,338	$209,588		
31st St., Hwy 85 to ditch outfall	60" Diameter Pipe	1,200	FT	$300	$360,000	$126,000	$486,000		
31st St., Hwy 85 to ditch outfall (2)	42" Diameter Pipe	900	FT	$210	$189,000	$66,150	$255,150		
Empire St., 32nd St. to ditch outfall	42" Diameter Pipe	500	FT	$210	$105,000	$36,750	$141,750	$1,401,503	$6,229
Regional Detention Pond									
Southeast corner of 11th Ave. and 31st St.	29.2 acre-ft Detention Pond	---	LS	$263,485	$263,485	$92,220	$355,705	$355,705	$1,358
TOTAL								$22,294,466	$68,092

Notes:

*23rd Avenue Basin costs were taken from the previous study, "23rd Avenue Drainage Basin Study". The contingency used for this basin was 20% since the design is final.

Prior to application of engineering and contingency allowances, the storm sewer construction costs were estimated as follows:

- $3.00 / inch-foot for new lines in open areas
- $5.00/ inch-foot for replacement lines in built-up areas

Cost estimates for pipes with diameters larger than 72" were estimated on a case by case basis. These costs were not based on $5.00/ inch-foot.

Actual costs will depend on final designs. Pipe diameters and channel depths will depend on installed slopes.