CITY OF COLORADO SPRINGS

DRAINAGE BASIN PLANNING STUDY

SHOOKS RUN

SEPTEMBER 1993

WILSON
&COMPANY

I. INTRODUCTION

SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY

TABLE OF CONTENTS

SHOOKS RUN

DRAINAGE BASIN PLANNING STUDY

LIST OF TABLES

SHOOKS RUN

DRAINAGE BASIN PLANNING STUDY

LIST OF FIGURES

I. INTRODUCTION

Authorization for Study

This Drainage Basin Planning Study (DBPS) for Shooks Run was authorized under the terms of the contract between the City of Colorado Springs (City) and Wilson & Company, approved by the Colorado Springs City Council on April 10, 1990. The following subconsultants also participated in the study:

A. Thomas and Thomas - Biological/Cultural/Recreational

B. CTL/Thompson, Inc. - Geotechnical

Purpose and Scope of Study

A drainage basin planning study is intended to be a preliminary and conceptual guide for future design and construction of improvements for the drainage basin. The study identifies types, locations, and approximate sizes of improvements but does not develop actual designs for the improvements. The scope of services for this study included the following:

A. Project Coordination

1. Throughout the study, coordinate with the City, other agencies and the public for review and input.

B. Basin Concept Study

1. Collect general data; such as topographic mapping, previous drainage studies, land use information, utility and R.O.W. information, and soils and geotechnical information.
2. Inventory and analyze the existing drainage system.
3. Identify existing drainage problems.
4. Inventory environmental and cultural resources.
5. Inventory recreational resources, including parks and open spaces.

C. Basin Alternative Analysis

1. Provide hydrologic and hydraulic analyses.
2. Define practical improvement alternatives.
3. Evaluate the improvement alternatives based on the goals established for the study.
4. Prepare a plan for the recommended alternative.

D. Final Drainage Basin Planning Study

1. Prepare a final report and technical appendices to document the study.

Technical Criteria

The City of Colorado Springs and El Paso County (City/County) *Drainage Criteria Manual*, dated October 1987 and revised November 1991, was used for the technical criteria for this study; such as overall drainage policy and criteria, hydrology, hydraulics, and improvement design.

City Council Resolution of Adoption of Study

Resolution No. 71-94

A RESOLUTION ADOPTING THE SHOOKS RUN DRAINAGE BASIN PLANNING STUDY AND CONTINUING THE EXEMPT STATUS OF THIS BASIN FROM A DRAINAGE BASIN FEE AND CREDIT FOR FACILITIES, PER SECTION 15-3-904(B) OF THE CITY CODE.

WHEREAS, the City Engineering Division of the City of Colorado Springs Department of Planning, Development and Finance has reviewed the Shooks Run Drainage Basin Planning Study as prepared by Wilson & Company, Colorado Springs, Colorado dated September 1993, and

WHEREAS, the City/County Drainage Board has recommended approval of the above study at their December 16, 1993 meeting;

NOW THEREFORE, BE IT RESOLVED by the City Council of the City of Colorado Springs:

Section 1. The Shooks Run Drainage Basin Planning Study, September 1993 by Wilson & Company is adopted for use.

Section 2. The exempt status of the Shooks Run Drainage Basin from a drainage basin fee and credit for facilities shall continue, per Section 15-3-904(B) of the City Code.

Dated at Colorado Springs, Colorado, this 26th day of April, 1994.

Mayor Robert Isaac

ATTEST:

Acting City Clerk

II. DRAINAGE BASIN LOCATION AND DESCRIPTION

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General Basin Location and Description

The existing Shooks Run drainage basin is located within Sections 27, 28, 32, 33 and 34, Township 13 South, Range 66 West; and Sections 3, 4, 5, 6, 7, 8, 9, 10, 15, 16, 17, 18, 19 and 20, Township 14 South, Range 66 West in the City of Colorado Springs, Colorado. The basin is bounded generally on the north by the Templeton Gap drainage basin; on the east by the Sand Creek drainage basin and the Spring Creek drainage basin; on the west by an unnamed drainage basin that is tributary to the Van Buren Channel along the old Chicago, Rock Island and Pacific Railroad, and the Monument/Fountain Creek drainage basin; and on the south by the Spring Creek drainage basin and an unnamed drainage basin that is tributary to Fountain Creek. The basin extends north to almost Austin Bluffs Parkway, east to almost Academy Boulevard, west to Cascade Avenue, and south just past Las Vegas Street. The location of the basin is illustrated on the Vicinity Map (Figure 1).

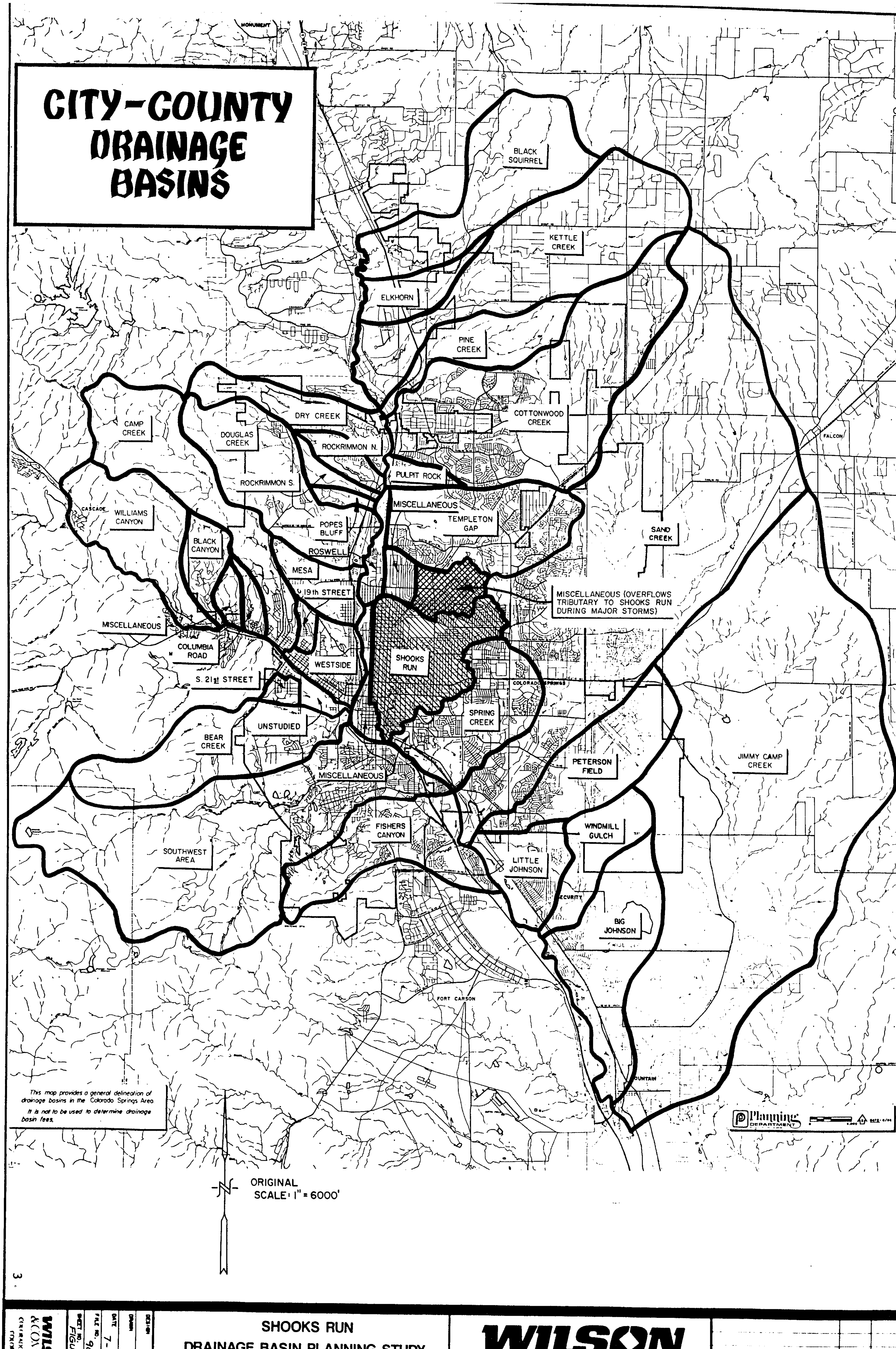
Historically, the Shooks Run drainage basin extended further to the northeast until the Templeton Gap Floodway was completed in 1948 by the U.S. Army Corps of Engineers. The Templeton Gap Floodway was constructed to divert approximately an eight-square-mile area of the original Shooks Run drainage basin to the west to Monument Creek. This diversion is located where Union Boulevard now enters the south side of the Austin Bluffs/Palmer Park area, about a half mile north of Fillmore Street.

The remaining, existing Shooks Run drainage basin includes an area of about ten square miles. The Van Buren channel diverts minor storm runoff flows from the upper basin of Shooks Run west to Monument Creek. This diversion is located at Templeton Gap Road, where it crosses the old Chicago, Rock Island and Pacific Railroad, just south of Van Buren Street. The area tributary to the diversion is about two square miles. Major storm runoff flows overtop the diversion structure, with a significant portion of the overflow continuing in Shooks Run. The lower basin of Shooks Run (below this diversion) contains an area of about eight square miles.

The basin slopes to the southwest, from elevation 6565 at the high point of the basin in Palmer Park to elevation 5885 at the outfall of the drainageway into Fountain Creek along the north side of Interstate Highway 25, about a quarter mile east of Nevada Avenue. The overall length of the basin is about seven miles. The average slope of the main channel is about one percent. The ground in the westerly portion of the basin slopes gently (about one percent) toward the main channel, while the ground in the easterly and northerly portions of the basin has moderate (about four to five percent) to steep (about 30 percent in Palmer Park) slopes.

Most of the main channel is a narrow and deep, eroded channel that is severely choked with overgrown native vegetation and significant amounts of trash and debris. The channel banks are unstable and consist of old, uncontrolled fill material that was placed as adjacent development encroached into the drainageway. There have been some makeshift attempts to stabilize the channel with riprap and retaining structures in isolated locations. The channel meanders through a mix of land use; consisting of industrial/commercial development, residential neighborhoods, and public park areas. There are many existing buildings immediately adjacent to the top of the channel banks. The roadway and railroad crossings were constructed many years ago, and most are significantly undersized and deteriorated.

There is an existing stormwater detention pond located on the east side of Patty Jewett Golf Course adjacent to Union Boulevard. There are also additional ponds in the Patty Jewett Golf Course and the Colorado Springs Country Club. These other ponds do not provide reliable detention since they are kept full most of the time. There are no other significant detention areas within the basin.



3

WILSON & COMPANY COLORADO SPRINGS, COLORADO	SHEET NO. FIGURE 1	FILE NO. 90-809	DATE 7-93	DRAWN	DESIGN	SHOOKS RUN DRAINAGE BASIN PLANNING STUDY VICINITY MAP	WILSON & COMPANY	REVISION	DATE	BY

III. GENERAL INFORMATION AND INVENTORIES

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Topographic Mapping and Field Surveying

Topographic mapping used in this study was obtained from the City. It was prepared from aerial photography taken in the Spring of 1988 as part of the Department of Utilities F.I.M.S. Project. The mapping was originally prepared at a scale of one inch to 200 feet with two-foot contour intervals. The mapping was then enlarged, or reduced, for the various drawings and maps used in this study.

Field surveying was provided at the main culvert and bridge crossings (streets and railroads) along the main channel of Shooks Run to supplement the topographic mapping. This field surveying obtained culvert sizes, invert elevations and other details regarding the culvert and bridge crossings.

Previous Drainage Studies

There have been numerous previous drainage studies prepared for areas within the Shooks Run drainage basin. Although most of the studies have dealt primarily with specific subdivisions within the basin, several comprehensive studies for large portions of the basin have also been prepared. The majority of these studies were completed utilizing the previous hydrologic criteria of the City/County and do not reflect current City/County criteria. The following previous drainage studies were reviewed as part of this Shooks Run DBPS.

Drainage Plan for Highland Acres Subdivision *by Karcich & Weber, Inc., April 1971.*
Area: Highland Hills #2 - 24.6 Acres
Method: Rational Method
Criteria: 5-Year Storm

Palmer Park Area Master Drainage Report *by Karcich & Weber, Inc., April 1972.*
Area: Palmer Park basin - 1040 Acres
Method: Rational Method
Criteria: 5-Year Storm

Shooks Run Master Drainage Basin Study *by Karcich & Weber, Inc., December 1972.*
Area: Shooks Run basin (downstream of the Van Buren Channel diversion) - 7.4 Square Miles
Method: SCS Triangular Hydrograph Method
Criteria: Shooks Run Channel 100-Year, 1-Hour Storm, 2.3"
Tributaries and Subdivisions 50-Year, 1-Hour Storm, 2.0"

Drainage Report for Dyer Subdivision *by Conrad Land Survey Co., March 1973.*
Area: Dyer Subdivision - 1.9 Acres
Method: Burkli-Ziegler Formula
Criteria: 5-Year Storm

Ocho Caballos Subdivision No. 1 Drainage Report *by Peak Engineering Co., April 1973.*
Area: Ocho Caballos Subdivision No. 1 - 8.6 Acres
Method: Rational Method
Criteria: 5-Year Storm

Drainage Report for Country Club Park Subdivision *by Trico Colorado, May 1977.*
Area: Country Club Park Subdivision - 14.7 Acres
Method: Rational Method
Criteria: 5-Year Storm

Drainage Plan for Country Club Acres *by HJ Kraettli & Sons, September 1978.*
Area: Country Club Acres - 13.8 Acres
Method: Modified SCS Method
Criteria: 5-Year Storm

Printers Park Master Drainage Report *by William P. Weber & Assoc., August 1980.*
Area: Printers Park - 179 Acres (17.9 Acres within Shooks Run basin)
Method: Modified SCS Method
Criteria: 5-Year, 6-Hour Storm, 2.1"

Drainage Report for Shooks Run Industrial Park Subdivision No. 1 *by William P. Weber & Assoc., October 1980.*
Area: Shooks Run Industrial Park - 13 Acres
Method: Rational Method
Criteria: 5-Year Storm

Drainage Study of Country Club Place *by Donell Jeffries, September 1983.*
Area: Country Club Place - 18.8 Acres
Method: Modified SCS Method
Criteria: 5-Year and 10-Year Storms

Lower Cragmor Master Drainage Plan *by JR Engineering Ltd., October 1988.*
Area: Lower Cragmor basin and Shooks Run basin tributary to Van Buren Channel - 2565 Acres
Method: UDSWM2-PC (Runoff Block of the EPA's Stormwater Management Model - SWMM) and Modified SCS Method
Criteria: 10-Year, 2-Hour Storm, 2.1" and 100-Year, 2-Hour Storm, 3.1"

FEMA Restudy of South Shooks Run *by Resource Consultants, Inc., February 1989.*
Area: South Shooks Run basin - 9.8 Square Miles
Method: SCS TR-20 Hydrologic Computer Program
Criteria: 10-Year, 24-Hour Storm, 3.1"; 50-Year, 24-Hour Storm, 3.9"; and 100-Year, 24-Hour Storm, 4.4"

Flood Insurance Study, City of Colorado Springs, El Paso County by Federal Emergency Management Agency, Revised February 1990.
Area: Shooks Run basin - 9.4 Square Miles
Method: Synthetic Unit Hydrograph Method from "Report on Hydrologic Investigation for the Flood Insurance Study of Colorado Springs and El Paso County, Colorado" by U.S. Department of the Army, Corps of Engineers, Albuquerque District, December 1976.
Criteria: 10-Year, 50-Year, 100-Year and 500-Year Storms

Master Drainage Development Plan for the Houck Estate at Union Boulevard and Fillmore Street, Colorado Springs, Colorado by Drexel-Barrell, June 1990.
Area: Shooks Run basin tributary to Union Boulevard and Fillmore Street - 730 Acres
Method: Rational Method and SCS TR-20 Hydrologic Computer Program
Criteria: 10-Year, 24-Hour Storm, 3.0" and 100-Year, 24-Hour, 4.6"

The comparison of the results of some of these previous studies and the Shooks Run DBPS is discussed in the Hydrologic Analysis section of this report.

Land Use Information

Existing land use information for the Shooks Run drainage basin was obtained through the review of City zoning maps and field observation. About 92 percent of the basin is already developed, five percent is open space that is too steep for development, and three percent is open space that will likely be developed in the future. The only significant area in the basin yet to develop is the Houck Estates property around the Union Boulevard/Circle Drive/ Fillmore Street intersection. The other areas yet to develop are smaller properties scattered around the basin that will be "in-fill" type development. Land use for these areas that may develop in the future was obtained from the City zoning maps. The following is a summary of the existing land use in the basin.

Land use	Area (Acres)	Percent of Shooks Run Basin
Residential	3974	62
Neighborhood commercial, shopping centers, schools, churches and hospitals	1009	16
Downtown commercial	153	2
Industrial	92	1
Golf courses and parks	650	10
Palmer Park and areas too steep for development	363	6
Open space areas likely to develop in the future	161	3
	6402	100

The existing and future land use information for the Shooks Run basin used in this study is illustrated on the Land Use Map (Figure 2).

Utility and Right-of-Way Information

Most of the major utility corridors within the basin are along major roadways. A sanitary sewer trunkline intermittently parallels the main channel of Shooks Run. There are also other major utilities that cross the main channel in various locations. Contacts with the different utility agencies confirmed that no new major utilities are planned for the basin because the study area is already almost fully developed. Existing utility information was obtained from the records of the utility agencies. It is anticipated that most of the drainage improvement/utility conflicts will be at roadway crossings of the main channel and a few other locations along the main channel.

Existing right-of-way and easement information along the main channel was obtained through review of subdivision plats and City records. Narrow drainage easements exist along isolated portions of the main channel. In some areas, the main channel is located within City park or golf course property. In many locations, existing street right-of-ways or alleys cross the main channel. However, there are no public right-of-ways or easements along significant reaches of the main channel.

The existing utility and right-of-way information is shown on the Existing Utility and R.O.W. maps (Figures 3-10).

Geologic and Soils Information

A. Geomorphology and Geologic Setting

The Shooks Run drainage basin lies east of the foothills of the Rampart Range contained within the Southern Rocky Mountain physiographic province. The most dominant feature in the basin is the sandstone bluffs which dominate Palmer Park to the north. Surficial deposits form gently south and west sloping areas within the basin and cover most of the other bedrock formations.

Bedrock underlying the basin consists mainly of the Pierre Shale. Overlying the Pierre Shale in the north part of the basin are the Laramie Formation and the Arapahoe Formation. Overlying the bedrock units within the basin are various surficial deposits which were deposited in more recent geologic times. These various geologic units are plotted on the Geologic Map (Figure 11) and are described in more detail in the following sections.

Over the past 100 years or so, the Shooks Run drainage basin has been an area of intense construction and development. This region, along with Old Colorado City, was developed early on. At this point in time, the basin is almost entirely developed. Due to this development, natural geologic conditions have been altered by the acts of man; and natural geologic features have been obscured by the present developed areas. The main channel of Shooks Run has been moved, altered, filled, and channelized to the point that no natural reaches now exist. Also, except for bedrock exposed by erosion, almost all side bank exposures consist of man-placed soil and fill materials.

B. Bedrock Units

Pierre Shale (Kp)
The Pierre Shale is the bedrock unit which underlies the majority of the basin. The Pierre Shale was deposited during the Cretaceous Age in a shallow inland sea. This bedrock formation consists mainly of clay shale which is typically blue-grey in its unweathered state, very dense, and contains some interbedded limestone and sandstone layers. The Pierre Shale is known for being expansive in weathered forms. Within the basin, the clay shale dominates. Publications indicate the thickness of this formation varies from about 3,000 to 5,000 feet. The Pierre Shale is exposed at several locations about two thirds of a mile upstream of Shooks Run's confluence with Fountain Creek. Downstream to the confluence within the stream channel, no exposures of bedrock were observed.

Laramie Formation (Kl)
The Laramie Formation of Cretaceous Age overlies the Pierre Shale in the northern part of the basin. Because of the surficial deposit cover, few exposures of the Laramie Formation exist within the basin. The Laramie Formation consists of brown to grey to white, fine-grained iron-stained sandstone, grey claystone, and coal beds. The Laramie Formation is well known for its coal beds which were mined in many parts of Colorado Springs. Undermined areas exist above the Laramie Formation in the northern part of the basin; however, these do not affect surface drainage conditions.

Arapahoe Formation (Kal, Kau)
The Arapahoe Formation overlies the Laramie Formation in the northern part of the basin. The Arapahoe Formation can be divided into two units. The lower unit is the Lower Andesitic Member and consists of brown to green to blue-grey sandstone, siltstone and claystone. These materials were weathered from volcanic rocks. This unit is mostly covered by surficial deposits. The upper unit is the Upper Arkosic Member and consists of tan to brown, iron-stained, cliff-forming coarse sandstone which outcrops in an arc marked by Pulpit Rock, Austin Bluffs, and Palmer Park.

C. Surficial Deposits

During relatively recent geologic times, the region has been subject to various erosional and depositional episodes, including some secondary glacial effects. This has resulted in an eroded bedrock surface on which the younger surficial deposits have been deposited. Even some of the surficial deposits have been subject to younger erosional processes which have tended to dissect and erode the older deposits.

Louviers Alluvium (Qlo)
The Louviers Alluvium is the oldest surficial deposit found within the basin and consists of alluvial deposits associated with Monument Creek and Shooks Run when they flowed at higher levels. It can be found in a wide band paralleling Monument Creek on the west side of Shooks Run. The Louviers Alluvium forms an elevated, broad, relatively flat terrace. In the downtown area, the Louviers forms the elevated, broad terrace on which the downtown region has been developed. The Louviers Alluvium typically consists of stratified sand, silt, and gravel material containing cobble and boulder material where influenced by Fountain Creek. Few exposures of Louviers Alluvium can be found along the channel due to vegetation cover and man-placed fill cover.

Eolian Sand (Qes)
Eolian (wind-blown) sand directly underlies the ground surface throughout most of the basin. This material generally consists of a tan, fine to coarse grained, silty to slightly silty sand, deposited by the action of wind in the geologic past. It covers both the older surficial deposits (such as the Louviers Alluvium) and the bedrock in the area. It is typically encountered in a low density condition and is prone to erosion by both wind and water.

Recent Alluvium
Recent Alluvium is associated with the main channel of Shooks Run and is found in a very narrow band within the creek bottom. The alluvium consists of sand and gravel with scattered cobble to boulder-sized materials, and silt and clay layers. The natural stream channel has been entirely altered by filling, dumping, channelization, and/or development encroachment.

Man-Placed Fill
Man-placed fill exists along most of the creek channel; virtually the entire floodplain and/or channel has been altered by filling, dumping, and development encroachment. Fill materials consist of all types of soil materials mixed with varying amounts of man-made materials; such as concrete, asphalt, metal, wood, and debris. During flooding, the presence of organics and wood could also provide additional sources for floating debris. The presence of man-made fills along the channel and in the floodplain could provide a source for pollution and solid waste problems. Given past management practices, the presence of industrial and commercial development along the channel and within the floodplain increases the likelihood of pollution sources.

D. Geologic Factors Affecting Drainage

Several geologic factors affect the overall drainage conditions in the basin. These include the location and type of bedrock, location and type of surficial soil deposits, and man-made development and disturbances within the basin and floodplain.

Erosion
Erosion of the soils and bedrock is a primary concern along Shooks Run. The banks and bed consist of soils and relatively soft bedrock which are all erodible under the velocities which characterize Shooks Run. The potential for erosion is reduced by vegetation which aids in bank protection. The hydraulic analysis shows the 100-year peak discharge velocities range from five to thirteen feet per second, with the majority being eight feet per second or higher.

The majority of the basin in underlain by the Pierre Shale. Although in its unweathered state the shale is considered to be "hard," it is still erodible and subject to slaking. The shale is eroded by scour during flooding, by slaking during cycles of wetting and drying, and by slaking during freeze-thaw cycles. Natural fractures within the shale also provide additional planes of weakness which result in stream bank slumps and failure. Data published in the City of Colorado Springs and El Paso County *Drainage Criteria Manual* (*Drainage Criteria Manual*) indicates that during flooding, the unweathered shale materials should be capable of withstanding water velocities on the order of six feet per second. Observations of shale exposures along both Monument and Fountain Creek indicate erosion of the shale along the active channel area may be occurring at the rate of one foot every ten to fifteen years. Along Shooks Run, it is also apparent that erosion of the Pierre Shale is occurring by scour, slaking and bank failure. Exposures of the Pierre Shale found along the channel are shown on the Geologic Map (Figure 11).

The surficial soil deposits and man-placed fill materials are the most erodible materials along the channel. These are also the materials which dominate the channel bottom and side slopes. The soil and fill deposits along the channel are highly variable in classification ranging from clay and silt layers, to fine sand, to coarse mixtures of sand, gravel, cobbles and boulders. In fill areas, these soil materials are mixed with varying amounts and types of debris. The *Drainage Criteria Manual* indicates these fill and soil materials should be capable of withstanding water velocities ranging from about two to five feet per second. The presence of organics and wood in the man-placed fill materials provide an additional source for floating debris during erosion and flooding.

Due to filling, dumping, and development along the channel and within the floodplain, the stream has been altered and constricted. Development along the channel is estimated to have occurred for about 100 years and has resulted in a narrower channel and/or floodplain. Observations along the channel indicate erosion, rather than deposition, is the dominant process along the bed and banks. Erosion is also concentrated at several "hot spots" where the creek bends, drops occur, and at some road crossings. Unless protected from erosion, it appears the future tendency will be for further bed and bank degradation.

Steep Slopes

The filling and dumping along the channel, along with localized bank erosion, has resulted in some steep slope areas. Although these steep slopes may stand vertically for an indefinite period of time when dry, when flooding occurs, the slopes become saturated; erosion occurs; and the slopes are subject to instability, slumping and failure. Slope failures along steep banks can be expected during flooding and may jeopardize structures (buildings, utilities and road crossings). In local areas, slope stability is aggravated by seeps and springs out of the slope. In the development of designs, it is, therefore, important to provide slope stabilization in addition to erosion protection.

E. Soils Information for the Hydrologic Analysis

Soils Information for the hydrologic analysis was obtained from *Soil Survey of El Paso County Area, Colorado*, June 1981, prepared by the Soil Conservation Service (S.C.S.). The natural soils of the basin are generally sandy loams and some clay loams over the various previously described bedrocks. These natural soils include the Ascalon sandy loam, Blakeland loamy sand, Blendon sandy loam, Bresser sandy loam, Chaseville gravelly sandy loam, Ellicott loamy coarse sand, Fluvaquentic Haplaquolls, Kutch clay loam, Nelson-Tassel fine sandy loams, Nunn clay loam, Razor-Midway complex, Travessila-Rock outcrop complex, Truckton sandy loam, and Ustic Torrifluvents loamy soils classifications. These soils classifications are mainly in S.C.S. Hydrologic Soils Groups A and B, with some in Groups C and D. The natural soils of the basin are illustrated on the General Soils Map (Figure 12).

Existing Drainage System Inventory

The inventory of the existing Shooks Run drainage system was completed in two parts. First, an office inventory was done through a detailed review of previous drainage reports, construction plans and other City drainage record maps. Next, an extensive field inventory was done to verify the information obtained in the office inventory and to identify other drainage improvements not recorded in any document. The field inventory included surface observation of the entire drainage basin and opening of many manhole and inlet covers to verify locations and sizes of underground facilities.

The existing drainage system inventory included the main channel of Shooks Run, storm sewer and channel systems, and minor surface systems. The inventory identified culverts, inverted siphons, storm sewers, inlets, manholes and detention ponds. The flow direction of all conduits, streets and street crosspans, and the high points in all streets were identified for the entire basin. The inventory information is illustrated on the one inch to 200 feet scale mapping for the project and referenced to a data base that includes size, type and length information for the existing drainage improvements. This mapping and data base were prepared separately from this report and are available through the City Engineering Division (Drainage Basin Facility Inventory, Shooks Run, September 1991).

Existing Drainage Problems

A number of drainage problem complaint letters received by the City Engineering Division from property owners within the basin were reviewed. These complaint letters are related to isolated problem areas concerning the minor drainage systems for the basin. A summary of these drainage complaint letters was prepared separately from this report.

Existing problem areas along the main channel were identified as a result of the hydrologic and hydraulic analyses for the existing condition. These problems include roadway crossing capacity and improved property flooding problems. These problems along the main channel are discussed in more detail in the Hydraulic Analysis section of this report.

Biological Resources Inventory

A. Vegetation

The diversity of vegetation along the Shooks Run corridor has been influenced by the adjacent land uses, channel improvements and streambank treatment. The primary vegetation is riparian in composition which occurs predominantly within the floodplain. It is comprised of woodland and shrubland species. The U.S. Fish and Wildlife service has mapped the corridor for various vegetation zones. These zones were field verified and are illustrated in Figures 13-18.

The non-riparian zones occur in small pockets along the corridor in a peripheral nature to the channel margin. These pockets include areas where there has been significant stream bed degradation, leaving steep banks with grasses, non-riparian species, elm and black locust. There also occurs pockets of cottonwood, willow and grass outcroppings adjacent to riparian habitats.

B. Riparian Vegetation

The riparian vegetation has been divided up into five categories for mapping purposes. These categories are mature riparian forest, immature riparian saplings, wetland shrubs, grassland margins, and herbaceous wetlands. The mature riparian woodland forest is dominated by well established, old cottonwoods and willows. These pockets of woodlands occur along the margins of the floodplain and frequently within the existing channel cross-section.

The riparian shrubs, limited to species that do not provide an overstory, are dominated by sandbar willow. The riparian shrubs occur usually with sand and gravel substrates and a relatively high level of groundwater. The regeneration of the willow is limited by the occurrence of flooding associated with significant rainfall events. The shrubland areas have a well developed understory with a mix of herbaceous wetlands species, primarily grasses and sedges.

C. Wetlands

Herbaceous wetlands occur sporadically within the floodplain of the Shooks Run corridor. Their distribution is predominantly restricted to occurrences with the shrub willow. Emergent wetlands are rare and limited to small areas of inundation and areas supplied by supplemental irrigation, runoff or seepage. The wetland areas were confirmed with field verification using the *Corps of Engineers Wetland Delineation Manual,* dated 1987, with an emphasis on vegetation indicators, and the U.S. Fish and Wildlife Service wetlands mappings, as well as extensive field observation.

D. Existing Channel Vegetation Description

The following channel reaches were included in the detailed biological resources evaluation.

Reach 1 - Fountain Creek to the Abandoned Railroad

The vegetation within this reach is comprised primarily of mature riparian forest. The dominant species are cottonwood, elm and willow. There are pockets of immature riparian saplings around the mobile home park that are comprised of willow inclusions. The ground plain is dominated by grassland margins.

Reach 2 - The Abandoned Railroad to Costilla Street

Within this reach there is a broader range of vegetation types. The dominant overstory is comprised of mature riparian species, willow, cottonwoods and elm. The immature riparian saplings only occur in a small grouping south of Costilla Street. The grassland margins are dominant due to the shade provided by the mature riparian forest overstory. One small area of wetland shrubs occurs just north of Fountain Boulevard.

Reach 3 - Costilla Street to Boulder Street

This reach covers a broad range of vegetation types and conditions. The mature riparian forest is dominant throughout with pockets being interrupted by walls, riprap or concrete areas. The mature forest is usually associated with well established grass margins. There are a few small pockets of immature riparian saplings south of Pikes Peak Avenue. There is also one small pocket of herbaceous wetlands comprised primarily of herbs and sedges.

Reach 4 - Boulder Street to Cache La Poudre Street

This reach has a greater variety of riparian vegetation groupings. The area south of Willamette Street is dominated by mature riparian forest and grassland margins with one pocket of wetland shrubs. The area north of Willamette Street is comprised of mature riparian forests with grassland margins. There are a few large, old cottonwoods south of Cache La Poudre Street. There are also pockets of immature riparian saplings and a small pocket of herbaceous wetlands comprised of Angelica grayi.

Reach 5 - Cache La Poudre Street to Patty Jewett Golf Course

This reach is comprised of mature riparian forest with grassland margins. There are a few old, well established cottonwoods by Cache La Poudre Street. Pockets of immature riparian saplings occur along the east bank with areas of ash and serviceberry. Wetland shrubs occur in a small pocket south of San Rafael Street.

Reach 6 - Patty Jewett Golf Course

The mature riparian forest is comprised of balsam poplar, willow and elm. There are pockets of immature saplings among the concrete rubble. There are pockets of wetland shrubs and herbaceous wetlands associated with auxiliary drainage areas. These pockets have willow saplings, milk weeds and sedges, respectively. The northern most end of the reach is a concrete drainage channel.

E. Wildlife

Mammals

The Colorado Division of Wildlife has generated mapping for the entire El Paso County area by the use of indicator species. The species mapping was based upon the following criteria: 1) indicator species for unique habitat, 2) threatened or endangered species, or 3) big game species of economic importance (such as mule deer is both an indicator species for habitat and economic value). The majority of the mammals within the corridor are smaller (such as raccoons, squirrels, foxes, skunks, porcupines, etc.). The larger riparian vegetation areas provide greater diversity of habitat coverage, food sources and species diversification. Reaches 4 and 5 of the channel provide excellent urban wildlife habitat.

Birds

Perhaps the most significant use of the corridor is that of the resident and migratory bird populations. Within the corridor boundary there are no nesting sites for threatened or endangered species, yet the corridor is used as hunting grounds by the prairie falcon and golden eagle. There is a prairie falcon nesting site in North Cheyenne Canyon and three golden eagle nesting sites within the city limits (two by the Garden of the Gods and one by 31st Street and U.S. Highway 24.

The corridor is considered to be a major migratory route with greater bird population concentrations than occurring ten miles east, for example, because of the vegetation and habitat coverage. The corridor is extensively used for breeding grounds, winter usage and resident bird populations.

Reptiles and Amphibians

The corridor provides an excellent habitat for reptiles and amphibians; such as turtles, toads, frogs, snakes, racers and lizards. The riparian vegetation provides excellent habitat for breeding, winter hibernation and food supplies.

Cultural and Park/Trail Resources Inventory

A. Cultural Resources

The Shooks Run Drainage Basin Planning Study identified the following cultural and historic resources within the study area. The earliest plattings of Colorado Springs lay between Cascade Street to the west, Willamette Street to the north, Wahsatch Avenue to the east and Moreno Street to the south. The Shooks Run area includes many additions to the original plat. The Shooks Run stream was named after Peter Shook, who acquired a land patent from the Bureau of Land Management, December 1, 1865. It was for 80 acres located at the south end of Shooks Run and includes the confluence of Shooks Run and Fountain Creek. A second significant element in the growth of Colorado Springs is the development of the Sinton Hill Dairy. The dairy was established in 1880 and is one of the oldest businesses in Colorado Springs. A third element that was critical to the development of Colorado Springs was its promotion as a health resort by General William Jackson Palmer. These elements have all contributed to the historic character of the Shooks Run corridor.

The National Historic Preservation Act of 1966 authorized the Secretary of the Interior to develop the National Register of Historic Places. Districts, sites, buildings, structures and objects which are historically or architecturally significant are included in the register. To document the growth and development of the historic character of Shooks Run, the following categories have been established.

1. National Historic Register: None presently on the register.

2. Eligible for the National Historic Register:

   a. Colorado School for the Deaf and Blind
   b. Garfield School
   c. Santa Fe Railroad Depot
   d. Octagonal Tent Cottages - 522 North Royer Street and 743 East Willamette Street

3. Locally significant, both historically and/or architecturally:

   a. Sinton Hill Dairy
   b. Peoples Methodist Episcopal Church
   c. Epiphany Episcopal Church
   d. Dale Street Chapel
   e. The abandoned Santa Fe Railroad bridge
   f. Individual residences that display architectural significance, which contribute significantly to the historic setting and local character of the Shooks Run area.

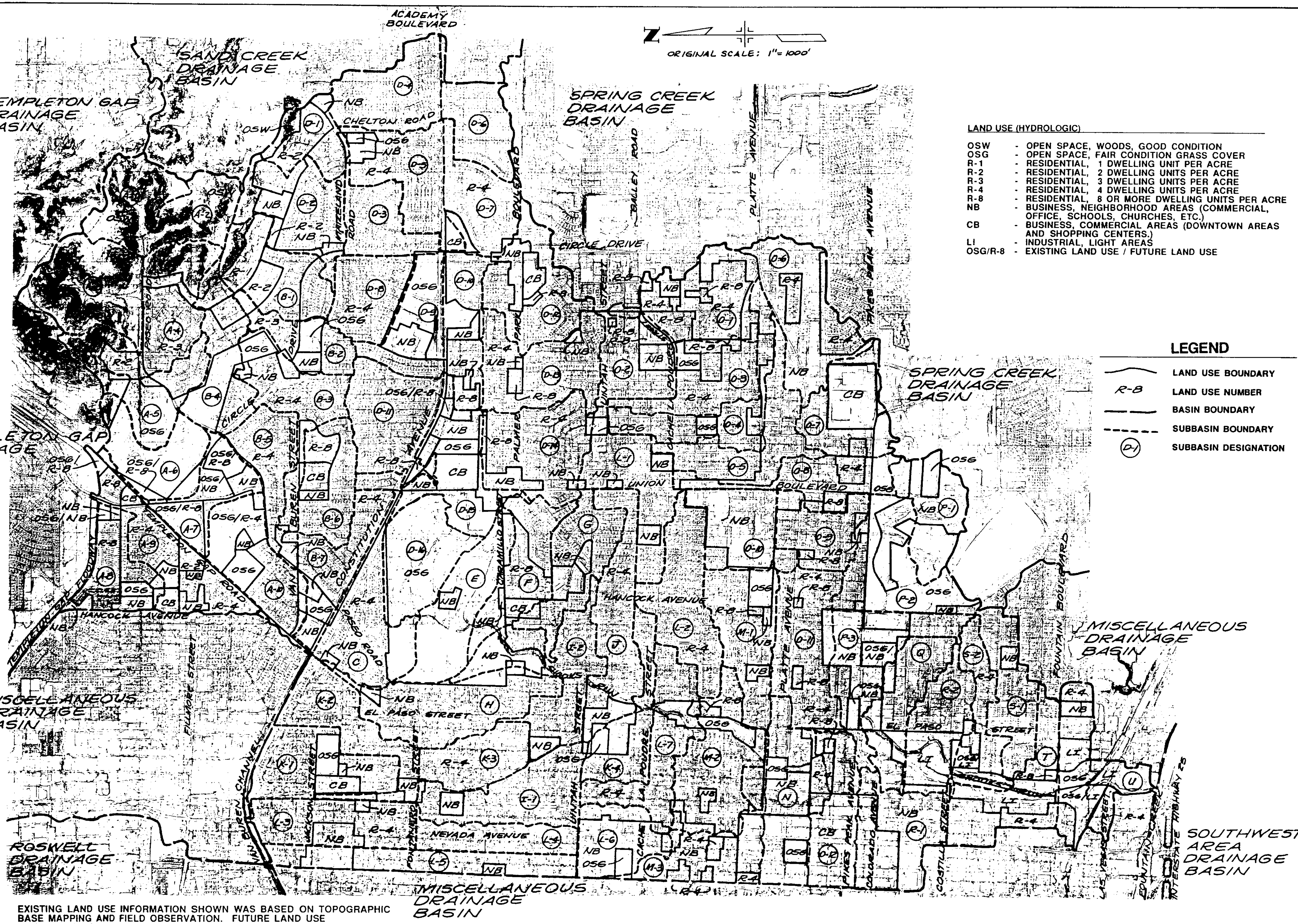
B. Recreation, Park, Open Space and Trail Resources

The Shooks Run corridor has a tremendous amount of variety in its recreational amenities and opportunities from providing access to inter-city neighborhoods, historic districts, Downtown and rural open spaces.

The City of Colorado Springs Transportation Plan has identified existing and proposed on-street and off-street bicycle routes. Shooks Run has been identified as a Preservation Corridor, linking up to the multi-use spine trail along Fountain Creek and the Rock Island Loop. The City of Colorado Springs Comprehensive Plan emphasizes the goal of providing a system of conveniently located parks, access points, encouraging bike routes, and enhancing the natural setting within the built environment. The existing on-street bike routes provide an initial framework for such a system.

A significant length of the corridor is bordered by park land, providing access to picnic shelters, play equipment, open space and Patty Jewett Golf Course. A well defined network of on-street bicycle paths connect to the Shooks Run corridor.

The cultural and park/trail resources along Shooks Run are illustrated in Figures 19-24.



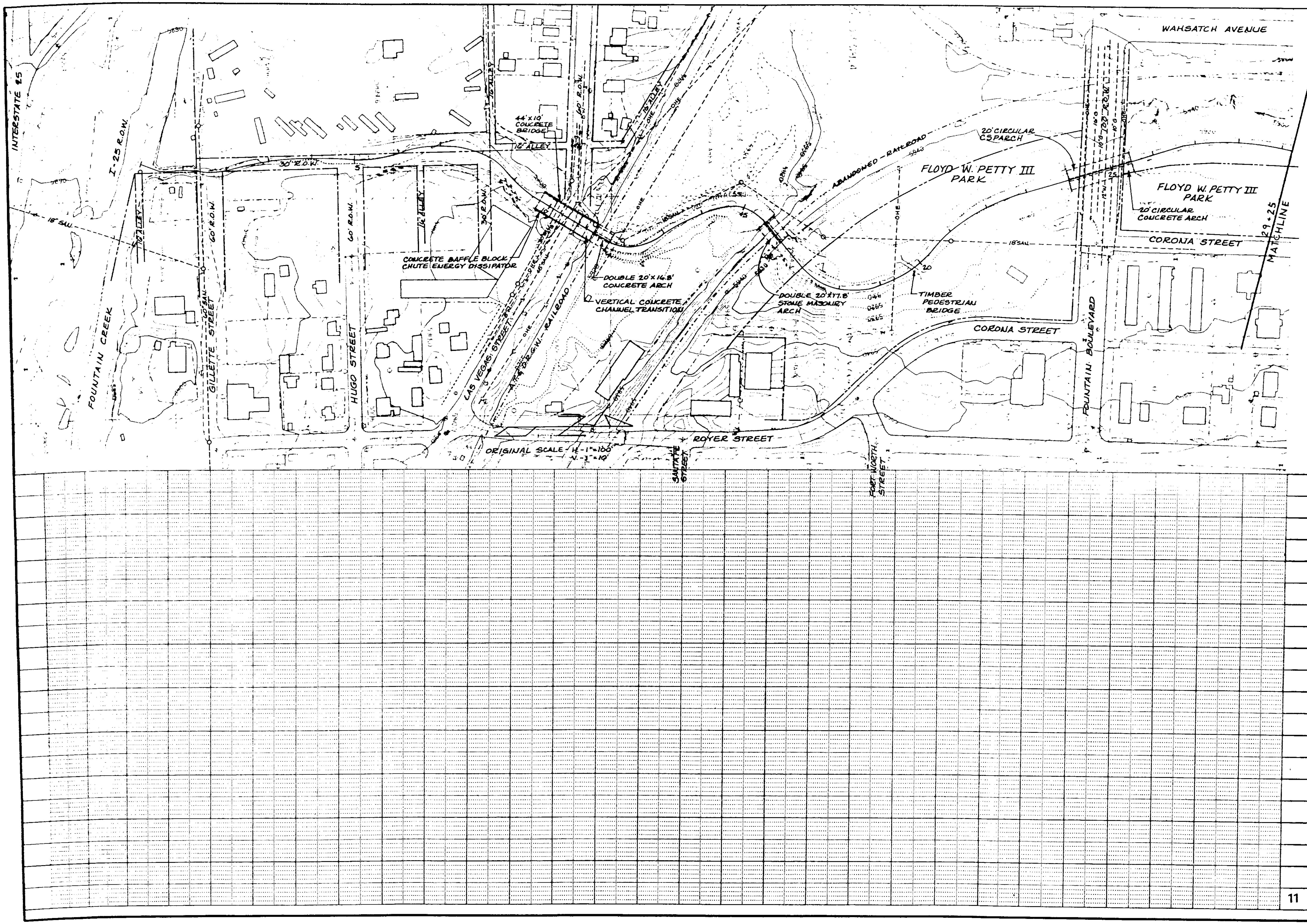
EXISTING LAND USE INFORMATION SHOWN WAS BASED ON TOPOGRAPHIC BASE MAPPING AND FIELD OBSERVATION. FUTURE LAND USE INFORMATION SHOWN WAS TAKEN FROM "MASTER PLANNED LAND USE", EL PASO COUNTY LAND USE DEPARTMENT, JANUARY 1987.

WILSON & COMPANY

SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
LAND USE MAP

DESIGN	WD
DRAWN	DJB
DATE	AUGUST, 1991
FILE NO.	90-804
SHEET NO.	FIGURE 2

WILSON & COMPANY
COLORADO SPRINGS, COLORADO



WILSON & COMPANY

REVISION | DATE | BY

SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
EXISTING UTILITIES AND R.O.W.

DESIGN
DRAWN
DATE
FILE NO. 90-809
SHEET NO. FIGURE 3

WILSON & COMPANY
COLORADO SPRINGS, COLORADO

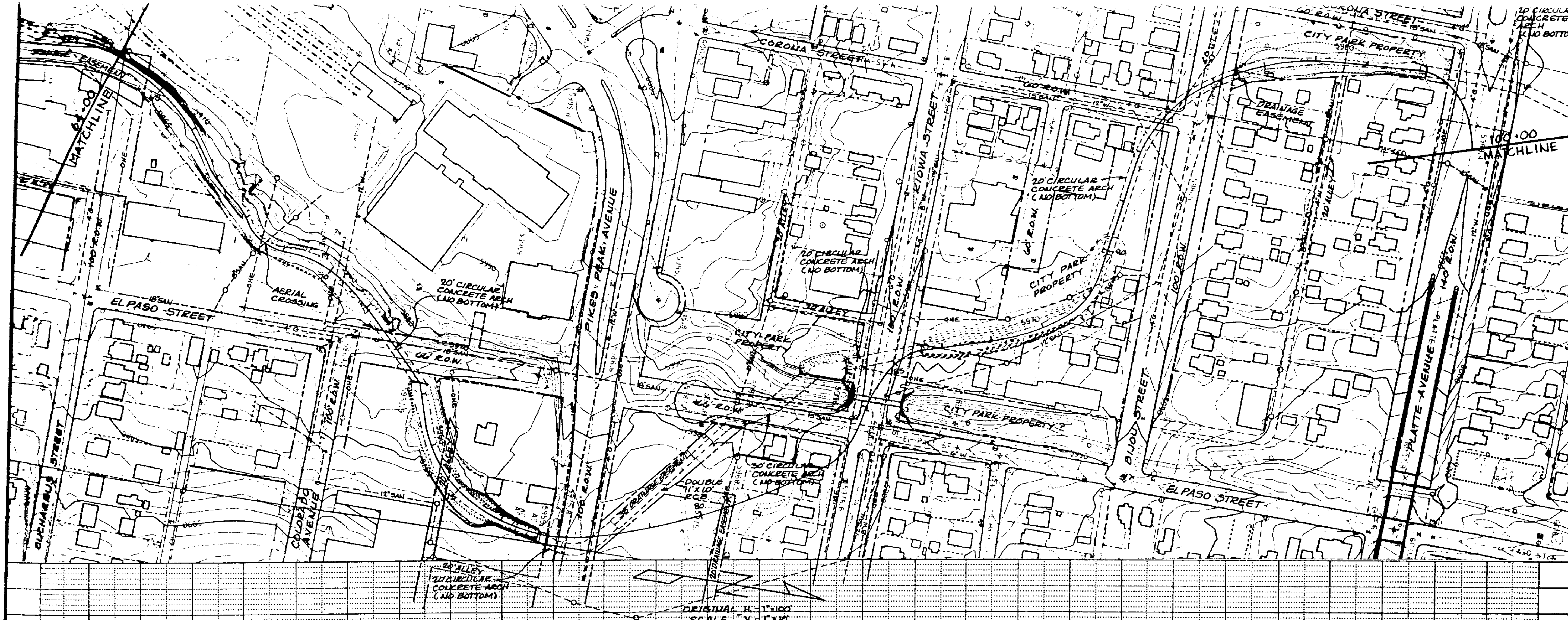
REVISION | DATE | BY

WILSON & COMPANY

SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
EXISTING UTILITIES AND R.O.W.

DESIGN
DRAWN
DATE
FILE NO. 90-809
SHEET NO. FIGURE 4

WILSON & COMPANY
COLORADO SPRINGS, COLORADO



REVISION | DATE | BY

WILSON & COMPANY

SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
EXISTING UTILITIES AND R.O.W.

DESIGN
DRAWN
DATE
FILE NO. 90-809
SHEET NO. FIGURE 5

WILSON & COMPANY
COLORADO SPRINGS, COLORADO

REVISION | DATE | BY

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SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
EXISTING UTILITIES AND R.O.W.

DESIGN

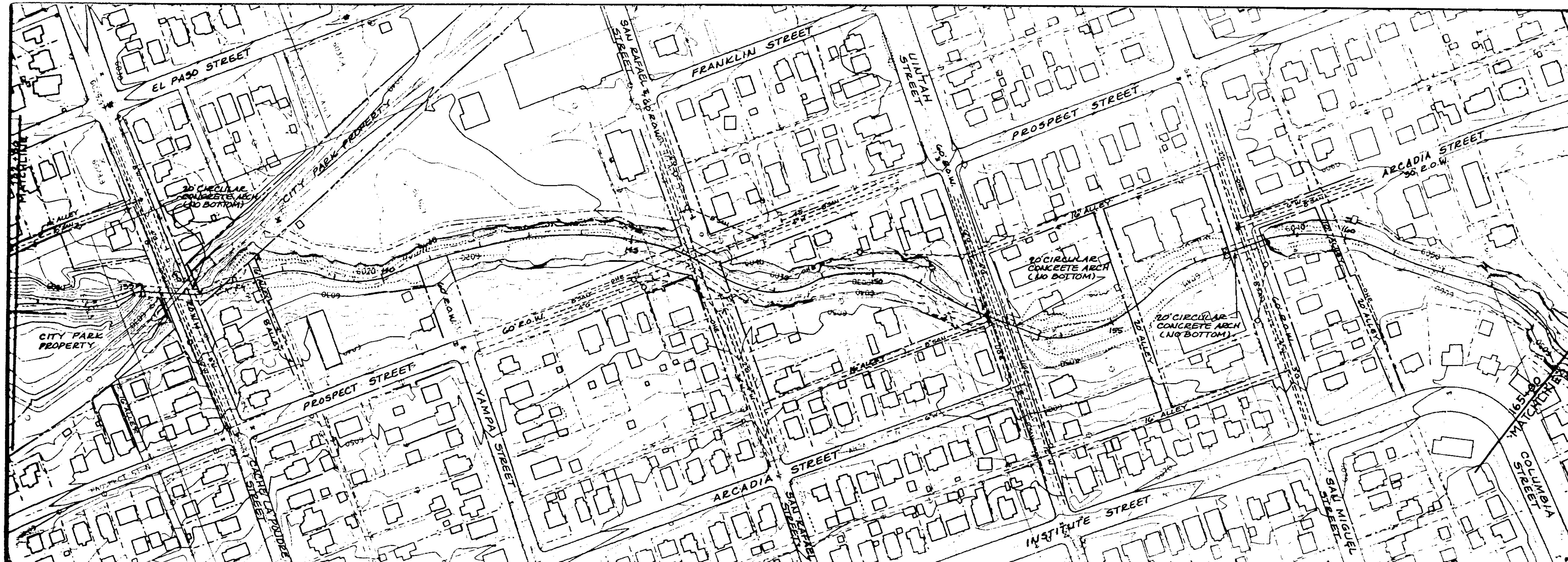
DRAWN

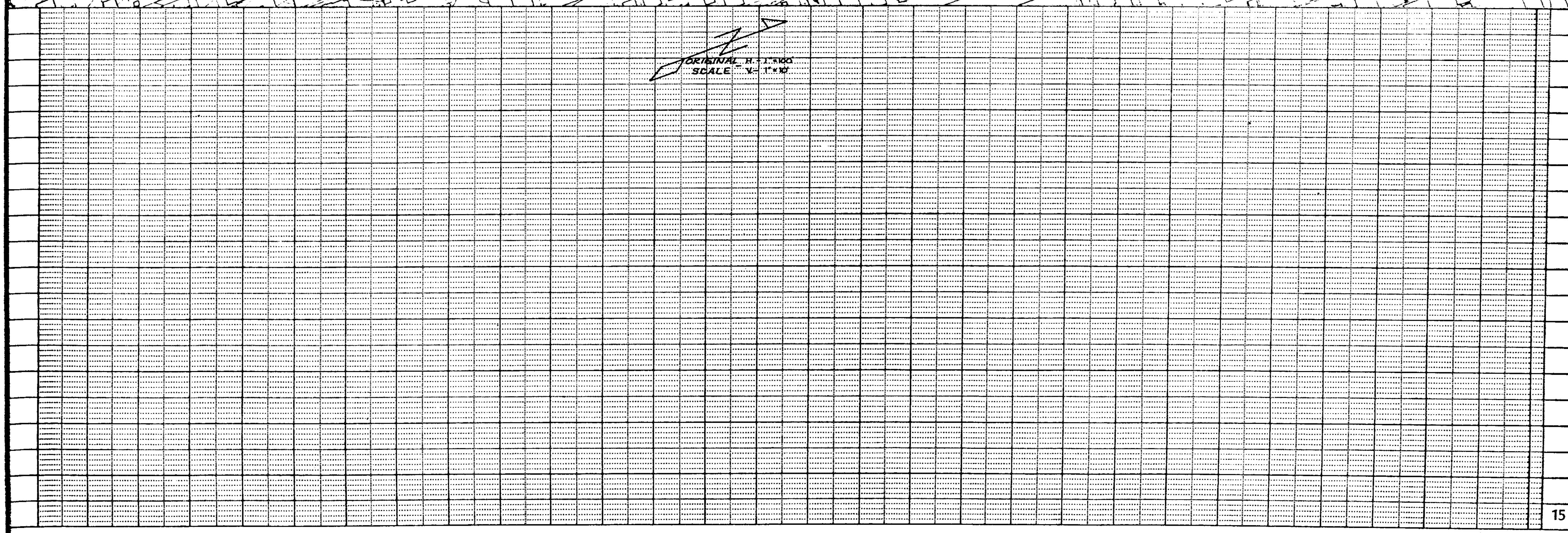
DATE

FILE NO. 90-809

SHEET NO. FIGURE 6

WILSON & COMPANY
COLORADO SPRINGS, COLORADO



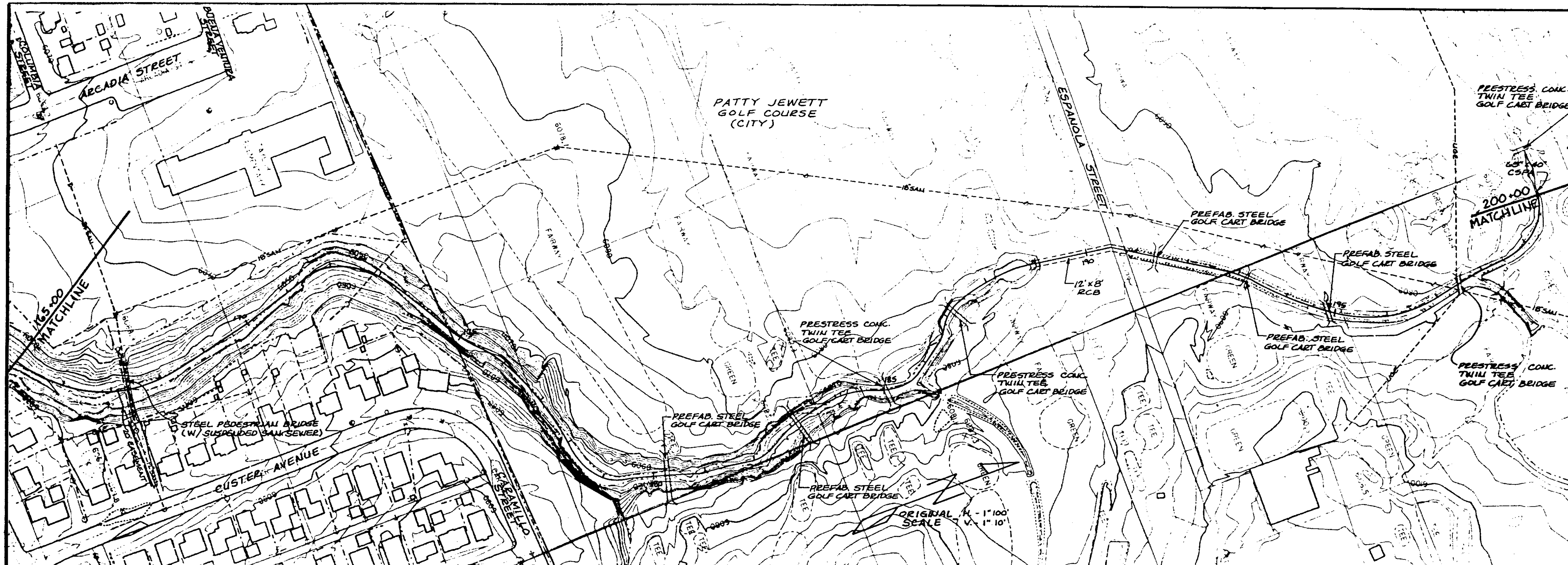


WILSON & COMPANY

SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
EXISTING UTILITIES AND R.O.W.

DESIGN	
DRAWN	
DATE	
FILE NO.	90-809
SHEET NO.	FIGURE 7

WILSON & COMPANY
COLORADO SPRINGS, COLORADO



REVISION	DATE	BY

WILSON & COMPANY

SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
EXISTING UTILITIES AND R.O.W.

DESIGN
DRAWN
DATE
FILE NO. 90-809
SHEET NO. FIGURE 8

WILSON & COMPANY
COLORADO SPRINGS, COLORADO

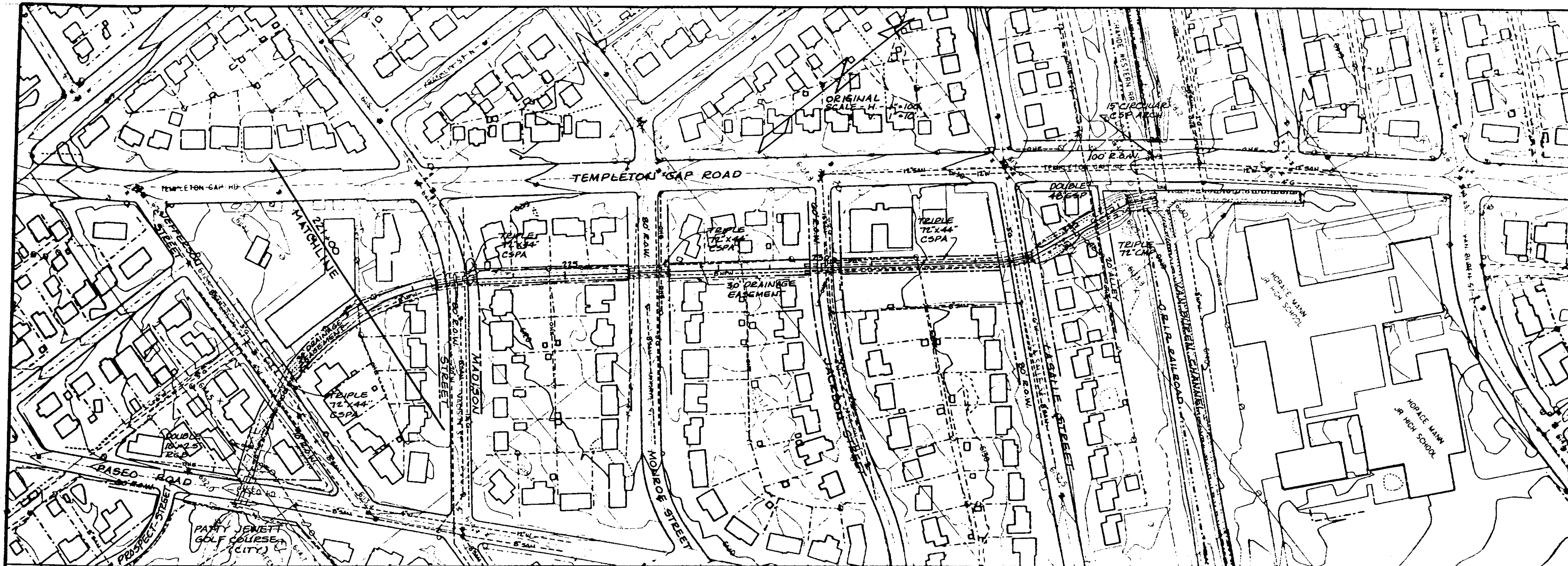
REVISION	DATE	BY

WILSON & COMPANY

SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
EXISTING UTILITIES AND R.O.W.

DESIGN
DRAWN
DATE
FILE NO. 90-809
SHEET NO. FIGURE 9

WILSON & COMPANY
COLORADO SPRINGS, COLORADO



REVISION	DATE	BY

WILSON & COMPANY

SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
EXISTING UTILITIES AND R.O.W.

DESIGN

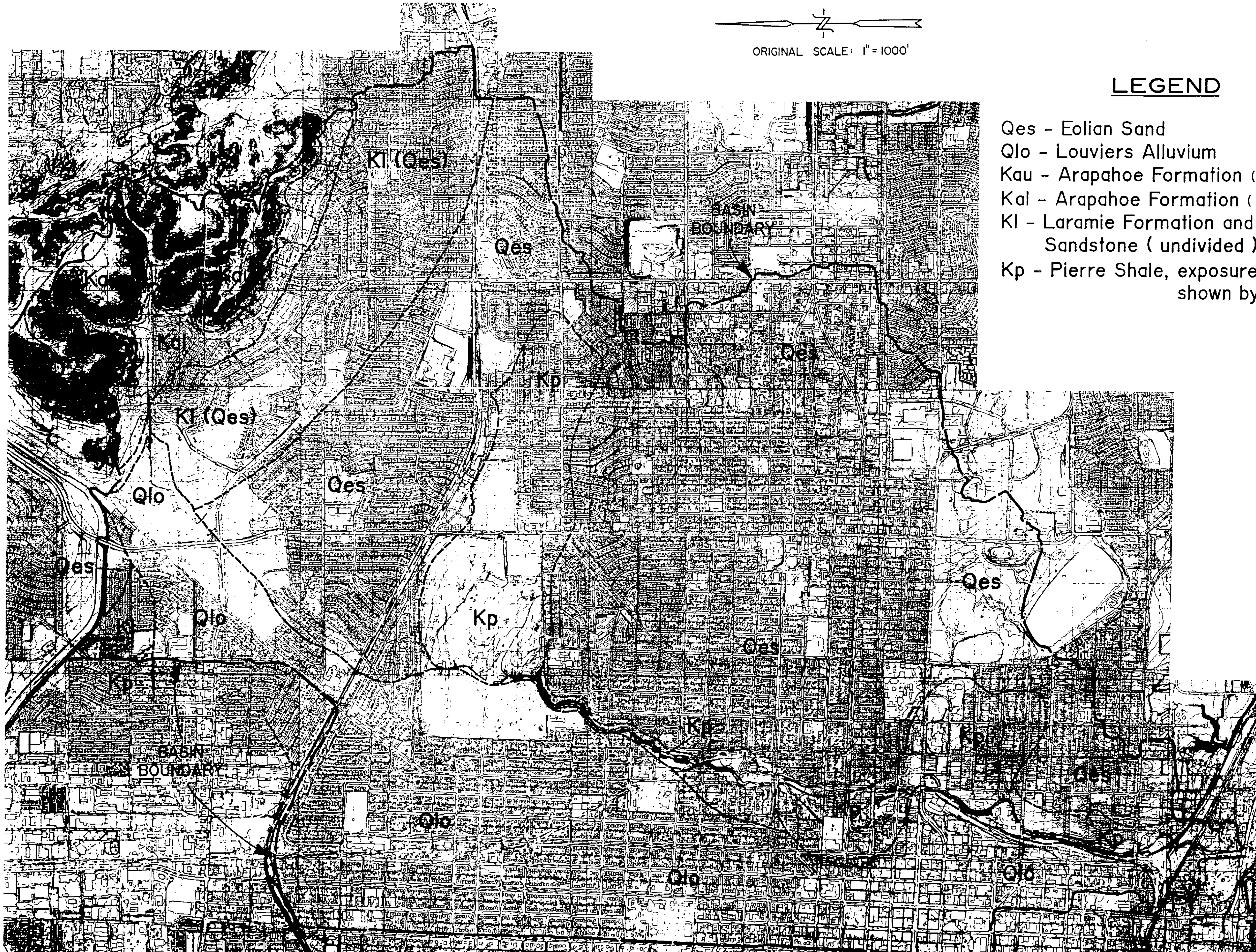
DRAWN

DATE

FILE NO. 90-809

SHEET NO. FIGURE 10

WILSON & COMPANY
COLORADO SPRINGS, COLORADO



GEOLOGIC MAP

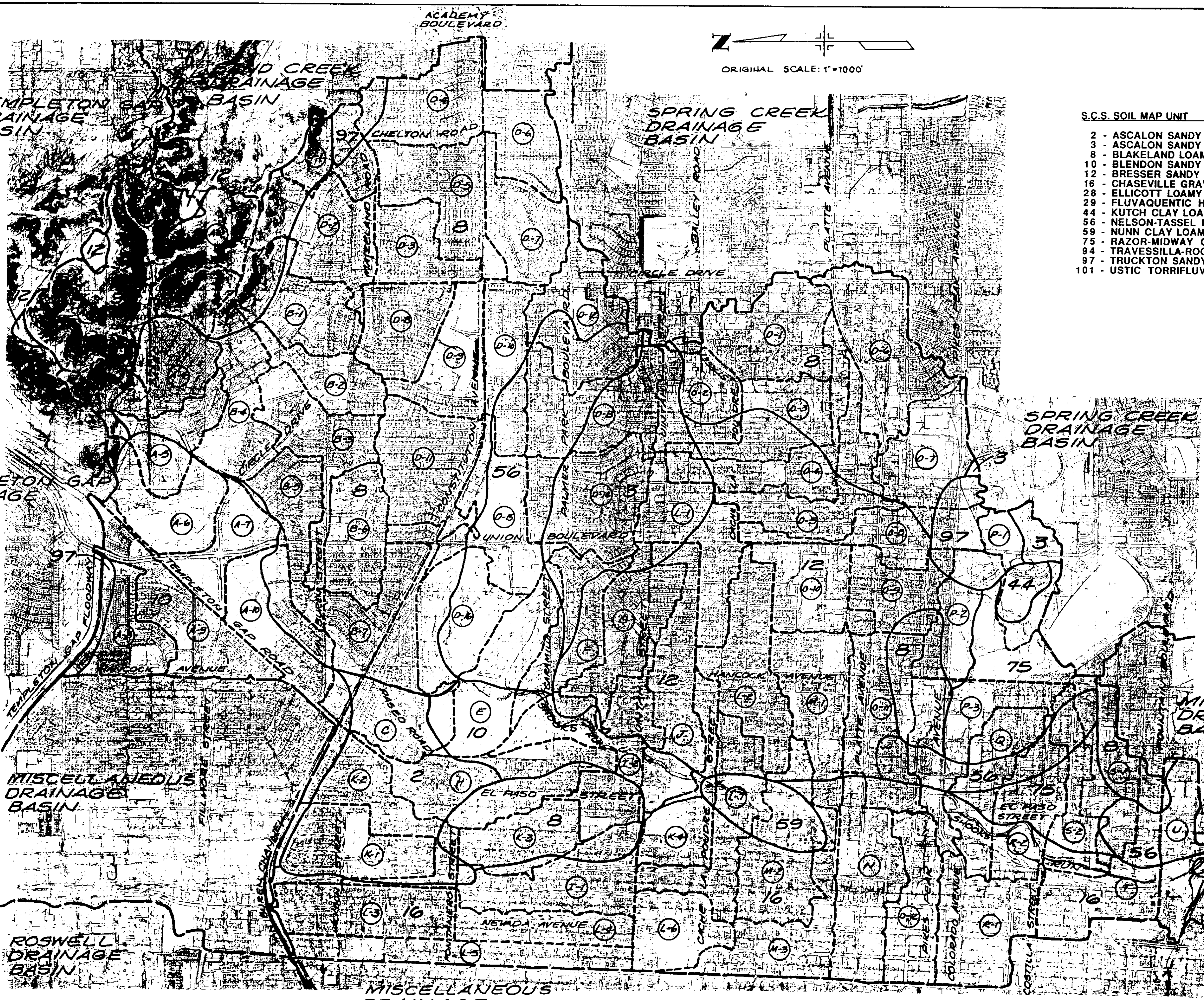
CTL/THOMPSON, INC.
CONSULTING GEOTECHNICAL AND MATERIALS ENGINEERS

SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
GEOLOGIC MAP

WILSON & COMPANY

DATE 7-93
FILE NO. 90-809
SHEET NO. FIGURE 11

WILSON & COMPANY
COLORADO SPRINGS, COLORADO



S.C.S. SOIL MAP UNIT	HYDROLOGIC SOIL GROUP
2 - ASCALON SANDY LOAM	B
3 - ASCALON SANDY LOAM	B
8 - BLAKELAND LOAMY SAND	A
10 - BLENDON SANDY LOAM	B
12 - BRESSER SANDY LOAM	B
16 - CHASEVILLE GRAVELLY SANDY LOAM	A
28 - ELLICOTT LOAMY COARSE SAND	A
29 - FLUVAQUENTIC HAPLAQUOLLS	B/D=USEC
44 - KUTCH CLAY LOAM	C
56 - NELSON-TASSEL FINE SANDY LOAMS	B/D=USEC
59 - NUNN CLAY LOAM	C
75 - RAZOR-MIDWAY COMPLEX	C/D=USEC
94 - TRAVESSILLA-ROCK OUTCROP COMPLEX	D/D=USED
97 - TRUCKTON SANDY LOAM	B
101 - USTIC TORRIFLUVENTS, LOAMY	B

LEGEND

- SOIL MAP UNIT BOUNDARY
- 97 SOIL MAP UNIT
- BASIN BOUNDARY
- SUBBASIN BOUNDARY
- (D-6) SUBBASIN DESIGNATION

SOILS INFORMATION SHOWN WAS TAKEN FROM "SOIL SURVEY OF EL PASO COUNTY AREA, COLORADO", SOIL CONSERVATION SERVICE, JUNE 1981

REVISION | DATE | BY

WILSON & COMPANY

SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
GENERAL SOILS MAP

DESIGN WD
DRAWN DJB
DATE AUGUST, 1991
FILE NO. 90-809
SHEET NO. FIGURE 12

WILSON & COMPANY
COLORADO SPRINGS, COLORADO

WILDLIFE IDENTIFICATION

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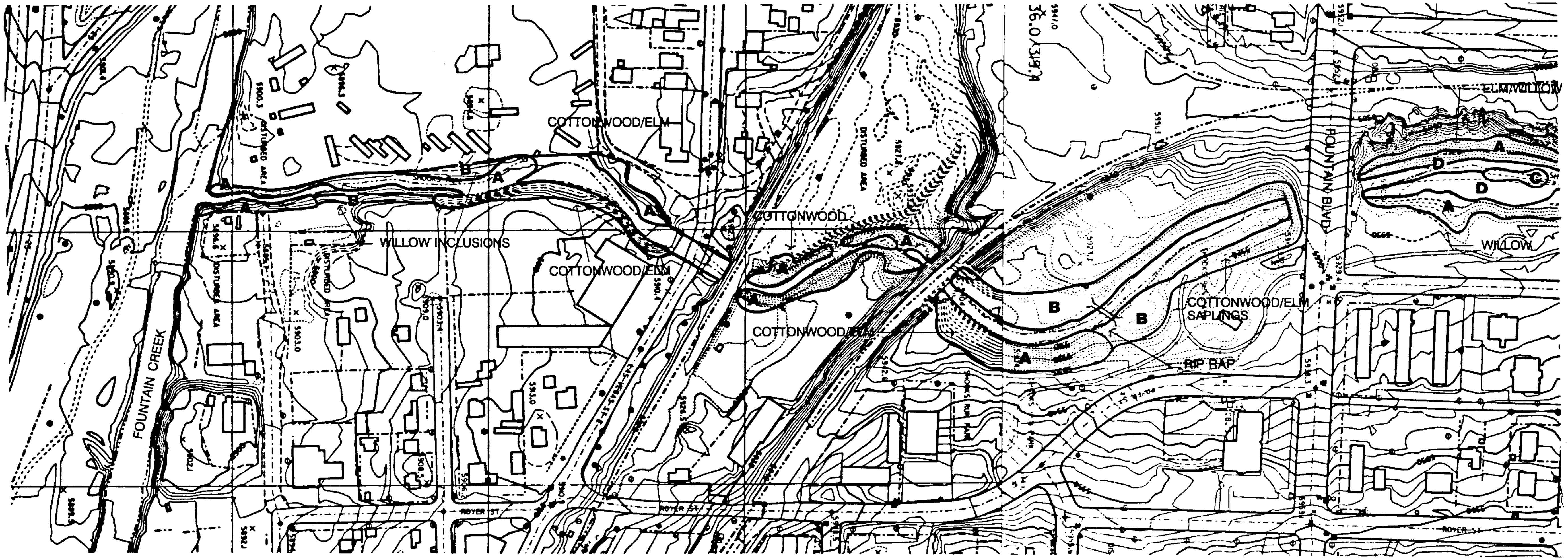
INDICATOR SPECIES FOR CRITICAL HABITATS	ECONOMIC IMPORTANCE	THREATENED OR ENDANGERED
1. Albertis Squirrel-Ponderosa Pine Forest	1. Mule Deer	1. Prairie Falcon
2. Beaver-Riparian	2. Black Bear	2. Golden Eagle
3. White-tailed Deer-Riparian	3. Big Horn Sheep	3. Peregrin Falcon
	4. White-tailed Deer	4. Sharp-tail Grouse

Refer to Sheet #1 for representative Mammal species
Refer to Sheet #2 for Bird species
Refer to Sheet #3 for Amphibian & Reptile species

For complete wildlife information see text of report.

MAMMALS	HABITAT
Beaver	Riparian
Porcupine	Wide range of habitats
Raccoon	Riparian
Spotted Skunk	Wide range of habitats
Mule Deer	Wide range of habitats
White-tailed Deer	Riparian
Shrew; Masked, Dusky, Least	Wide range of habitats/riparian
Mouse; White-footed, Hispid Pocket, Western Harvest, Brush, House	Wide range of habitats
Vole; Meadow, Prairie	
Rat; Hispid, Cotton, Eastern Wood, Norway, Ord's Kangaroo, Bushy-tailed	Wide range of habitats



LEGEND

A. Mature Riparian Forest:

*Understory well developed, trunks larger than 5" in diameter.

*Typical species:

Peachleaf Willow	(Salix amygdaloides)
Balsam Poplar	(Populus balsamifera)
Plains Cottonwood	(Populus sargentii)
Common Boxelder	(Acer negundo)
Narrowleaf Cottonwood	(Populus accuminata/anqustifolia
Green Ash	(Fraxinus pennsylvanica)

B. Immature Riparian Saplings:

*Shorter, denser plant material, understory not well developed due to shade, less than 3" in diameter.

*Typical species:

American Elm	(Ulmus americana)
Siberian Elm	(Ulmus pumila)
Black Locust	(Robinia pseudoacacia)
Common Boxelder	(Acer negundo)

C. Wetland Shrubs:

*Typically less than 10' tall, understory not weel developed due to shade.

*Typical species:

Sandbar Willow	(Salix exidua)
Dwarf Alpine Currant	(Ribes aureum)
Common Snowberry	(Symphoricarpos alba)
Wood Rose	(Rosa Woodsii)
Yellow Clematis	(Clematis orientalis - vine)

D. Grassland Margins:

*Includes riparian grasses, small pockets of herbaceous wetland perennials, also small weed pockets.

*Typical species:

Intermediate Wheatgrass	(Agrophyron intermedium)
Rough Bentgrass	(Agrostis stolonifera/scabra)
Smooth Broam	(Bromus inermis)
Kentucky Bluegrass	(Poa pratensis)
Canadian Bluegrass	(Poa canadensis)
Canada Wildrye	(Elymus canadensis)
Creeping Wildrye	(Elymus tricoides)
Wild Yarrow	(Achillea lanulosa)
Canadian Thistle	(Cirsium canadensis)
White Goosefoot	(Chenopodium album)
Coast-Blite Goosefoot	(Chenopodium rubrum)

E. Herbaceous Wetlands:

*Non-woody perennials, need annual foundation to survive. Mostly forbs, sedges and some grasses.

*Typical species:

Sedge Species	(Carex species)
Angelica Species	(Angelica species)
Swamp Milkweed	(Asclepias incarnata)
Rush Species	(Juncus species)
Broad-Leaf Cattail	(Typha latifolia)

F. Concrete Channel:

-Fully lined trapezoidal channel

G. Walls:

-Wood, granite, riprap, concrete, dumped or poured
-Eroded slopes, includes undercut banks

0 50 100 200 300

SCALE: N.T.S.

THOMAS & THOMAS

Planning · Urban Design · Landscape Architecture

FIGURE 13

313 East Costilla Colorado Springs, Colorado 80903
(719) 578-8777

SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
BIOLOGICAL RESOURCE INVENTORY

WILSON & COMPANY

DESIGN
DRAWN
DATE 9-8-93
FILE NO.
SHEET NO.

WILSON & COMPANY
COLORADO SPRINGS, COLORADO

WILDLIFE IDENTIFICATION

The wildlife inventory was performed as a critical aspect of the initial phases of this study. The corridor is used by an abundance of mammals, birds, reptiles and amphibians as breeding and non-breeding habitats. The mapping of wildlife species has been provided by the Colorado Division of Wildlife as per House Bill 1041. The species were selected for mapping based upon one of the following criteria:

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The following lists have been generated to list representative species of the corridor. These lists are not all inclusive but a random sample for representative purposes.

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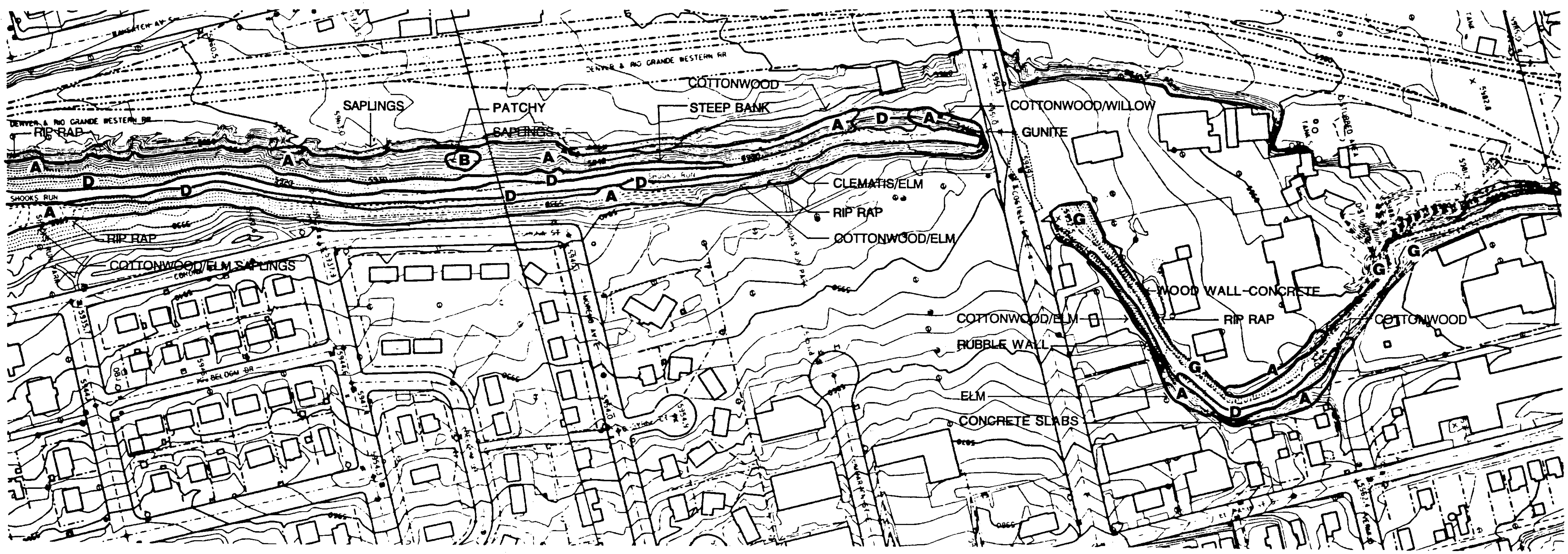
1. Albertis Squirrel-Ponderosa Pine Forest	1. Mule Deer	1. Prairie Falcon
2. Beaver-Riparian	2. Black Bear	2. Golden Eagle
3. White-tailed Deer-Riparian	3. Big Horn Sheep	3. Peregrin Falcon
	4. White-tailed Deer	4. Sharp-tail Grouse

Refer to Sheet #1 for representative Mammal species
Refer to Sheet #2 for Bird species
Refer to Sheet #3 for Amphibian & Reptile species

For complete wildlife information see text of report.

SONG BIRDS

Dowey Woodpecker	Breeding/Migration
Horned Lark	Breeding/Migration
Steller's, Blue, Scrub Jay	Breeding-winter
Black-Billed Magpie	Breeding
American Crow	Breeding/Migration
Common Raven	Breeding/Migration
Black-Capped Chickadee	Breeding-winter
Mountain Chickadee	Breeding-winter
Townsend's Solitare	Breeding-winter
American Robin	Breeding-winter



LEGEND

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*Typical species:

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B. Immature Riparian Saplings:

*Shorter, denser plant material, understory not well developed due to shade, less than 3" in diameter.

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D. Grassland Margins:

*Includes riparian grasses, small pockets of herbaceous wetland perennials, also small weed pockets.

*Typical species:

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E. Herbaceous Wetlands:

*Non-woody perennials, need annual foundation to survive. Mostly forbs, sedges and some grasses.

*Typical species:

Sedge Species	(Carex species)
Angelica Species	(Angelica species)
Swamp Milkweed	(Asclepias incarnata)
Rush Species	(Juncus species)
Broad-Leaf Cattail	(Typha latifolia)

F. Concrete Channel:

-Fully lined trapezoidal channel

G. Walls:

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0 50 100 200 300

SCALE: N.T.S.

THOMAS & THOMAS

Planning · Urban Design · Landscape Architecture

FIGURE 14

313 East Costilla Colorado Springs, Colorado 80903
(719) 578-8777

WILSON & COMPANY

SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
BIOLOGICAL RESOURCE INVENTORY

DESIGN
DRAWN jd
DATE 9-8-93
FILE NO.
SHEET NO.

WILSON & COMPANY
COLORADO SPRINGS, COLORADO

<u>WILDLIFE IDENTIFCATION</u>

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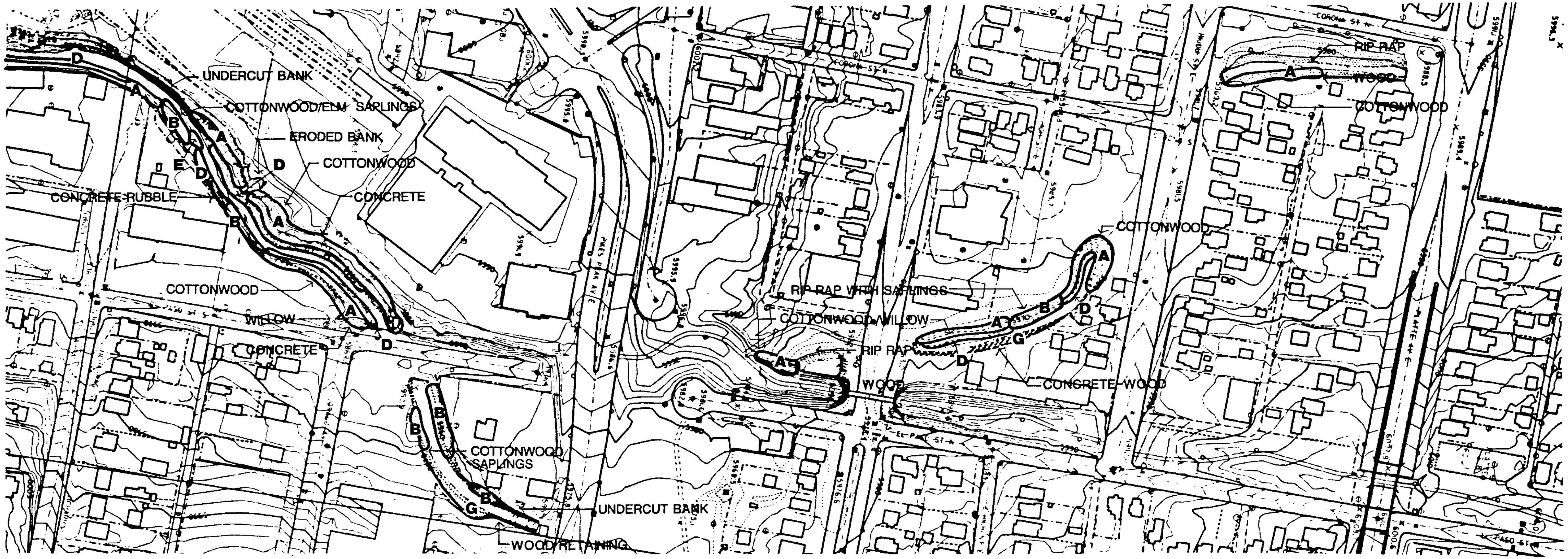
Refer to Sheet #3 for Amphibian & Reptile species

For complete wildlife information see text of report.

AMPHIBIANS & REPTILES	HABITAT
Tiger Salamander	Riparian
Toads; Great Plains, Red Spotted, Woodhouse	Riparian lowlands/breeding
Frog; Boreal Chorus, Plains Leopard, Bull, Northern Leopard	Riparian lowlands/breeding
Turtle; Common Snapping, Box, Western Painted	Riparian/breeding-fairly common
Red-lipped Prairie Lizard	Riparian/breeding
Great Plains Skunk	Riparian/breeding
Eastern Yellowbelly Racer	Riparian/breeding
Snake; Great Plains Rat, Plains Hog Nose, Milk, Northern Water, Western Smooth Green, Bull, Plains Blackhead, Western Black Head Garter	



<u>LEGEND</u>

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0 50 100 200 300

SCALE: N.T.S.

THOMAS & THOMAS

Planning · Urban Design · Landscape Architecture

FIGURE 15

313 East Costilla Colorado Springs, Colorado 80903
(719) 578-8777

WILSON & COMPANY

SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
BIOLOGICAL RESOURCE INVENTORY

REVISION | DATE | BY

DESIGN
DRAWN kl
DATE 9-8-93
FILE NO.
SHEET NO.

WILSON & COMPANY
COLORADO SPRINGS, COLORADO

WILDLIFE IDENTIFICATION

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2. Beaver-Riparian	2. Black Bear	2. Golden Eagle
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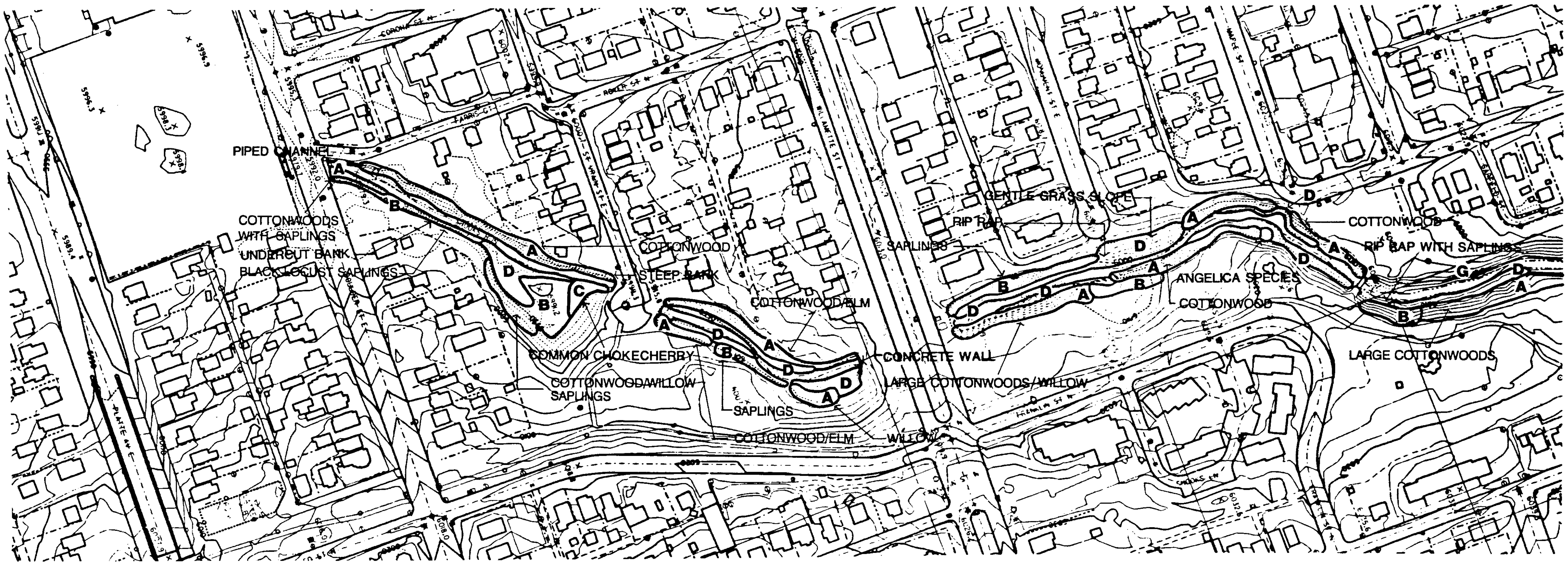
	4. White-tailed Deer	4. Sharp-tail Grouse

Refer to Sheet #1 for representative Mammal species
Refer to Sheet #2 for Bird species
Refer to Sheet #3 for Amphibian & Reptile species

For complete wildlife information see text of report.



LEGEND

A. Mature Riparian Forest:

*Understory well developed, trunks larger than 5" in diameter.

*Typical species:		
	Peachleaf Willow	(Salix amygdaloides)
	Balsam Poplar	(Populus balsamifera)
	Plains Cottonwood	(Populus sargentii)
	Common Boxelder	(Acer negundo)
	Narrowleaf Cottonwood	(Populus accuminata/anqustifolia
	Green Ash	(Fraxinus pennsylvanica)

B. Immature Riparian Saplings:

*Shorter, denser plant material, understory not well developed due to shade, less than 3" in diameter.

*Typical species:		
	American Elm	(Ulmus americana)
	Siberian Elm	(Ulmus pumila)
	Black Locust	(Robinia pseudoacacia)
	Common Boxelder	(Acer negundo)

C. Wetland Shrubs:

*Typically less than 10' tall, understory not weel developed due to shade.

*Typical species:		
	Sandbar Willow	(Salix exidua)
	Dwarf Alpine Currant	(Ribes aureum)
	Common Snowberry	(Symphoricarpos alba)
	Wood Rose	(Rosa Woodsii)
	Yellow Clematis	(Clematis orientalis - vine)

D. Grassland Margins:

*Includes riparian grasses, small pockets of herbaceous wetland perennials, also small weed pockets.

*Typical species:		
	Intermediate Wheatgrass	(Agrophyron intermedium)
	Rough Bentgrass	(Agrostis stolonifera/scabra)
	Smooth Broam	(Bromus inermis)
	Kentucky Bluegrass	(Poa pratensis)
	Canadian Bluegrass	(Poa canadensis)
	Canada Wildrye	(Elymus canadensis)
	Creeping Wildrye	(Elymus tricoides)
	Wild Yarrow	(Achillea lanulosa)
	Canadian Thistle	(Cirsium canadensis)
	White Goosefoot	(Chenopodium album)
	Coast-Blite Goosefoot	(Chenopodium rubrum)

E. Herbaceous Wetlands:

*Non-woody perennials, need annual foundation to survive. Mostly forbs, sedges and some grasses.

*Typical species:		
	Sedge Species	(Carex species)
	Angelica Species	(Angelica species)
	Swamp Milkweed	(Asclepias incarnata)
	Rush Species	(Juncus species)
	Broad-Leaf Cattail	(Typha latifolia)

F. Concrete Channel:

-Fully lined trapezoidal channel

G. Walls:

-Wood, granite, riprap, concrete, dumped or poured
-Eroded slopes, includes undercut banks

0 50 100 200 300

SCALE: N.T.S.

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FIGURE 16

313 East Costilla Colorado Springs, Colorado 80903
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SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
BIOLOGICAL RESOURCE INVENTORY

DESIGN
DRAWN kl
DATE 7-8-93
FILE NO. —
SHEET NO.

WILSON & COMPANY
COLORADO SPRINGS, COLORADO

WILDLIFE IDENTIFICATION

The wildlife inventory was performed as a critical aspect of the initial phases of this study. The corridor is used by an abundance of mammals, birds, reptiles and amphibians as breeding and non-breeding habitats. The mapping of wildlife species has been provided by the Colorado Division of Wildlife as per House Bill 1041. The species were selected for mapping based upon one of the following criteria:

1) Indicator species for unique habitat.
2) Big game species of economic importance.
3) Threatened or endangered species.

The following lists have been generated to list representative species of the corridor. These lists are not all inclusive but a random sample for representative purposes.

INDICATOR SPECIES FOR CRITICAL HABITATS	ECONOMIC IMPORTANCE	THREATENED OR ENDANGERED
1. Albertis Squirrel-Ponderosa Pine Forest	1. Mule Deer	1. Prairie Falcon
2. Beaver-Riparian	2. Black Bear	2. Golden Eagle
3. White-tailed Deer-Riparian	3. Big Horn Sheep	3. Peregrin Falcon
	4. White-tailed Deer	4. Sharp-tail Grouse

Refer to Sheet #1 for representative Mammal species
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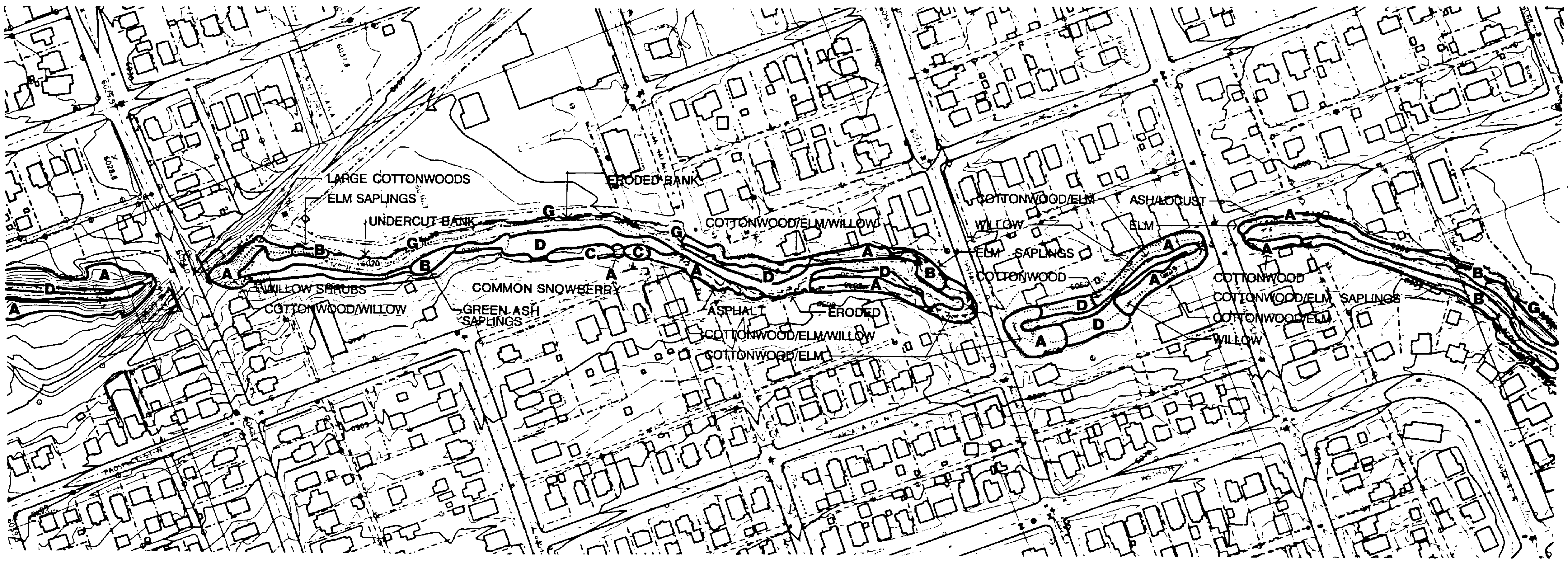
For complete wildlife information see text of report.



LEGEND

A. Mature Riparian Forest:

*Understory well developed, trunks larger than 5" in diameter.

*Typical species:

Peachleaf Willow	(Salix amygdaloides)
Balsam Poplar	(Populus balsamifera)
Plains Cottonwood	(Populus sargentii)
Common Boxelder	(Acer negundo)
Narrowleaf Cottonwood	(Populus accuminata/anqustifolia
Green Ash	(Fraxinus pennsylvanica)

B. Immature Riparian Saplings:

*Shorter, denser plant material, understory not well developed due to shade, less than 3" in diameter.

*Typical species:

American Elm	(Ulmus americana)
Siberian Elm	(Ulmus pumila)
Black Locust	(Robinia pseudoacacia)
Common Boxelder	(Acer negundo)

C. Wetland Shrubs:

*Typically less than 10' tall, understory not weel developed due to shade.

*Typical species:

Sandbar Willow	(Salix exidua)
Dwarf Alpine Currant	(Ribes aureum)
Common Snowberry	(Symphoricarpos alba)
Wood Rose	(Rosa Woodsii)
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D. Grassland Margins:

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Rush Species	(Juncus species)
Broad-Leaf Cattail	(Typha latifolia)

F. Concrete Channel:

-Fully lined trapezoidal channel

G. Walls:

-Wood, granite, riprap, concrete, dumped or poured
-Eroded slopes, includes undercut banks

0 50 100 200 300

SCALE: N.T.S.

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FIGURE 17

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SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
BIOLOGICAL RESOURCE INVENTORY

REVISION | DATE | BY

DESIGN
DRAWN JCL
DATE 9-8-93
FILE NO.
SHEET NO.

WILSON & COMPANY
COLORADO SPRINGS, COLORADO

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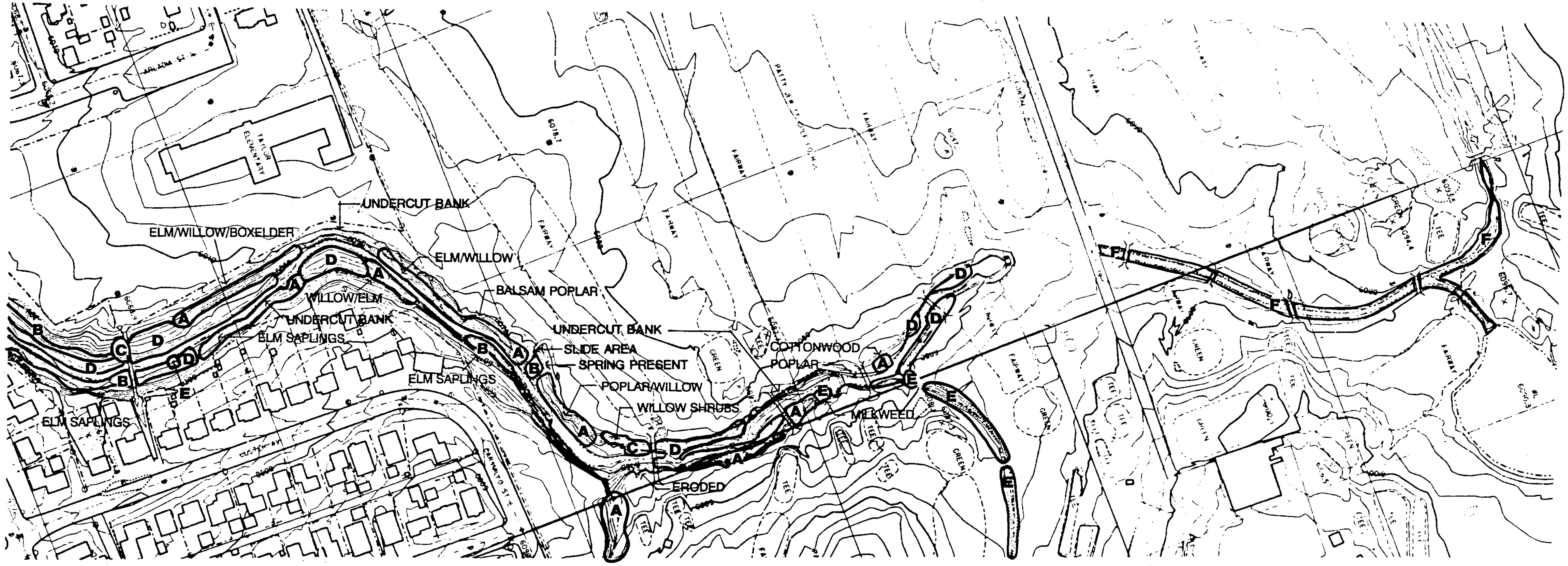

LEGEND

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-Eroded slopes, includes undercut banks

0 50 100 200 300

SCALE: N.T.S.

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FIGURE 18

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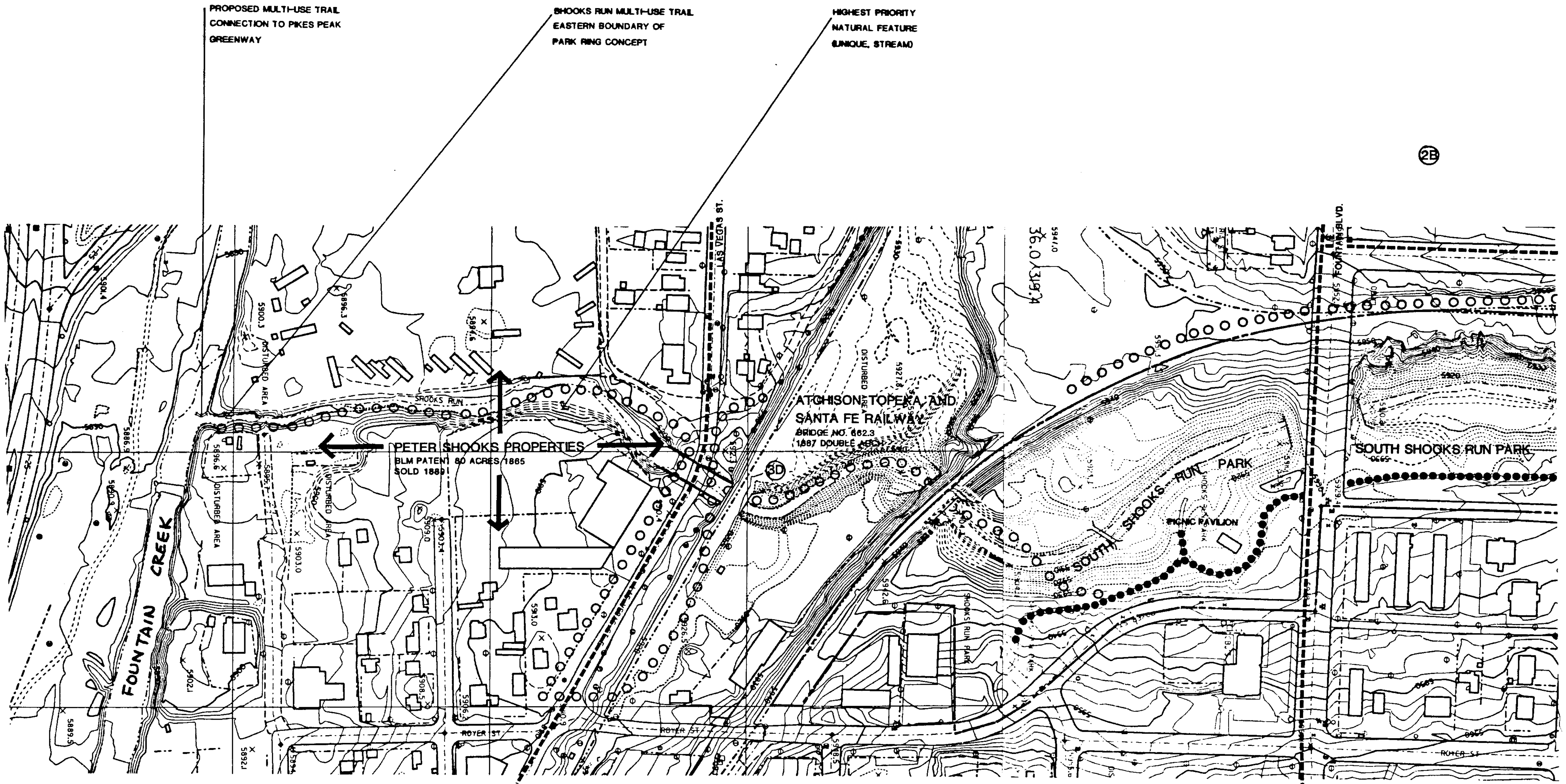
SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
BIOLOGICAL RESOURCE INVENTORY

DESIGN
DRAWN
DATE 9-8-93
FILE NO.
SHEET NO.

WILSON & COMPANY
COLORADO SPRINGS, COLORADO



LEGEND

1. National Historic Register: None presently on the register.
2. Eligible for the National Historic Register:
   - a. Colorado School for the Deaf and Blind
   - b. Garfield School
   - c. Santa Fe Railroad Depot
   - d. Octagonal Tent Cottages - 522 N. Royer & 743 E. Williamette
3. Locally significant, both historically and/or architecturally:
   - a. Sinton Hill Dairy - 419 S. El Paso St.
   - b. Peoples Methodist Episcopal Church - 601 E. St. Vrain
   - c. Epiphany Episcopal Church - 623 E. Dale St.
   - d. Santa Fe Railroad Bridge
   - e. Individual residences that display architectural significance, which contribute significantly to the historic setting and local character of the Shooks Run area.

LEGEND

- ●●●●● EXISTING TRAILS
- ○ ○ ○ PROPOSED MULTI-USE TRAILS
- ▬ ▬ ▬ EXISTING ON-STREET BIKE ROUTES
- — - — PARK BOUNDARY

0 50 100 200 300

SCALE: N.T.S.

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FIGURE 19

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SHOOKS RUN

DRAINAGE BASIN PLANNING STUDY

CULTURAL / HISTORIC / TRAIL RESOURCES INVENTORY

DESIGN	
DRAWN	JcJ
DATE	7-8-93
FILE NO.	
SHEET NO.	

REVISION | DATE | BY

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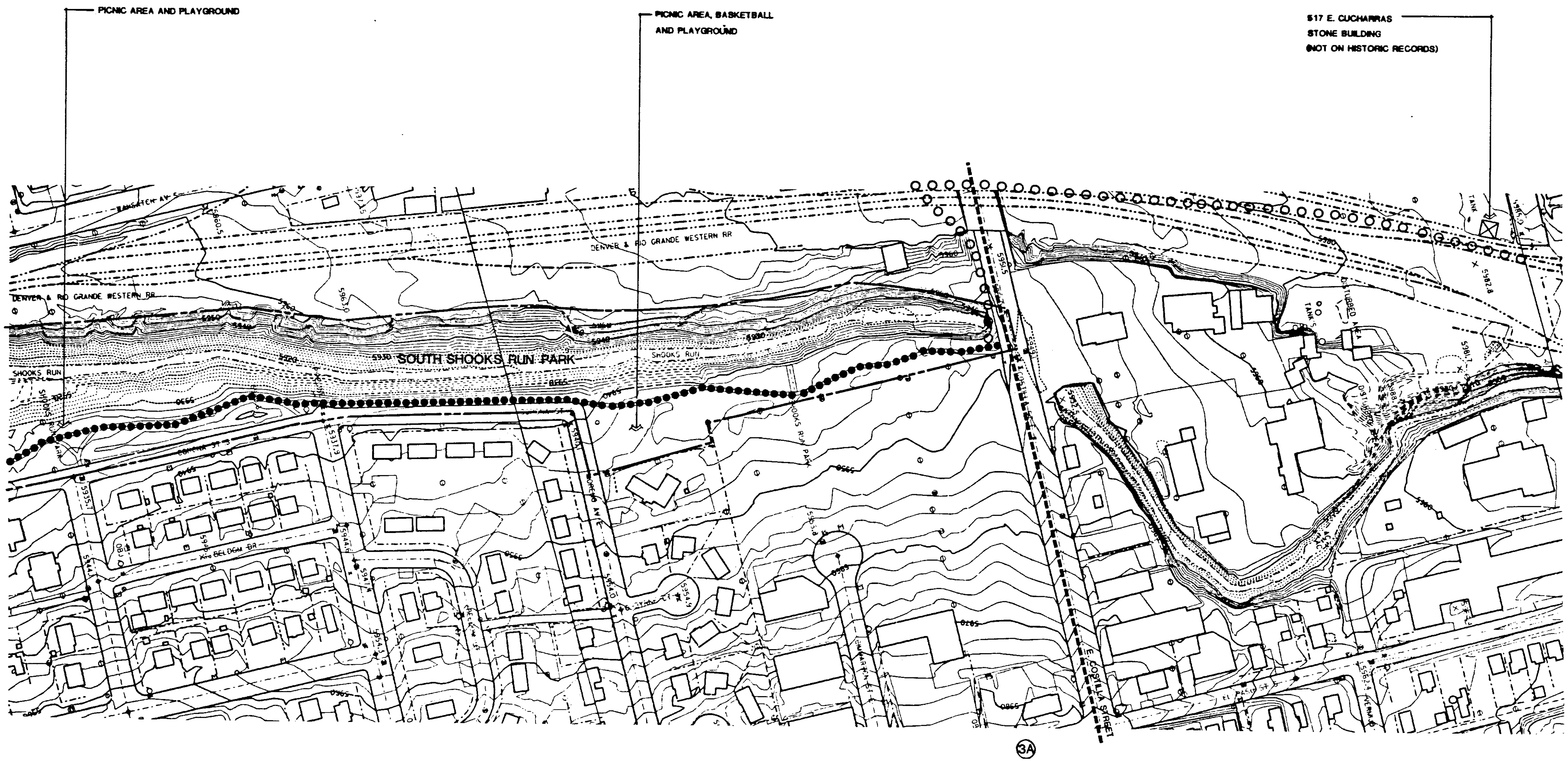

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LEGEND

●●●●● EXISTING TRAILS
○○○ PROPOSED MULTI-USE TRAILS
▬ ▬ ▬ EXISTING ON-STREET BIKE ROUTES
— — — PARK BOUNDARY

0 50 100 200 300
SCALE : N.T.S.

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FIGURE 20

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DRAINAGE BASIN PLANNING STUDY
CULTURAL /HISTORIC /TRAIL RESOURCES INVENTORY

DESIGN
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DATE
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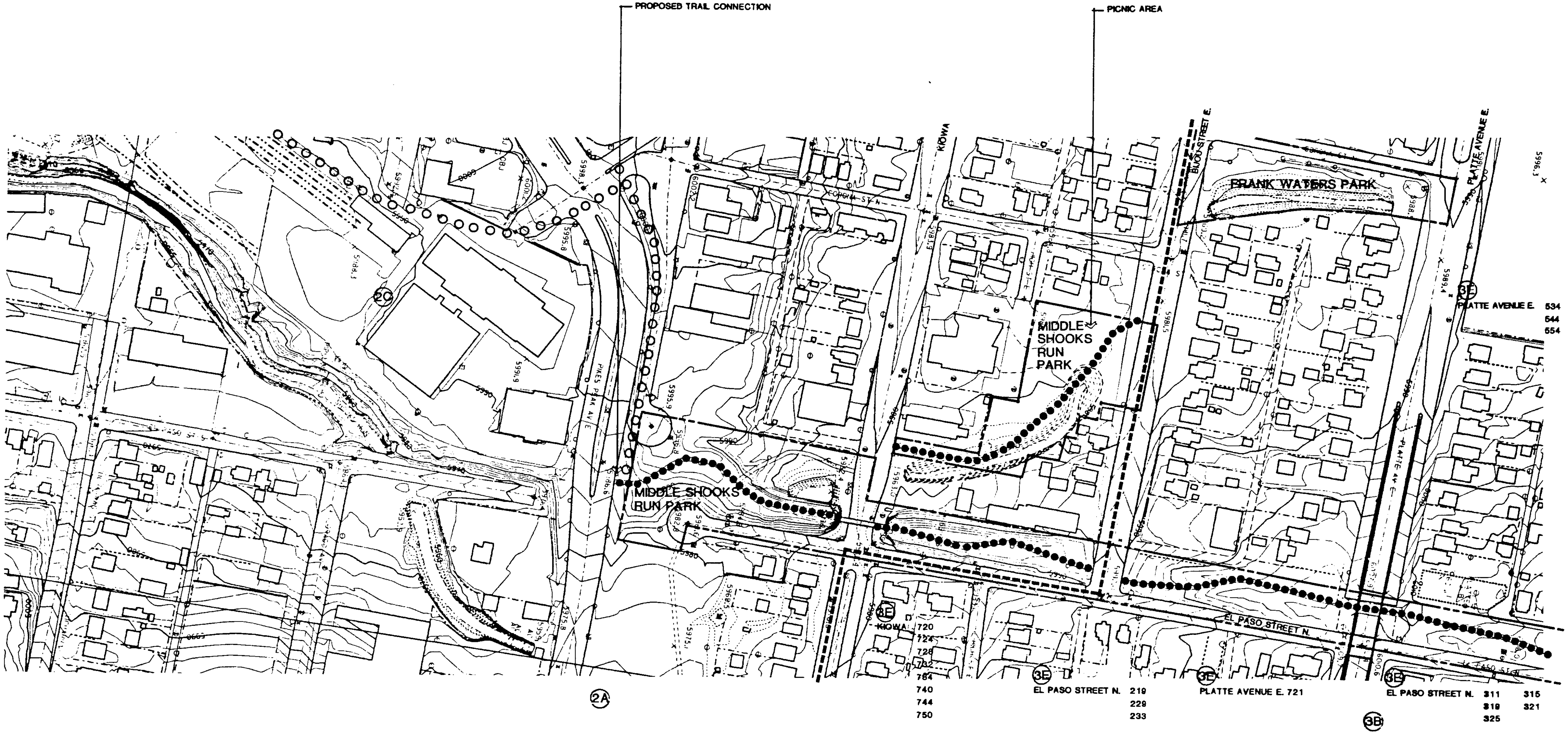

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LEGEND

●●●●● EXISTING TRAILS
○ ○ ○ PROPOSED MULTI-USE TRAILS
▬ ▬ ▬ EXISTING ON-STREET BIKE ROUTES
— — — PARK BOUNDARY

0 50 100 200 300
SCALE: N.T.S.

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FIGURE 21

313 East Costilla Colorado Springs, Colorado 80903
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SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
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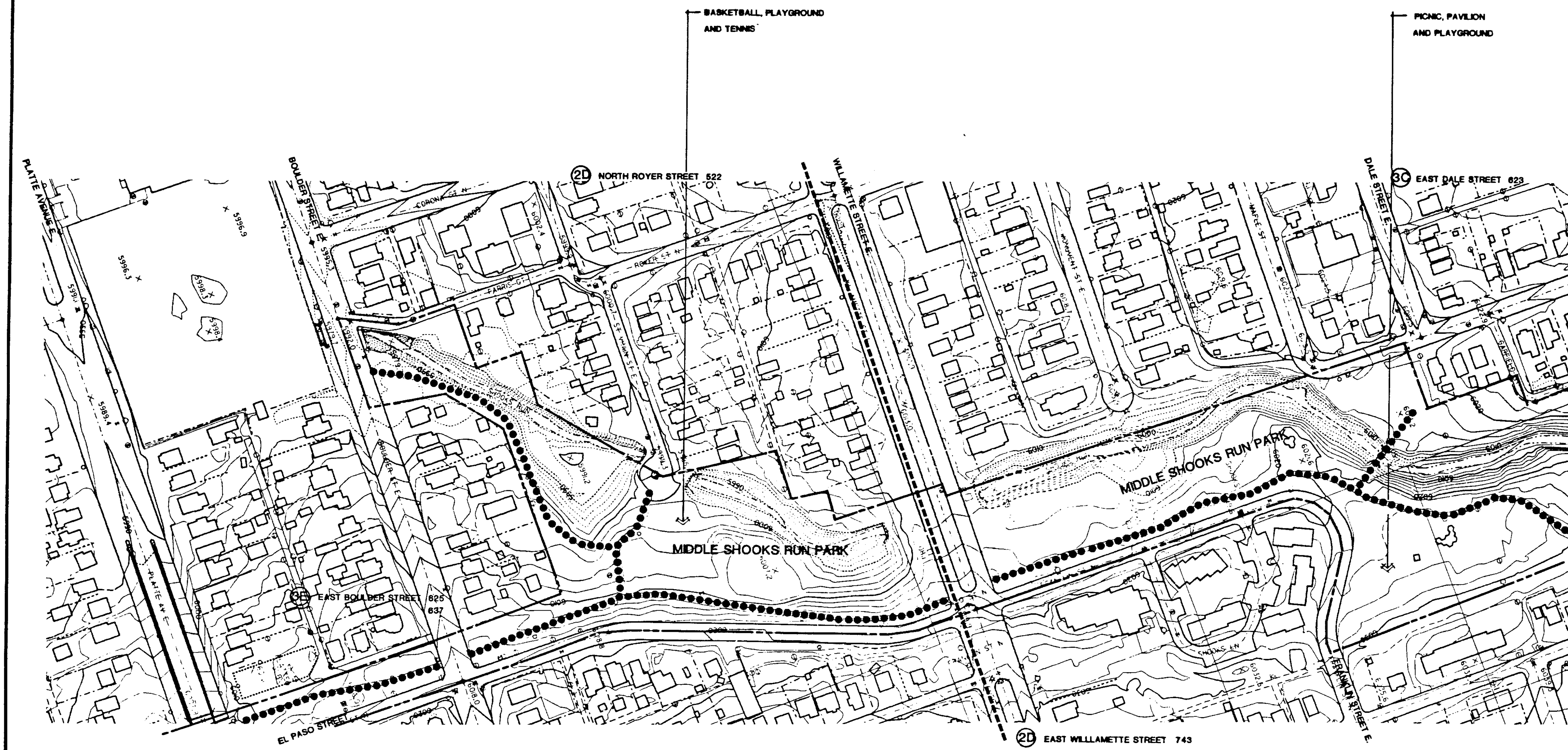

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LEGEND

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○○○ PROPOSED MULTI-USE TRAILS
▬ ▬ ▬ ▬ EXISTING ON-STREET BIKE ROUTES
— · — PARK BOUNDARY

0 50 100 200 300
SCALE: N.T.S.

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FIGURE 22

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SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
CULTURAL /HISTORIC /TRAIL RESOURCES INVENTORY

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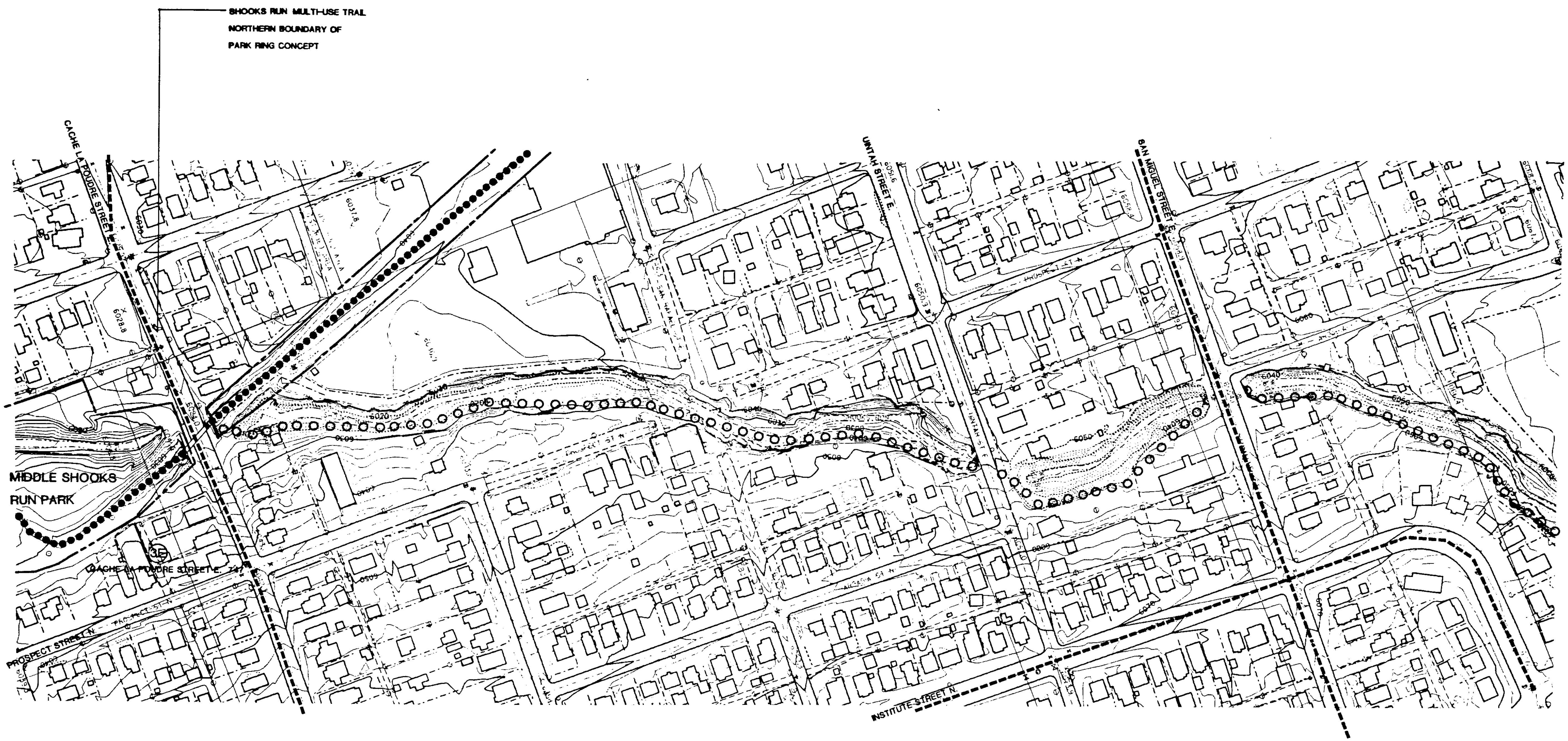

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○ ○ ○ PROPOSED MULTI-USE TRAILS
▬ ▬ ▬ EXISTING ON-STREET BIKE ROUTES
— — — PARK BOUNDARY

0 50 100 200 300
SCALE : N.T.S.

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FIGURE 23

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SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
CULTURAL/HISTORIC/TRAIL RESOURCES INVENTORY

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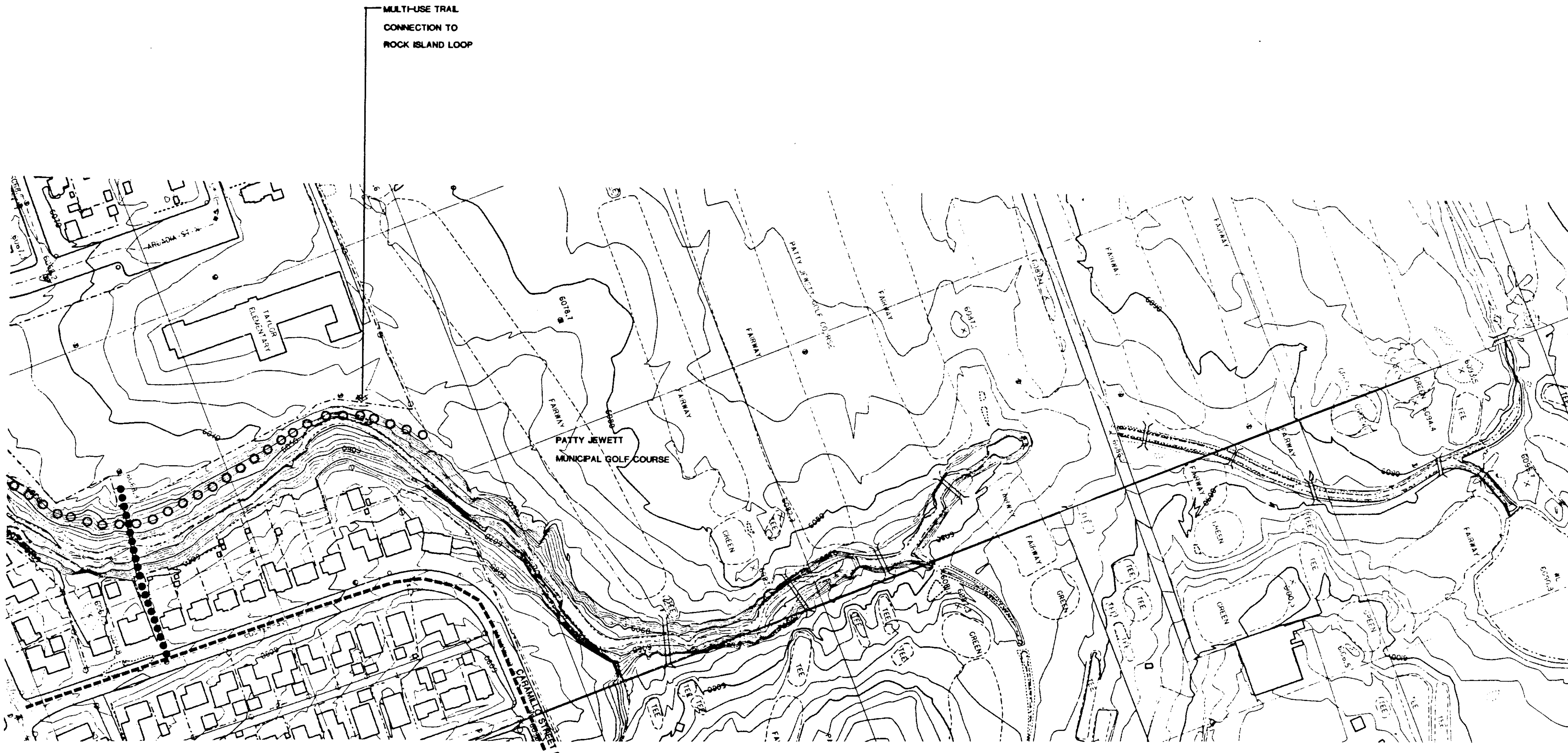
COLORADO SPRINGS, COLORADO



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LEGEND

●●●●● EXISTING TRAILS

○○○ PROPOSED MULTI-USE TRAILS

▬ ▬ ▬ EXISTING ON-STREET BIKE ROUTES

– – ——— PARK BOUNDARY

0 50 100 200 300

SCALE : N.T.S.

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FIGURE 24

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SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
CULTURAL /HISTORIC /TRAIL RESOURCES INVENTORY

DESIGN	
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DATE	9-8-93
FILE NO.	
SHEET NO.	

WILSON & COMPANY
COLORADO SPRINGS, COLORADO

IV. HYDROLOGIC ANALYSIS

IV. HYDROLOGIC ANALYSIS

Methodology

The hydrologic model used to estimate the peak discharges and volumes for the Shooks Run basin was the TR-20 Computer Program for Project Formulation Hydrology by the Soil Conservation Service. The hydrologic analysis included both the initial storm (10-year return frequency) and the major storm (100-year return frequency), for both existing and fully-developed basin conditions, based on Antecedent Moisture Condition 2. The overall basin was delineated and divided into 78 subbasins (approximately 100 acres maximum) based on the topographic mapping and the existing drainage system inventory. This basin and subbasin delineation is illustrated on the Hydrology Map (Figure 25). The Rational Method was also used to estimate the peak discharges for the subbasins for comparison with, and possible calibration of, the TR-20 model.

Basin and Routing Parameters

Basin parameters for both the TR-20 model and the Rational Method were identified for each subbasin. Subbasin area, height and length information was measured from the topographic mapping. Weighted curve numbers (CN) and runoff coefficients (C) were calculated based on the Land Use Map (Figure 2) and the General Soils Map (Figure 12). The time of concentrations for the different subbasins was estimated using overland flow time and travel time based on the topographic mapping and the existing drainage system inventory. The basin parameters are included in Table 1.

The parameters for the routing of the peak discharge through the various subbasins for the TR-20 model were estimated based on the topographic mapping and the existing drainage system inventory. These same routing parameters were also used for future development conditions because future improvements are not anticipated to alter routing significantly. The TR-20 Routing Schematic (Figure 26) illustrates the routing sequence for the entire basin. The routing parameters are included in Table 2. The routing parameters for the approximate flow diversion at the Van Buren channel were estimated using simple culvert and weir calculations based on field survey information. The routing parameters for this diversion are included in Table 3. The routing parameters for the existing detention pond east of the Patty Jewett Golf Course were based on the topographic mapping supplemented with field survey information. The routing parameters for this detention pond are included in Table 4.

Rainfall

Rainfall information for use in the TR-20 model was based on the National Oceanic and Atmospheric Administration *Atlas 2, Precipitation - Frequency Atlas of the Western United States, Volume III - Colorado*, 1973, as included in the City/County *Drainage Criteria Manual*. Total rainfall amounts used were 3.1 inches for the 10-year, 24-hour storm and 4.5 inches for the 100-year, 24-hour storm. The standard Soil Conservation Service Type II-A storm distribution was also used.

Rainfall intensity-duration-frequency information for use in the Rational Method was taken from the City/County *Drainage Criteria Manual*.

Analysis Results

The peak discharges for each subbasin and at selected design points in the overall basin are illustrated on the Hydrology Map (Figure 25) and included in Table 5 and Table 6. Both existing and fully-developed basin condition peak discharges are included. The detailed TR-20 model output and Rational Method calculations are included in the Technical Appendix for this study available through the City Engineering Division.

TR-20 Model/Rational Method Comparison and Calibration

As a part of this study, the peak discharges estimated for each of the subbasins using the Rational Method were compared with those estimated using the TR-20 model for possible calibration of the TR-20 model. The estimates using each method were developed using procedures and criteria recommended in the City/County *Drainage Criteria Manual*. The results for the 100-year peak discharge for each subbasin were compared by first subtracting the Rational Method peak discharge from the TR-20 model peak discharge and dividing this difference by the Rational Method peak discharge. (A positive percentage difference, therefore, indicates a Rational Method peak discharge less than the peak discharge estimated using the TR-20 model.) Comparison of the peak discharge, as estimated using the two procedures for each of the 78 subbasins, shows slightly more than half of the subbasins have a greater than ten percent difference. A summary of these peak discharges by subbasin, and the comparison, is included in Table 7.

Since the areas and times of concentration for each subbasin are identical for both methods, the differences appear to be in the Rational Method "runoff coefficient" and TR-20 model "runoff curve numbers." Composite values for runoff coefficients and curve numbers were calculated through a weighted average considering SCS hydrologic soil groups and land use. Runoff coefficients and curve numbers for the different soils groups and land uses were taken from the City/County *Drainage Criteria Manual*. A detailed review and comparison of the resultant peak discharges as determined using the two methods reveal the following general patterns:

A. Subbasins with a +10 percent (TR-20 model peak discharge higher than those generated using Rational Method) and greater difference are predominantly comprised of open space or wooded area land uses, usually on C or D soil groups, or predominantly business land uses on any soil group.

B. Subbasins with a -10 percent (Rational Method peak discharges higher than TR-20 model) and greater differences are predominantly residential (four dwelling units per acre) land use, usually on A or B soil groups.

C. Subbasins with differences within a range of -9 percent to +9 percent usually contain a more general mix of land uses and soil types.

The results of this comparison indicate there are discrepancies between runoff coefficients used with the Rational Method and curve numbers used with TR-20 for particular land uses and soil groups as currently presented in the City/County *Drainage Criteria Manual*.

During this analysis, consideration was given to the possibility of calibrating the TR-20 model to more closely approximate the results achieved through the Rational Method. The intent of the calibration was to reconcile possible differences between future designs of minor facilities which, based on the City/County *Drainage Criteria Manual* policies, would be developed using the Rational Method; and those of future major facilities, which, again, based on the City/County *Drainage Criteria Manual*, would be designed using the TR-20 model.

One possible calibration involved adjusting the CN Table (for use with TR-20 model) contained within the *Drainage Criteria Manual* to attain similar results as those achieved with the Rational Method. This was done using a "typical" basin size. Results varied slightly when actual basins significantly larger or smaller than the "typical" were evaluated. Two separate calibrations would be required to reconcile differences for both the 10-year and 100-year storms. While this procedure was clear and reproducible (by subsequent hydrologists), it varies significantly from policy officially adopted within the *Drainage Criteria Manual.*

Another possible calibration involved adjusting individual CN's for subbasins within the Shooks Run basin to reach similar discharge values under the two methods. This adjustment would be done by comparing the percent impervious assumed in relation to the runoff coefficients from the Rational Method and the percent impervious assumed in relation to the CN's for TR-20 model. This comparison would rely on field observation and engineering judgment to determine which value for percent impervious, Rational Method or TR-20 model, appeared more appropriate for a given subbasin. This type of subjective assessment of percent impervious and adjustment of runoff coefficients and curve numbers results in the following difficulties:

A. For basins as large as 100 acres, no accurate and definable assessment of the percent of imperviousness could reasonably be made. Making a recommendation that, based on observation and experience, a basin that otherwise would be assigned a CN of 70 should, in this case, be 65 or 75, could not be done with any confidence or defended should it ever be challenged.

B. This would have been the first and only drainage basin planning study for which any calibration of this kind would have been made. It is important that information provided within a master plan study be in accordance with adopted policy, and be understandable and reproducible by those who will use the document. Any calibration method employed should be one which can be applied to all studies, and one which subsequent evaluations can use with confidence.

Based on consideration of these issues and since the results achieved using either hydrologic method are within a reasonable and compatible range, the TR-20 model was not calibrated to more closely agree with the Rational Method. The TR-20 model results were used for evaluation of the main channel and should also be used for evaluation of major trunklines and laterals. The Rational Method results should be used for evaluation of local and minor systems with the individual subbasins. This approach results in the most consistent application of the *Drainage Criteria Manual.*

Comparison with Results of Previous Drainage Studies

The results of the hydrologic analysis of this study were compared with the results of the following previous drainage studies for, or within, the Shooks Run basin.

A. *Shooks Run Master Drainage Basin Study*, 1972

B. *Palmer Park Area Master Drainage Basin Report*, 1972

C. *Lower Cragmor Master Drainage Plan*, 1988

D. *FEMA Restudy of South Shooks Run*, 1989

E. *Flood Insurance Study, City of Colorado Springs, El Paso County*, 1990

F. *Master Drainage Development Plan for the Houck Estate at Union Boulevard and Fillmore Street*, 1990

A comparison of the peak discharges from the DBPS and these previous studies is included in Table 8.

Of the three master drainage studies, only the *Lower Cragmor Master Drainage Plan*, 1988 used current rainfall criteria. The other two master drainage studies identified major drainage improvements based on either a 5-year design storm or a 50-year design storm. Use of these lower design storm frequencies results in undersized improvements based on current criteria.

The *Palmer Park Area Master Drainage Report*, 1972 was developed based on the concept of "allowing occasional minor flooding, while sizing the storm drainage facility for maximum use." In addition, the storm sewers were designed to carry the 5-year storm minus 20 cubic feet per second, which would be carried by the streets in the area. Since the philosophy of utilizing streets to carry stormwater has changed over the years, it is apparent that many of the storm sewer systems installed utilizing the recommendations in the Palmer Park study are undersized based on current criteria.

The *Shooks Run Master Drainage Basin Study*, 1972 was evaluated based on the 100-year, one-hour storm for the main channel and the 50-year, one-hour storm for subdivisions and tributaries to Shooks Run. These design storms also result in undersized improvements based on current criteria.

The *FEMA Restudy of South Shooks Run*, 1989 was generally based on current City/County criteria. The hydrologic model of that study was less complex than the one developed in this Shooks Run DBPS.

Coordination with the Federal Emergency Management Agency (FEMA)

The results of this hydrologic analysis were compared in detail with the *FEMA Restudy of South Shooks Run*, 1989. There was coordination with FEMA, FEMA's engineering consultant and the

City Engineering Division to attempt to resolve the differences between the two analyses that were identified in the comparison.

Both the hydrologic analyses for this DBPS and for the recently completed FEMA study were conducted using a TR-20 model. The DBPS analysis divided the Shooks Run basin into 78 subbasins, while the FEMA restudy used only 12 subbasins. The existing condition 100-year peak discharges that were estimated in the DBPS (6840 cfs at the outfall) and the FEMA restudy (5570 cfs at the outfall) vary considerably. A detailed comparison of the input parameters used with each study, and the results of each analysis, has been completed and is summarized here.

A. Different overall basin sizes were used. The DBPS considered the Shooks Run basin to contain 10.0 square miles, while the FEMA restudy indicated the basin contains 9.8 square miles.

B. Different total rainfall was used for the 100-year storm. The DBPS used 4.50 inches of rainfall, and the FEMA restudy used 4.45 inches.

C. Different subbasin sizes were used. As mentioned previously, the DBPS divided the basin into 78 subbasins, and the FEMA restudy analyzed only 12. This had a significant input in terms of routing and peak discharge attenuation.

D. Some different subbasins were delineated. The DBPS delineation of subbasins reflects several extensive existing storm sewer systems.

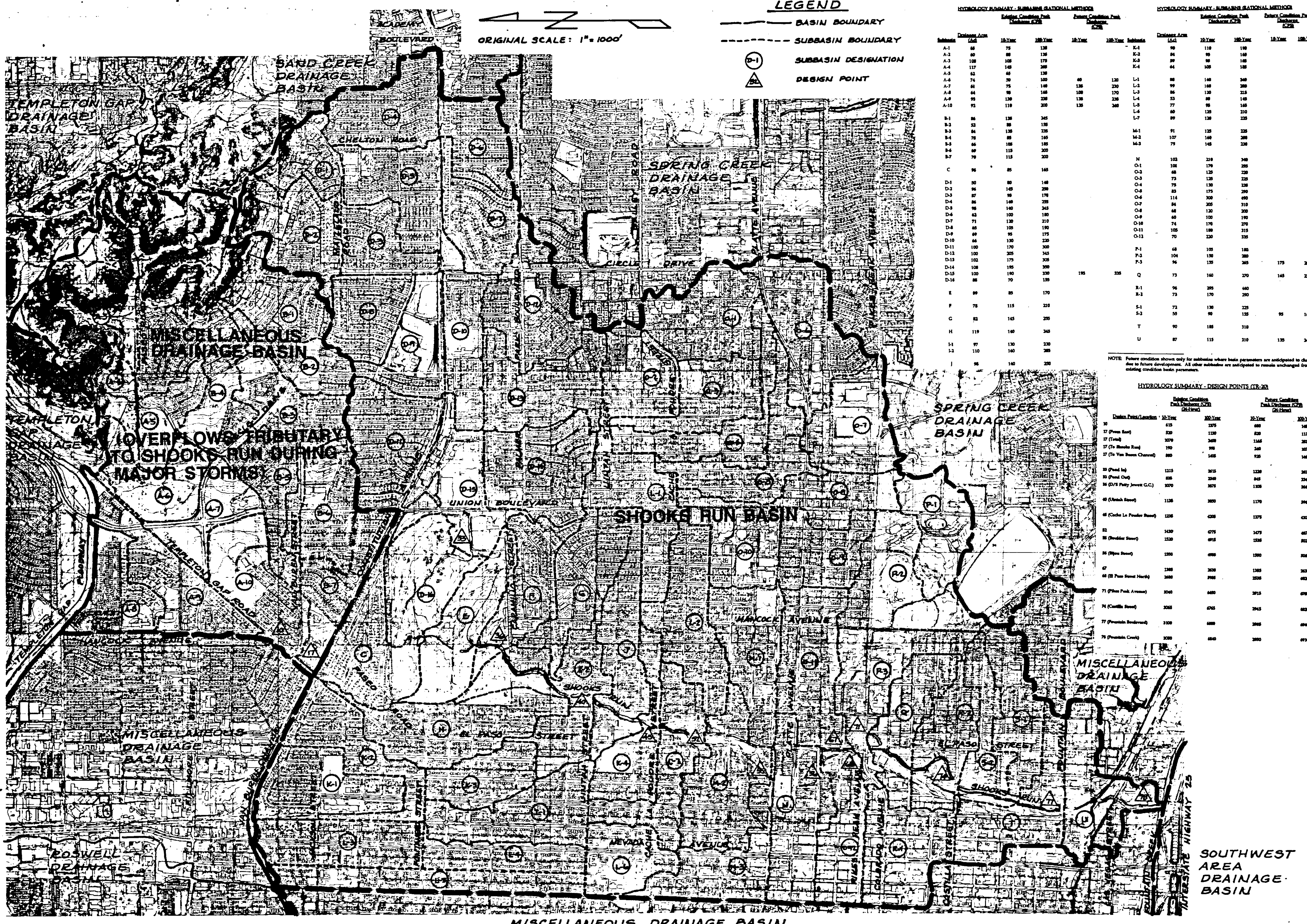
E. Different subbasin parameters were used, including size, runoff coefficient and times of concentration. These differences are generally minor, however, within the upper Shooks Run basin, north of the Van Buren channel, significant variance between times of concentration had a major impact on the peak discharges estimated.

F. Different main channel routing parameters were used, including lengths, cross-sections and roughness coefficients.

G. Different storage/discharge parameters were used for the detention pond near the Patty Jewett Golf Course. The FEMA restudy used parameters taken from the construction plans filed at the Office of the State Engineer. The DBPS parameters were based on actual existing conditions measured from project base mapping and supplemented with field survey information.

H. Different routing parameters were used for the Van Buren channel diversion. The DBPS TR-20 model reflected field surveys of the diversion structure at the Van Buren channel. The DBPS analyzed the culvert crossing of Templeton Gap Road based on culvert calculations, while the FEMA restudy analyzed the culvert crossing based on open channel flow calculations. Based on the DBPS field information and evaluation, of the 2400 cfs currently tributary to the Van Buren channel diversion structure during the existing condition 100-year discharge (this varies from the FEMA restudy estimate of 675 cfs as discussed above), approximately 1405 cfs is actually diverted to the west and carried along the Van Buren channel to the outfall at Monument Creek. The remaining 995 cfs continues south within the historic Shooks Run main channel. The FEMA study concluded all runoff reaching the diversion structure is diverted west along the Van Buren channel.

The parameters used within the DBPS model were extensively reviewed to evaluate the differences with the FEMA restudy. The DBPS TR-20 model is in conformance with the City/County *Drainage Criteria Manual* and is appropriate for this large, complex and urbanized basin. The results are well within the anticipated ranges of results for such a basin. This DBPS hydrologic analysis resulted in identification of an existing floodplain, which varies from that delineated in the FEMA restudy due to the larger peak discharges. While no resolution between the two hydrologic analyses was reached, FEMA representatives suggested use of the DBPS analysis for the purpose of planning future improvements may be appropriate even though it is more conservative than the FEMA restudy, as long as it is not used for floodplain regulation.



HYDROLOGY SUMMARY TABLES

HYDROLOGY SUMMARY - SUBBASINS (RATIONAL METHOD)

Subbasin	Drainage Area (Ac)	Existing Condition Peak Discharge (CFS) 10-Year	Existing Condition Peak Discharge (CFS) 100-Year	Future Condition Peak Discharge (CFS) 10-Year	Future Condition Peak Discharge (CFS) 100-Year
A-1	66	75	130		
A-2	60	80	135		
A-3	108	105	175		
A-4	117	145	205		
A-5	62	65	130		
A-6	74	50	100	60	120
A-7	61	75	140	135	230
A-8	64	95	160	100	170
A-9	99	130	230	130	230
A-10	92	110	200	135	240
B-1	86	135	245		
B-2	52	85	155		
B-3	84	130	235		
B-4	78	85	165		
B-5	66	105	185		
B-6	60	115	200		
B-7	70	115	200		
C	96	85	165		
D-1	50	80	140		
D-2	96	145	250		
D-3	87	95	170		
D-4	86	140	255		
D-5	98	140	245		
D-6	63	100	180		
D-7	71	120	210		
D-8	65	105	190		
D-9	69	95	175		
D-10	66	130	220		
D-11	100	170	300		
D-12	100	205	345		
D-13	102	175	305		
D-14	108	195	300		
D-15	100	190	330	195	335
D-16	88	70	135		
E	89	85	170		
F	78	115	210		
G	82	145	255		
H	119	160	345		
I-1	97	130	230		
I-2	110	160	285		
J	98	140	250		
K-1	90	110	190		
K-2	84	95	160		
K-3	89	98	165		
K-4	64	105	188		
L-1	88	140	240		
L-2	99	160	280		
L-3	86	120	215		
L-4	53	80	145		
L-5	77	95	165		
L-6	60	125	210		
L-7	89	120	225		
M-1	91	125	225		
M-2	107	140	280		
M-3	79	145	230		
N	102	210	340		
O-1	108	170	295		
O-2	68	125	220		
O-3	73	125	225		
O-4	75	130	238		
O-5	83	175	290		
O-6	114	300	490		
O-7	84	205	310		
O-8	68	120	200		
O-9	60	100	190		
O-10	74	170	270		
O-11	105	180	315		
O-12	70	220	335		
P-1	68	105	180		
P-2	104	150	280		
P-3	96	135	265	175	290
Q	73	160	270	165	275
R-1	96	295	460		
R-2	73	170	290		
S-1	72	130	225		
S-2	55	90	155	95	165
T	90	185	310		
U	87	115	210	135	240

NOTE: Future condition shown only for subbasins where basin parameters are anticipated to change due to future development. All other subbasins are anticipated to remain unchanged from existing condition basin parameters.

HYDROLOGY SUMMARY - DESIGN POINTS (TR-20)

Design Point/Location	Existing Condition Peak Discharge (CFS) (24-Hour) 10-Year	Existing Condition Peak Discharge (CFS) (24-Hour) 100-Year	Future Condition Peak Discharge (CFS) (24-Hour) 10-Year	Future Condition Peak Discharge (CFS) (24-Hour) 100-Year
30	615	1375	680	1480
17 (From East)	520	1130	520	1130
17 (Total)	1070	2400	1165	2535
17 (To Shooks Run)	190	995	240	1075
17 (To Van Buren Channel)	880	1405	925	1460
33 (Pond In)	1215	2615	1220	2620
33 (Pond Out)	835	2340	845	2345
36 (D/S Patty Jewett G.C.)	1070	3675	1305	3645
40 (Uintah Street)	1135	3850	1170	3940
45 (Cache La Poudre Street)	1235	4205	1275	4305
52	1430	4775	1475	4875
55 (Boulder Street)	1520	4915	1535	5020
56 (Bijou Street)	1550	4965	1580	5080
67	1365	2630	1365	2630
68 (El Paso Street North)	2680	5905	2535	6020
71 (Pikes Peak Avenue)	3040	6450	2715	6785
74 (Costilla Street)	3065	6765	2945	6820
77 (Fountain Boulevard)	3100	6800	2965	6840
78 (Fountain Creek)	3080	6840	2890	6920

MISCELLANEOUS DRAINAGE BASIN

WILSON & COMPANY

SHOOKS RUN
DRAINAGE BASIN PLANNING STUDY
HYDROLOGY MAP

DESIGN
DRAWN
DATE FEBRUARY 1992
FILE NO. 90-809
SHEET NO. FIGURE 25

WILSON & COMPANY
COLORADO SPRINGS, COLORADO

TABLE 1
Hydrology Basin Paramenters

Subbasin	Drainage Area (Ac)	Time of Concentration (Hrs)	TR-20 Weighted Curve Number: Existing	TR-20 Weighted Curve Number: Future	Rational Method Weighted Runoff Coefficient: Exist. 10-Yr	Exist. 100-Yr	Future 10-Yr	Future 100-Yr
A-1	65	0.32	73		0.33	0.38		
A-2	60	0.32	77		0.38	0.43		
A-3	108	0.45	75		0.33	0.38		
A-4	117	0.40	75		0.40	0.49		
A-5	62	0.38	71		0.33	0.44		
A-6	74	0.52	69	73	0.25	0.34	0.31	0.40
A-7	61	0.32	74	88	0.35	0.44	0.64	0.72
A-8	64	0.52	83	84	0.56	0.65	0.58	0.67
A-9	93	0.57	80	81	0.56	0.65	0.58	0.66
A-10	92	0.42	73	76	0.39	0.48	0.49	0.58
B-1	86	0.30	75		0.43	0.54		
B-2	52	0.32	76		0.47	0.57		
B-3	84	0.38	76		0.50	0.60		
B-4	78	0.40	73		0.35	0.46		
B-5	66	0.40	76		0.51	0.61		
B-6	69	0.42	80		0.56	0.65		
B-7	70	0.40	78		0.53	0.62		
C	96	0.80	74		0.45	0.55		
D-1	50	0.30	77		0.44	0.53		
D-2	96	0.40	74		0.48	0.57		
D-3	57	0.35	75		0.50	0.60		
D-4	86	0.37	75		0.50	0.60		
D-5	95	0.47	77		0.53	0.62		
D-6	62	0.37	75		0.50	0.60		
D-7	71	0.38	77		0.53	0.63		
D-8	65	0.37	75		0.50	0.60		
D-9	69	0.35	75		0.41	0.50		
D-10	66	0.30	80		0.54	0.63		
D-11	100	0.37	76		0.52	0.61		
D-12	100	0.37	83		0.62	0.70		
D-13	102	0.40	79		0.55	0.65		
D-14	108	0.35	79		0.55	0.65		
D-15	100	0.35	85	86	0.57	0.66	0.59	0.67
D-16	88	0.48	75		0.29	0.42		

NOTE: Future condition shown only for subbasins where basin parameters are anticipated to change due to future development. All other subbasins are anticipated to remain unchanged from existing condition basin parameters.

TABLE 1
Hydrology Basin Paramenters

Subbasin	Drainage Area (Ac)	Time of Concentration (Hrs)	TR-20 Weighted Curve Number: Existing	TR-20 Weighted Curve Number: Future	Rational Method Weighted Runoff Coefficient: Exist. 10-Yr	Exist. 100-Yr	Future 10-Yr	Future 100-Yr
E	89	0.43	76		0.31	0.43		
F	78	0.45	81		0.51	0.62		
G	82	0.37	78		0.54	0.63		
H	119	0.67	76		0.51	0.61		
I-1	97	0.55	77		0.53	0.62		
I-2	110	0.38	74		0.45	0.55		
J	98	0.50	77		0.53	0.62		
K-1	90	0.63	76		0.52	0.61		
K-2	84	0.73	77		0.53	0.62		
K-3	59	0.38	75		0.50	0.60		
K-4	64	0.40	78		0.53	0.62		
L-1	88	0.43	77		0.53	0.62		
L-2	99	0.38	75		0.50	0.60		
L-3	86	0.53	78		0.54	0.63		
L-4	53	0.42	75		0.50	0.60		
L-5	77	0.70	78		0.55	0.64		
L-6	60	0.37	85		0.64	0.71		
L-7	89	0.50	77		0.50	0.61		
M-1	91	0.47	75		0.49	0.59		
M-2	107	0.47	79		0.53	0.62		
M-3	79	0.58	89		0.73	0.78		
N	102	0.38	83		0.65	0.71		
O-1	101	0.42	80		0.56	0.65		
O-2	68	0.35	79		0.56	0.65		
O-3	73	0.32	76		0.49	0.59		
O-4	75	0.33	76		0.51	0.61		
O-5	83	0.37	84		0.64	0.71		
O-6	114	0.25	87		0.68	0.74		

NOTE: Future condition shown only for subbasins where basin parameters are anticipated to change due to future development. All other subbasins are anticipated to remain unchanged from existing condition basin parameters.

TABLE 1
Hydrology Basin Paramenters

Subbasin	Drainage Area (Ac)	Time of Concentration (Hrs)	TR-20 Weighted Curve Number Existing	TR-20 Weighted Curve Number Future	Rational Method Weighted Runoff Coefficient Exist. 10-Yr	Exist. 100-Yr	Future 10-Yr	Future 100-Yr
O-7	84	0.38	89		0.76	0.79		
O-8	68	0.45	85		0.62	0.69		
O-9	60	0.33	77		0.53	0.62		
O-10	74	0.38	89		0.71	0.77		
O-11	105	0.38	78		0.54	0.64		
O-12	70	0.27	91		0.82	0.84		
P-1	68	0.40	83		0.49	0.57		
P-2	104	0.35	80		0.43	0.54		
P-3	96	0.48	86	89	0.57	0.66	0.67	0.74
Q	73	0.33	86	87	0.64	0.72	0.66	0.74
R-1	96	0.27	92		0.81	0.84		
R-2	73	0.30	86		0.65	0.75		
S-1	72	0.38	81		0.57	0.67		
S-2	55	0.43	81	83	0.54	0.64	0.58	0.68
T	90	0.37	84		0.62	0.70		
U	87	0.55	81	84	0.54	0.63	0.63	0.72

NOTE: Future condition shown only for subbasins where basin parameters are anticipated to change due to future development. All other subbasins are anticipated to remain unchanged from existing condition basin parameters.

TABLE 2
TR-20 Subbasin Routing Parameters

Subbasin Routing	Length (feet)	x	m
A-2	500	0.92	1.51
A-3	2300	0.71	1.49
A-4	550	1.70	1.46
A-5	1800	1.05	1.47
A-6	1400	0.45	1.63
A-7	1500	1.59	1.33
A-1--A-7 through A-10	3250	1.82	1.33
A-9	2400	1.43	1.33
A-8 & A-9 through A-10	1450	4.35	1.44
B-2	1150	2.62	1.33
B-3	3550	6.75	1.40
B-1--B-3 through B-5	900	6.04	1.42
B-4 through B-5	3700	2.26	1.33
B-1--B-5 through B-7	2300	1.89	1.33
B-6 through B-7	2700	0.95	1.51
C	3850	0.80	1.45
D-1 through D-2, D-3 & D-5	3700	9.64	1.34
D-2 through D-3	2300	3.07	1.33
D-4 through D-5	3100	1.59	1.33
D-1--D-5 through D-9	1750	0.75	1.53
D-7	2350	1.33	1.33
D-6 & D-7 through D-10	3400	2.47	1.33
D-8 through D-9	1800	2.52	1.33
D-1--D-5, D-8 & D-9 through D-10	2250	2.52	1.33
D-1--D-10 through D-15	2900	1.75	1.33
D-11 through D-15	1200	0.88	1.49
D-13	2000	4.55	1.40
D-14	1700	3.18	1.46
D-12--D-14 through D-15	1300	0.98	1.46
D-16	2450	0.67	1.44
E	1250	2.47	1.51
F	700	0.21	1.52
A--F through I-2	2650	0.21	1.52
G through I-2	1050	0.22	1.59
H through I-2	650	0.22	1.59
I-1 through I-2	1800	1.13	1.33

TABLE 2
TR-20 Subbasin Routing Parameters

Subbasin Routing	Length (feet)	x	m
J	1700	0.20	1.52
K-2	500	4.27	1.42
K-3	2750	3.97	1.44
K-4	2800	3.97	1.44
A--K through L-7	1250	0.21	1.52
L-2	4050	2.26	1.33
L-4	3600	1.51	1.33
L-3 & L-4 through L-6	2100	1.51	1.33
L-5 through L-6	2600	1.43	1.33
L-3--L-6 through L-7	2700	1.51	1.33
A--L through M-2	1800	0.19	1.52
M-1 through M-2	650	3.19	1.33
N	1900	0.48	1.53
O-1 through O-3	1350	5.05	1.42
O-2 through O-3	1900	2.42	1.33
O-4	1200	3.31	1.42
O-5	1800	4.35	1.44
O-6 through O-7	1400	6.43	1.40
O-8	1250	1.43	1.33
O-9	1600	1.51	1.33
O-11	4300	1.29	1.51
A--O through P-3	650	0.79	1.33
P-2	1500	0.67	1.50
P-1 & P-2 through P-3	2950	1.42	1.33
Q	1300	0.14	1.50
R-2	1500	0.22	1.51
S-2	1450	0.20	1.51
T	1050	0.16	1.50
U	2450	0.19	1.51

FIGURE 26

SHOOKS RUN TR-20 ROUTING SCHEMATIC

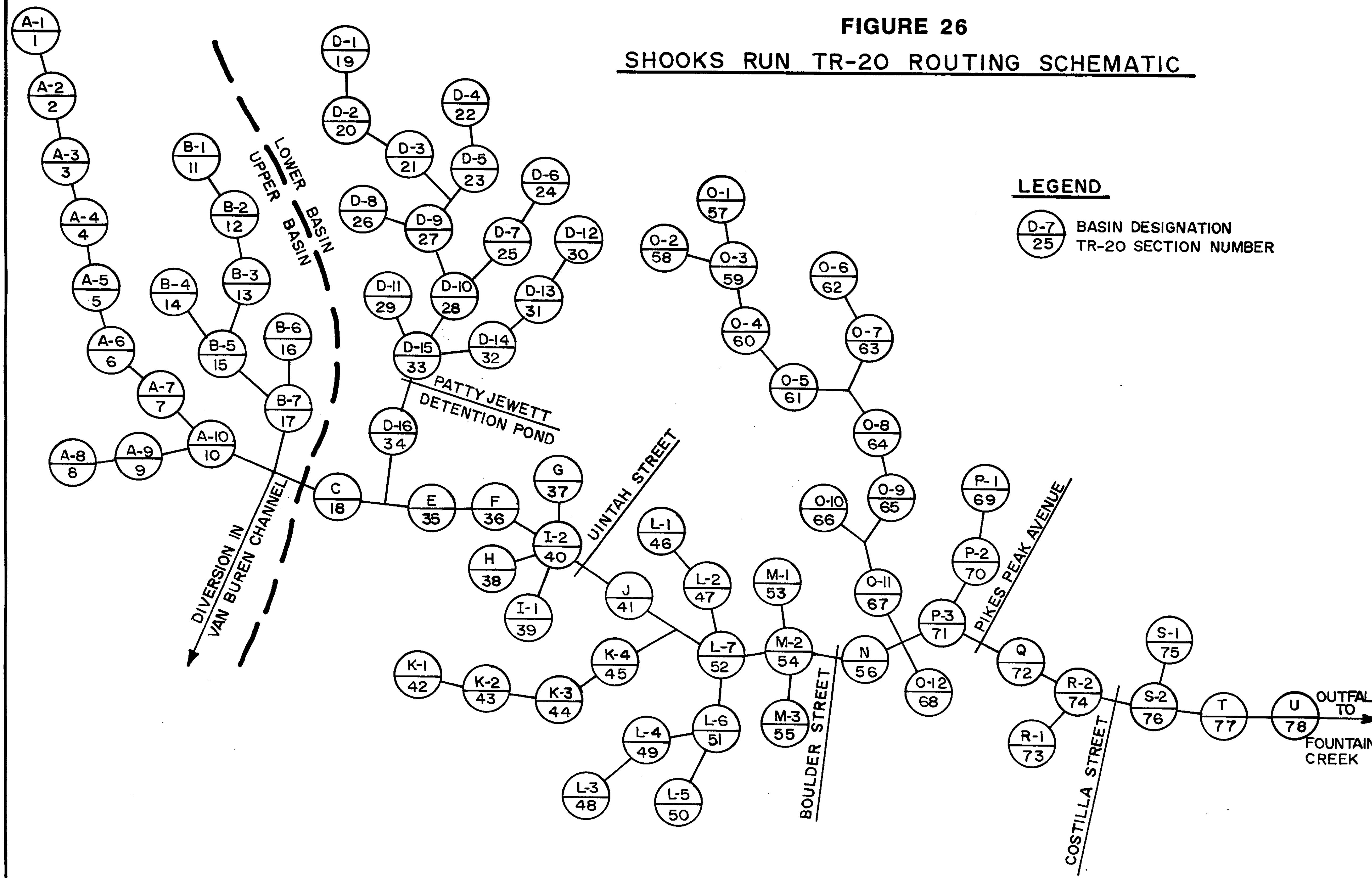


TABLE 3
TR-20 Van Buren Channel/Shooks Run Diversion Routing Parameters
(Existing Condition)

Stage	Van Buren Channel Discharge (CFS)	Van Buren Channel Flow Area (Sq. Ft.)	Shooks Run Discharge (CFS)	Shooks Run Flow Area (Sq. Ft.)
6130.3	0	0	0	0
6131.0	20	2.3	0	0
6132.0	60	6.8	0	0
6133.0	120	13.6	0	0
6134.0	200	22.7	0	0
6135.0	320	36.3	3	0.6
6136.0	450	51.0	33	7.8
6136.5	520	58.9	60	14.4
6137.0	580	65.7	78	18.3
6137.5	640	72.5	105	22.5
6138.0	700	79.3	123	22.6
6138.5	760	86.1	147	22.7
6139.0	800	88.4	165	22.8
6139.5	850	88.5	180	22.9
6140.0	880	88.6	192	23.0
6140.5	925	100.1	243	49.0
6141.0	1057	146.9	460	128.2
6141.5	1321	228.9	868	249.0
6142.0	1753	346.5	1502	412.0
6142.5	2583	500.7	2386	616.0

TABLE 4
TR-20 Patty Jewett Detention Pond Routing Parameters
(Existing Condition)

Stage	Storage (Acre Feet)	Discharge (CFS)
6104.5	0	0
6106.0	0.8	30
6107.0	2.1	70
6108.0	4.0	120
6109.0	6.4	170
6110.0	9.1	210
6111.0	12.1	250
6112.0	15.5	280
6113.0	19.2	310
6113.5	21.2	335
6114.0	23.3	420
6114.5	25.4	545
6115.0	27.6	705
6115.5	29.9	895
6116.0	32.2	1105
6116.5	34.6	1350
6117.0	37.1	1615
6117.5	39.7	1910
6118.0	42.3	2225
6118.5	45.1	3050

TABLE 5
Hydrology Summary - Subbasins (Rational Method)

Subbasin	Drainage Area (Ac)	Existing Condition Peak Discharge (CFS) 10-Year	Existing Condition Peak Discharge (CFS) 100-Year	Future Condition Peak Discharge (CFS) 10-Year	Future Condition Peak Discharge (CFS) 100-Year
A-1	65	75	130		
A-2	60	80	135		
A-3	108	105	175		
A-4	117	145	265		
A-5	62	65	130		
A-6	74	50	100	60	120
A-7	61	75	140	135	230
A-8	64	95	165	100	170
A-9	93	130	230	135	235
A-10	92	110	200	135	240
B-1	86	135	245		
B-2	52	85	155		
B-3	84	135	235		
B-4	78	85	165		
B-5	66	105	185		
B-6	69	115	200		
B-7	70	115	200		
C	96	85	165		
D-1	50	80	140		
D-2	96	145	250		
D-3	57	95	170		
D-4	86	140	255		
D-5	95	140	245		
D-6	62	100	180		
D-7	71	120	210		
D-8	65	105	190		
D-9	69	95	175		
D-10	66	130	220		
D-11	100	170	300		
D-12	100	205	345		

NOTE: Future condition shown only for subbasins where basin parameters are anticipated to change due to future development. All other subbasins are anticipated to remain unchanged from existing condition basin parameters.

TABLE 5
Hydrology Summary - Subbasins (Rational Method)

Subbasin	Drainage Area (Ac)	Existing Condition Peak Discharge (CFS) 10-Year	Existing Condition Peak Discharge (CFS) 100-Year	Future Condition Peak Discharge (CFS) 10-Year	Future Condition Peak Discharge (CFS) 100-Year
D-13	102	175	305		
D-14	108	195	350		
D-15	100	190	330	195	335
D-16	88	70	155		
E	89	85	170		
F	78	115	210		
G	82	145	255		
H	119	140	245		
I-1	97	130	230		
I-2	110	160	285		
J	98	140	250		
K-1	90	110	190		
K-2	84	95	165		
K-3	59	95	165		
K-4	64	105	185		
L-1	88	140	240		
L-2	99	160	280		
L-3	86	120	215		
L-4	53	80	145		
L-5	77	95	165		
L-6	60	125	210		
L-7	89	120	225		
M-1	91	125	225		
M-2	107	160	280		

NOTE: Future condition shown only for subbasins where basin parameters are anticipated to change due to future development. All other subbasins are anticipated to remain unchanged from existing condition basin parameters.

TABLE 5
Hydrology Summary - Subbasins (Rational Method)

Subbasin	Drainage Area (Ac)	Existing Condition Peak Discharge (CFS)		Future Condition Peak Discharge (CFS)	
		10-Year	100-Year	10-Year	100-Year
M-3	79	145	230		
N	102	210	340		
O-1	101	170	295		
O-2	68	125	220		
O-3	73	125	225		
O-4	75	130	235		
O-5	83	175	290		
O-6	114	300	490		
O-7	84	205	310		
O-8	68	120	200		
O-9	60	100	190		
O-10	74	170	270		
O-11	105	180	315		
O-12	70	220	335		
P-1	68	105	180		
P-2	104	150	280		
P-3	96	155	265	175	290
Q	73	160	270	165	275
R-1	96	295	460		
R-2	73	170	290		
S-1	72	130	225		
S-2	55	90	155	95	165
T	90	185	310		
U	87	115	210	135	240

NOTE: Future condition shown only for subbasins where basin parameters are anticipated to change due to future development. All other subbasins are anticipated to remain unchanged from existing condition basin parameters.

TABLE 6
Hydrology Summary - Design Points (TR-20)

Design Point/Location	Existing Condition Peak Discharge (CFS) (24-Hour)		Future Condition Peak Discharge (CFS) (24-Hour)	
	10-Year	100-Year	10-Year	100-Year
10	615	1375	680	1480
17 (From East)	520	1130	520	1130
17 (Total)	1070	2400	1165	2535
17 (To Shooks Run)	190	995	240	1075
17 (To Van Buren Channel)	880	1405	925	1460
33 (Pond In)	1215	2615	1220	2620
33 (Pond Out)	835	2340	845	2345
36 (D/S Patty Jewett G.C.)	1070	3575	1105	3665
40 (Uintah Street)	1135	3850	1170	3940
45 (Cache La Poudre Street)	1235	4205	1275	4305
52	1430	4775	1475	4875
55 (Boulder Street)	1520	4915	1535	5020
56 (Bijou Street)	1550	4955	1550	5060
67	1385	2630	1385	2630
68 (El Paso Street North)	2680	5985	2535	6020
71 (Pikes Peak Avenue)	3040	6650	2915	6705
74 (Costilla Street)	3065	6765	2945	6820
77 (Fountain Boulevard)	3100	6880	2985	6940
78 (Fountain Creek)	3050	6840	2950	6910

TABLE 7
Hydrology Summary - Subbasins (Comparison Rational Method/TR-20)

		Existing Condition Peak Discharge					Future Condition Peak Discharge				
		Rational		TR-20 (24-Hour)			Rational		TR-20 (24-Hour)		
Subbasin	Area (Ac)	10-Year (CFS)	100-Year (CFS)	10-Year (CFS)	100-Year (CFS)	100-Year Difference Divided by Rational	10-Year (CFS)	100-Year (CFS)	10-Year (CFS)	100-Year (CFS)	100-Year Difference Divided by Rational
A-1	65	75	130	70	150	+15%					
A-2	60	80	135	85	165	+22%					
A-3	108	105	175	110	235	+34%					
A-4	117	145	265	125	265	--					
A-5	62	65	130	50	120	-8%					
A-6	74	50	100	45	105	+5%	60	120	60	130	+8%
A-7	61	75	140	70	150	+7%	135	230	145	245	+7%
A-8	64	95	165	95	175	+6%	100	170	100	180	+6%
A-9	93	130	230	110	215	-7%	135	235	115	220	-6%
A-10	92	110	200	85	185	-7%	135	240	100	215	-10%
B-1	86	135	245	110	225	-8%					
B-2	52	85	155	65	135	-13%					
B-3	84	135	235	100	205	-13%					
B-4	78	85	165	70	160	-3%					
B-5	66	105	185	75	155	-16%					
B-6	69	115	200	100	190	-5%					
B-7	70	115	200	90	180	-10%					
C	96	85	165	60	130	-21%					

NOTE: Future conditions shown only for subbasins where basin parameters are anticipated to change due to future development. All other subbasins are anticipated to remain unchanged from existing condition basin parameters.

TABLE 7
Hydrology Summary - Subbasins (Comparison Rational Method/TR-20)

		Existing Condition Peak Discharge					Future Condition Peak Discharge				
		Rational		TR-20 (24-Hour)			Rational		TR-20 (24-Hour)		
Subbasin	Area (Ac)	10-Year (CFS)	100-Year (CFS)	10-Year (CFS)	100-Year (CFS)	100-Year Difference Divided by Rational	10-Year (CFS)	100-Year (CFS)	10-Year (CFS)	100-Year (CFS)	100-Year Difference Divided by Rational
D-1	50	80	140	70	140	--					
D-2	96	145	250	95	205	-18%					
D-3	57	95	170	65	140	-18%					
D-4	86	140	255	95	200	-22%					
D-5	95	140	245	105	215	-12%					
D-6	62	100	180	70	145	-19%					
D-7	71	120	210	90	180	-14%					
D-8	65	105	190	75	155	-18%					
D-9	69	95	175	80	165	-6%					
D-10	66	130	220	110	210	-5%					
D-11	100	170	300	120	245	-18%					
D-12	100	205	345	175	325	-6%					
D-13	102	175	305	140	270	-11%					
D-14	108	195	350	160	310	-11%					
D-15	100	190	330	200	355	+8%	195	335	210	365	+9%
D-16	88	70	155	85	180	+16%					
E	89	85	170	95	205	+21%					
F	78	115	210	115	215	+2%					
G	82	145	255	110	220	-14%					

NOTE: Future conditions shown only for subbasins where basin parameters are anticipated to change due to future development. All other subbasins are anticipated to remain unchanged from existing condition basin parameters.

TABLE 7
Hydrology Summary - Subbasins (Comparison Rational Method/TR-20)

		Existing Condition Peak Discharge					Future Condition Peak Discharge				
		Rational		TR-20 (24-Hour)			Rational		TR-20 (24-Hour)		
Subbasin	Area (Ac)	10-Year (CFS)	100-Year (CFS)	10-Year (CFS)	100-Year (CFS)	100-Year Difference Divided by Rational	10-Year (CFS)	100-Year (CFS)	10-Year (CFS)	100-Year (CFS)	100-Year Difference Divided by Rational
H	119	140	245	95	205	-16%					
I-1	97	130	230	97	200	-13%					
I-2	110	160	285	115	245	-14%					
J	98	140	250	105	215	-14%					
K-1	90	110	190	75	165	-13%					
K-2	84	95	165	70	145	-12%					
K-3	59	95	165	65	135	-18%					
K-4	64	105	185	80	165	-11%					
L-1	88	140	240	105	210	-12%					
L-2	99	160	280	110	230	-18%					
L-3	86	120	215	95	190	-12%					
L-4	53	80	145	55	115	-21%					
L-5	77	95	165	70	140	-15%					
L-6	60	125	210	120	210	--					
L-7	89	120	225	95	195	-13%					
M-1	91	125	225	90	190	-16%					
M-2	107	160	280	135	265	-5%					
M-3	79	145	230	150	250	+9%					

NOTE: Future conditions shown only for subbasins where basin parameters are anticipated to change due to future development. All other subbasins are anticipated to remain unchanged from existing condition basin parameters.

TABLE 7
Hydrology Summary - Subbasins (Comparison Rational Method/TR-20)

		Existing Condition Peak Discharge					Future Condition Peak Discharge				
		Rational		TR-20 (24-Hour)			Rational		TR-20 (24-Hour)		
Subbasin	Area (Ac)	10-Year (CFS)	100-Year (CFS)	10-Year (CFS)	100-Year (CFS)	100-Year Difference Divided by Rational	10-Year (CFS)	100-Year (CFS)	10-Year (CFS)	100-Year (CFS)	100-Year Difference Divided by Rational
N	102	210	340	180	325	-4%					
O-1	101	170	295	145	275	-7%					
O-2	68	125	220	100	195	-11%					
O-3	73	125	225	95	195	-13%					
O-4	75	130	235	95	195	-17%					
O-5	83	175	290	155	280	-3%					
O-6	114	300	490	285	480	-2%					
O-7	84	205	310	195	325	+5%					
O-8	68	120	200	120	220	+10%					
O-9	60	110	190	80	165	-13%					
O-10	74	170	270	175	290	+7%					
O-11	105	180	315	140	275	-13%					
O-12	70	220	335	200	320	-4%					
P-1	68	105	180	115	210	+17%					
P-2	104	150	280	160	310	+11%					
P-3	96	155	265	175	305	+15%	175	290	200	340	+17%
Q	73	160	270	160	275	+2%	165	275	165	280	+2%
R-1	96	295	460	285	450	-2%					
R-2	73	170	290	165	285	-2%					

NOTE: Future conditions shown only for subbasins where basin parameters are anticipated to change due to future development. All other subbasins are anticipated to remain unchanged from existing condition basin parameters.

TABLE 7
Hydrology Summary - Subbasins (Comparison Rational Method/TR-20)

		Existing Condition Peak Discharge					Future Condition Peak Discharge				
		Rational		TR-20 (24-Hour)			Rational		TR-20 (24-Hour)		
Subbasin	Area (Ac)	10-Year (CFS)	100-Year (CFS)	10-Year (CFS)	100-Year (CFS)	100-Year Difference Divided by Rational	10-Year (CFS)	100-Year (CFS)	10-Year (CFS)	100-Year (CFS)	100-Year Difference Divided by Rational
S-1	72	130	225	115	215	-4%					
S-2	55	90	155	80	155	--	95	165	90	165	--
T	90	185	310	170	300	-3%					
U	87	115	210	110	210	--	135	240	130	240	--

NOTE: Future conditions shown only for subbasins where basin parameters are anticipated to change due to future development. All other subbasins are anticipated to remain unchanged from existing condition basin parameters.

TABLE 8
Hydrology Comparison With Previous Drainage Studies
(Peak Discharges - CFS)

DBPS Design Point/ Location	DBPS Exist. 100-Year	1972 Master Basin 100-Year	1986 Flood Insurance 100-Year	1972 Palmer Park 5-Year	1988 Lower Cragmor 100-Year	1990 Houck Estates 100-Year	1989 FEMA Restudy 100-Year
10	1375	---	---	---	---	1730	---
17 (Total)	2400	---	---	---	1910	---	675
17 (To Shooks Run)	995	0	---	---	---	---	0
17 (To Van Buren Channel)	1405	---	---	---	---	---	675
33 (Pond In)	2615	1645	---	705	---	---	1360
33 (Pond Out)	2340		---	---	---	---	810
36 (D/S Patty Jewett G.C.)	3575	1505	5700	---	---	---	1100
40 (Uintah Street)	3850	2195	5700	---	---	---	1100
52	4775	2690	5700	---	---	---	2510
55 (Boulder Street)	4915	2805	5700	---	---	---	2510
67	2630	1045	---	---	---	---	2055
68 (El Paso St. North)	5985	3995	7700	---	---	---	4865
71 (Pikes Peak Avenue)	6650	4295	7800	---	---	---	4865
74 (Costilla Street)	6765	4495	7800	---	---	---	5475
77 (Fountain Boulevard)	6880	4540	7800	---	---	---	5570
78 (Fountain Creek)	6840	4525	7800	---	---	---	5570

V. HYDRAULIC ANALYSIS

V. HYDRAULIC ANALYSIS

Methodology

A detailed hydraulic analysis was done for the main channel of Shooks Run from Fountain Creek to the Van Buren channel. The existing development condition 100-year floodplain was delineated using the U.S. Army Corps of Engineers HEC-2 computer program (HEC-2) to identify problem areas along the main channel. Channel cross-section and length information was taken from the topographic mapping for the project and supplemented by field surveys. Channel roughness coefficients were estimated based on field observation.

Analysis Results

The existing floodplain delineation identified many existing problems along the main channel. Most of the 38 existing roadways, railroads and paths that cross the channel are overtopped by the 100-year peak discharge. Only two railroads, one pedestrian path and three golf cart path crossings have adequate capacities for the 100-year peak discharge. Table 9 is a summary of the flow conditions at each of the crossings during the 100-year discharge. Many private and public buildings and properties are within the existing 100-year floodplain. These include private commercial and industrial buildings; residences and apartment buildings; commercial and industrial lots; residential yards; and public parks, golf course property, and street right-of-ways along the entire channel. The hydraulic analysis also identifies high flow velocities along the entire channel that are potentially highly erosive due to the existing, unstable geologic and vegetation conditions. The existing 100-year floodplain and problem areas along the main channel are illustrated on Figures 49-56.

The future development condition 100-year floodplain with the recommended improvements for the main channel was also delineated. This future condition 100-year floodplain is also illustrated on Figures 49-56 so that comparisons with the existing condition 100-year floodplain can be made.

Comparison with FEMA Floodplain

As previously discussed, a direct comparison with the FEMA floodplain is not possible because of differences in the hydrologic analyses of this DBPS and the FEMA restudy. Review of the hydraulic analysis of the FEMA restudy revealed that it was based on channel cross-sections and lengths that were taken, for the most part, from the original *Flood Insurance Study for Shooks Run* done by the Corps of Engineers, rather than the topographic mapping used in the DBPS. Comparison of some of the cross-sections used in the DBPS based on the project topographic mapping with cross-sections used in the FEMA restudy at approximately the same locations shows considerable differences that would also lead to considerable differences in floodplain delineation.

TABLE 9
Existing Structure Evaluation

Location (Station)	Crossing	Structure Size/ Description	100-Year Peak Discharge (CFS)	Structure Discharge (CFS)	Comments
10+10 to 10+80	Las Vegas Street	40'x10' Concrete Twin Tee Bridge	6840	5830	Inlet Control - 0.5' Overflow of Road
11+20 to 11+65	A.T.S.F. & D.R.G.W. Railroad	Double 20'x16.5' Concrete Arch Culvert	6840	6840	Outlet Control - No Overflow
15+60 to 16+20	Abandoned Railroad	Double 20'x17.9' Stone Masonry Arch Culvert	6840	6840	Outlet Control - No Overflow
19+76 to 19+84	Pedestrian Path	55'x4.7' Timber Bridge	6860	915	Outlet Control - 11.5' Overflow of Path
24+00 to 25+50	Fountain Boulevard	20'x9.5' Concrete Arch & 20'x11' CMP Arch Culvert	6880	5600	Outlet Control - 2.5' Overflow of Road
48+65 to 50+65	Costilla Street	20'x11.9' Concrete Arch Culvert	6765	3885	Inlet Control - 3.3' Overflow of Road
58+06 to 58+09	18" Sanitary Sewer	65'x5.5' Concrete Aerial Crossing	6670	1610	Outlet Control - 7.8' Overflow of Crossing
71+55 to 72+80	El Paso Street (South)	20'x9' Concrete Arch Culvert	6650	2160	Inlet Control - 3.2' Overflow of Road
76+80 to 84+10	Pikes Peak Avenue/ El Paso Street (North)	20'x12' Concrete Arch/ Double 11'x10'RCB/ 30'x19.3' Conc. Arch Culv.	6650	3760	Outlet Control - 3.8' Overflow of Road (El Paso Street North)
84+50 to 85+60	Kiowa Street	20'x11.1' Concrete Arch Culvert	4955	2095	Outlet Control - 3.8' Overflow of Road
89+95 to 94+50	Bijou Street	20'x8.7' Concrete Arch Culvert	4955	945	Outlet Control - 2.7' Overflow of Road
98+10 to 106+00	Platte Avenue/ Athletic Field	20'x11.2' Conc. Arch/20'x 12.3' CMP Arch Culvert	4915	2790	Outlet Control - 1.5' Overflow of Road (Platte Avenue)
106+10 to 106+30	Boulder Street	40'x11.5' Steel I-Beam Bridge	4915	2790	Outlet Control - 6.6' Overflow of Road
112+35 to 113+40	St. Vrain Street	20'x11.9' Concrete Arch Culvert	4830	2960	Inlet Control - 1.9' Overflow of Road
117+75 to 119+80	Willamette Street	20'x12' Concrete Arch Culvert	4775	3695	Inlet Control - 1.7' Overflow of Road

TABLE 9
Existing Structure Evaluation

Location (Station)	Crossing	Structure Size/ Description	100-Year Peak Discharge (CFS)	Structure Discharge (CFS)	Comments
128+66 to 128+74	Pedestrian Path	27'x10.2' Timber Bridge	4205	1170	Inlet Control - 4.7' Overflow of Road
135+15 to 137+05	Cache La Poudre Street	20'x12.7' Concrete Arch Culvert	4205	2845	Inlet Control - 2.7' Overflow of Road
152+45 to 153+55	Uintah Street	20'x10.3' Concrete Arch Culvert	3850	3160	Inlet Control - 1.2' Overflow of Road
157+55 to 158+40	San Miguel Street	20'x11.5' Concrete Arch Culvert	3850	2360	Outlet Control - 2.1' Overflow of Road
167+35 to 167+39	Pedestrian Path	115'x19.4' Steel I-Beam Bridge	3575	3575	Inlet Control - No Overflow
180+21 to 180+29	Golf Cart Path	80'x18' Prefab. Steel Bridge	3470	3470	Inlet Control - No Overflow
183+11 to 183+19	Golf Cart Path	80'x17.6' Prefab. Steel Bridge	3470	3470	Inlet Control - No Overflow
184+50 to 184+55	--	20'x6' Concrete Drop Structure	3470	2380	5.1' Overflow of Drop Side Walls
185+01 to 185+09	Golf Cart Path	45'x7.7' Concrete Twin Tee Bridge	3470	1675	Outlet Control - 2.6' Overflow of Path
187+11 to 187+19	Golf Cart Path	50'x8.3' Concrete Twin Tee Bridge	3470	1610	Outlet Control - 2.7' Overflow of Path
189+05 to 190+85	Española Street	12'x8' RCB Culvert	3470	1460	Inlet Control - 2.7' Overflow of Road
191+31 to 191+39	Golf Cart Path	40'x8.4' Prefab. Steel Bridge	3470	965	Outlet Control - 4.0' Overflow of Path
193+16 to 193+20	Golf Cart Path	30'x7.8' Prefab. Steel Bridge	3470	810	Outlet Control - 3.7' Overflow of Path
194+81 to 194+89	Golf Cart Path	40'x8.5' Prefab. Steel Bridge	3375	1105	Outlet Control - 3.4' Overflow of Path
197+46 to 197+54	Golf Cart Path	22'x6.0' Concrete Twin Tee Bridge	3375	465	Outlet Control - 4.0' Overflow of Path
200+10 to 200+25	Golf Cart Path	65"x40" CMP Arch Culvert	1035	170	Inlet Control - 2.2' Overflow of Path

TABLE 9
Existing Structure Evaluation

Location (Station)	Crossing	Structure Size/ Description	100-Year Peak Discharge (CFS)	Structure Discharge (CFS)	Comments
200+96 to 201+04	Golf Cart Path	30'x5.0' Concrete Twin Tee Bridge	1035	1035	Inlet Control - No Overflow
216+40 to 216+95	Paseo Road	Double 10'x2.5' RCB Culvert	1035	405	Inlet Control - 0.9' Overflow of Road
218+30 to 219+10	Jefferson Street	Triple 72"x44" CMP Arch Culvert	1035	240	Outlet Control - 1.7' Overflow of Road
222+50 to 223+30	Madison Street	Triple 72"x44" CMP Arch Culvert	1035	470	Outlet Control - 1.0' Overflow of Road
226+25 to 227+05	Monroe Street	Triple 72"x44" CMP Arch Culvert	1035	385	Outlet Control - 1.3' Overflow of Road
229+70 to 234+15	Jackson Street/ LaSalle Street	Triple 72"x44" CMP Arch Culvert	1035	375	Outlet Control - 1.0' Overflow of Roads
235+40 to 235+90	Pedestrian Path	Double 48" CMP Arch Culvert	995	295	Inlet Control - 2.1' Overflow of Path
236+20 to 236+75	C.R.I.P. Railroad	Triple 72" CMP Culvert with 5.6'x1.9' Weir Plate Openings	995	190	Inlet Control - 1.7' Overflow of Railroad