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Executive Summary

1.1 Authorization

The Jimmy Camp Creek Drainage Basin Planning Study [DBPS] was authorized by the City of Colorado Springs under the terms of agreement between the City of Colorado Springs and Kiowa Engineering Corporation. Due to the extensive regional implications of this study, input and review to the technical scope of this project was provided by the City of Fountain and El Paso County. The area subject to study is presented on Figure I-1.

1.2 Purpose and Scope

The purpose of the study is to analyze the existing and future drainage conditions of the watershed, quantify surface runoff, define floodplains, identify drainage impacts, develop alternate solutions, and prepare a final drainage plan for implementation within the watershed. The information developed from this study will be used to regulate future development and mitigate the major drainageways within the watershed.

Specific tasks required for the study:

1. Meet with the City to obtain information, present study findings, and gain direction for future analyses.
2. Contact agencies and/or individuals that have knowledge or specific interest in the study area.
3. Inventory and compile the existing drainage system.
4. Apply the latest City/County policies and criteria.
5. Perform hydraulic and hydrologic analyses.
6. Identify existing and potential drainage and/or flooding problems.
7. Mitigate impacts of developed runoff on Fountain Creek.
8. Develop improvement alternatives to reduce existing and potential flooding problems, and mitigate the impact of stormwater runoff on environmentally significant areas.
9. Recommend and prepare a conceptual design for a selected alternative plan.
10. Prepare written reports for submittal to the City of Colorado Springs.
11. Apply the City Zoning Code Streamside Overlay and the Streamside Design Guidelines policies, standards and criteria, as appropriate and applicable for a drainage basin planning study.

1.3 Mapping

Project mapping for hydrologic analyses was obtained through USGS digital 7.5-minute quadrangles (20-foot contours) and supplemented with Colorado Springs Utilities FIMS mapping (2-foot contour) along the Jimmy Camp Creek channel. Additional 2-foot contour mapping was utilized for the properties of Banning Lewis Ranch and Rolling Hills Ranch. The specific quadrangles used for the study area are Falcon NW, Falcon, Elsmere, Corral Bluffs, Fountain, and Fountain NE. Revisions to the mapping vary across the quadrangles. In general, the mapping is compiled from aerial photographs taken in 1947, field checked in 1948, revised from aerial photographs taken in 1960, and field checked in 1961, and revised from aerial photographs taken in 1969 and 1975, but not field checked. Some mapping has been further revised from aerial photographs taken in 1988, field checked in 1993, and edited and published in 1994. All USGS mapping is prepared at a contour interval of twenty-feet. The horizontal control is NAD 1927 with projection zone 13 Colorado Coordinate System central and north zones. The vertical datum is 1929. In addition to the contour information, the USGS mapping provides roadway alignments and major drainage paths. This mapping was deemed suitable for the hydrologic analyses portion of this study. The USGS mapping was supplemented with 2-foot contour mapping where available.

Topographic mapping used in the delineation of floodplains and the conceptual design plans was obtained from the City of Colorado Springs Facilities Information Mapping Services (FIMS). This mapping was compiled from aerial photography and was produced with a 2-foot contour interval. The vertical datum of the topographic mapping is the National Geodetic Vertical Datum of 1929.

1.4 Stakeholder Review

As part of the completion of the technical analyses and the development of alternatives, individuals, major property owners and organizations with an interest in development of the long-term storm water management and major drainageway stabilization measures were contacted and routinely notified regarding their attendance at progress meetings. Six stakeholder meetings were held over a two year period between 2008 and 2010. Comments arising from these meetings were documented and addressed as part of the completion of the DBPS. A partial listing of stakeholders is presented below:

Organization
City of Colorado Springs Engineering Division
City of Colorado Springs Department of Utilities
City of Colorado Springs Planning Department
City of Colorado Springs Parks and Recreation
City of Fountain Department of Public Works
El Paso County Public Services Department
El Paso County Development Services Department
Banning Lewis Ranch
Colorado Centre Metropolitan District
Lorson Ranch Development
Rolling Hills Ranch Development
US Army Corps of Engineers
National Resource Conservation Service
El Paso County Department of Transportation

1.5 Study Area

The study area consists of the Jimmy Camp Creek watershed located in El Paso County. Jimmy Camp Creek is an east bank tributary to Fountain Creek with its outfall lying just west of Old Pueblo Road [Main Street] near the City of Fountain's historic downtown. The watershed is generally bounded by Powers Boulevard to the west, Blaney Road to the east, Old Pueblo Road to the south, and Garrett Road to the north. The Jimmy Camp Creek watershed has a drainage area of 67.1 square miles.

The topography of the study area slopes from north to south beginning near elevation 6880 feet at Garrett Road and ending near elevation 5490 feet at the outfall to Fountain Creek. The main channel of Jimmy Camp Creek has an average slope of 1.0% over a length of 24 miles.

There are nine major tributaries defined within the Jimmy Camp Creek watershed: East Fork, Franceville, Strip Mine, Corral, Marksheffel, West Fork, Ohio, C and S, and Blaney Tributaries. All of these tributaries have drainage areas greater than one square mile. The West Fork tributary was recently studied and the results have been published in a report entitled, West Fork Jimmy Camp Creek Drainage Basin Planning Study, dated October 2003. This 4.1 square mile drainage basin was studied in detail, planned, reviewed, and accepted as an approved drainage plan for the basin. The West Fork has a defined plan of drainage improvements, flood detention, and required right-of-way.

1.6 Flood History

Throughout recorded history, the Jimmy Camp Basin has always experienced severe weather events with wide fluctuations that include drought, hail, floods and devastating snowstorms. With low population density in the basin prior to the last twenty years, endangerment of lives and damage to property was limited and rarely reported. Flooding mainly occurs in the summer months of May to August during intense rain events of several days duration when a warm, moist air mass from the Gulf of Mexico collides with a colder air mass from the north. Although frequently severe isolated summer thunderstorms rarely cause a major flood as the more frequent storms tend to be limited in area and duration.

The June 18, 1965 flood is the flood of record in El Paso County. As much as 14 inches of rain fell over several days. Hailstones near Fountain were said to be as large as tennis balls. The flow at Jimmy Camp Creek was estimated to be 124,000 cubic feet per second at a point about 4.5 miles upstream from the confluence. Considerable damage to roads and bridges occurred in the sparsely populated area. In the City of Fountain, Ohio Avenue washed out along with the railroad trestle. Santa Fe was overtopped and gullies formed on the approaches.

A large regional flood also occurred on May 30, 1935 after several days of rain. As in the 1965, the majority of damages were to agriculture, roads and bridges. In the summer of 1972, two separate flood events caused damage in the basin. The first event of July 18th, there were reports of two- to five-inches of rain in the Franceville Tributary causing about $100,000 damages to roads and bridges. State Highway 94 was closed due to bridges being washed out. Later in the summer on August 3rd, a flood did an additional $50,000 in damages to bridges and isolated eight families east of Jimmy Camp Creek on Peaceful Valley Road.

The U.S.G.S. installed a stream gage near the mouth of Jimmy Camp Creek in 1976. Review of gage records for water years 1976-2005 indicate peak flows of 4,810 cubic feet per second and 4,530 cubic feet per second for 1994 and 1995 respectively and 3,600 cubic feet per second in 1985. During the 30 years of record, the gage recorded peak flows over 1,000 cubic feet per second during seven years. Flood history clearly indicates that a potential for flash flooding is present in the Jimmy Camp Creek Basin and will increase as urbanization continues.

1.7 Land Use

Hydrologic impervious information for each sub-watershed land use was developed for input into the HEC-HMS hydrology model. The amount of impervious area within each sub-watershed was estimated for two conditions: (1) existing development and (2) anticipated maximum future development.

Currently, the watershed is predominantly undeveloped with a land use of pasture or open range. The pockets of existing development found within the study area are a mix of rural residential, single-family residential and commercial. The lower reach of the watershed extends into the City of Fountain where single-family residential, multi-family residential, public facilities and commercial properties are found. Impervious areas for existing conditions were compiled by examining the City's 2005 online aerial photography (2' resolution), project mapping, and by field inspections to the area. The overall watershed imperviousness for the existing condition in Jimmy Camp Creek is 4.5%.

The future impervious cover was estimated by reviewing land use planning studies provided by the City of Colorado Springs, City of Fountain, and El Paso County. Over 60-percent of the watershed has detailed development planned for five major properties within the drainage basin. These developments are Banning Lewis Ranch (40%), Rolling Hills Ranch (5%), Lorson Ranch (3%), Norris Ranch (3%) and the City of Fountain (10%) 2005 Land Use Update. Each of these developments are in the early stages of development. Lorson Ranch and Banning-Lewis Ranch are at this time actively developing. This level of detailed future development in a watershed study is unusual and provides an exceptionally detailed future conditions land use map

1.8 Soil

Soil information was obtained from the Soils Survey of El Paso County Area, Colorado, USDA Soil Conservation Service, 1981. The significance of soil type for hydrologic analysis is in the infiltration rate. Soils are classified into four hydrologic classifications; namely, Types A, B, C, and D. Initial infiltration rates range from 5.0 inches per hour for Type A soils to 3.0 inches per hour for Type C and D soils.

The study area contains all four Hydrologic Soils Group classifications. The study area is predominantly comprised of Type B soils, which constitute half of the watershed area. Type B soils can be characterized as silt loam or loam. These soils have a moderately high rate of infiltration of 4.5 inches/hour. The second most common soil type is Type C soils that have moderately low infiltration and moderately high runoff potential. These soils comprise one quarter of the watershed area. Soil Types A and D constitute the remaining one quarter (approximately one eighth each) of the watershed and are spread throughout the area. Soil characteristics significantly influence hydrologic responses, but they are also a concern to a planning study due to the erosion and sediment potential that can develop with increased base flows and more frequent high channel velocities caused by urban development.

1.9 Hydrology

Hydrologic analysis was conducted to determine the 2-, 5-, 10-, and 100-year peak flows for existing and future development conditions. The *Hydrologic Modeling System HEC-HMS, version 3.5,* was used to develop runoff hydrographs from individual sub-basins and to route and combine them through a model of the drainageways. A total of 356 sub-basins were developed for the 67.1 square mile study area. The sub-basins generally range in size from 70 acres to 150 acres, averaging 112 acres. The maximum sub-basin size was set below 200 acres. The watershed includes 6 large tributaries ranging in size from 4 to 10 square miles, and 3 small tributaries ranging from 1 to 2 square miles. The 6 large tributaries constitute 57% of the total watershed area and are an important factor to the Jimmy Camp Creek hydrology.

Input data was prepared using guidelines and values recommended in the City of Colorado Springs and El Paso County Drainage Criteria Manual [DCM]. Hydrologic parameters were measured from the twenty-foot contour interval USGS project mapping. Impervious values were measured from recent aerial photography and field inspections. Soil parameters were measured from the SCS Soils Survey for El Paso County. The results of the hydrologic analysis were compared to previous studies. Individual sub-basin results were evaluated by cubic feet per second/acre for reasonableness based on the applied sub-basin imperviousness. Discussions of specific hydrologic parameters and results follow.

Due to inconsistencies between the gauge data and the preliminary hydrologic model output for the frequent flood events (2-year and 5-year), additional work was undertaken to better calibrate the existing conditions model. Historical storm characteristics and channel geomorphology analyses were completed. Although the record data was limited due to the infancy of the technology, it does show that basic assumptions used for conventional rainfall-runoff models are not consistent with the recorded storm data. It appears that the basin conditions prior to the more frequent storm events (2-year and 5-year) are better represented by the AMC I (drier) conditions as opposed to the AMC II (wetter) conditions as normally applied. The data used for the analyses was not sufficient to analyze more severe storms, such as the 10-year and 100-year events therefore modeling for the DBPS for these conditions was based on conventional criteria of uniform rainfall a 24-hour duration, and an AMC II condition. Further analyses of rainfall-runoff data would be required to determine if these assumptions should be revised for future studies such as DBPS updates or MDDPs.

2.0 Design Rainfall

The 10-year and 100-year design rainfall for the study was determined from the NOAA Atlas 2, Volume III isopluvials for 24-hour precipitation. An areal adjustment factor of 94.4% was applied to the point rainfall according to the depth-area curves listed in the NOAA Atlas for a 67 square mile drainage area. In accordance with DCM standards a Type II distribution was applied to the 24-hour point rainfall. For the 2-year and 5-year frequencies the design rainfall amounts shown in DBPS Table III-2 with appropriate areal adjustments were applied uniformly over the entire watershed and distributed over 6-hours.

The following table lists the point rainfall depths, areal reduction factor, and adjusted point rainfall used for the various design storm frequencies. The 24-hour storm duration was used for the 100- and 10-year storm events per DCM standards. Analysis of the storm rainfall within the Jimmy Camp Creek basin determined that a 6-hour storm duration was more appropriate for the 2- and 5-year events.

Table III-2
Design Rainfall

Frequency:	100-yr	10-yr	5-yr	2-yr
24-hr Point Rainfall (in):	4.5	3.2	2.7	2.1
6-hr Point Rainfall (in):	3.5	2.4	2.1	1.7
Areal Reduction:	***94.4%***	***94.4%***	***94.4%***	***94.4%***
24-hr Adjusted Rainfall (in):	4.25	3.02	2.55	1.98
6-hr Adjusted Rainfall (in):	3.30	2.27	1.98	1.60

The 6-hour storm distribution for the 2-year and 5-year events should only be used to estimate undeveloped basin conditions and to set flow limits for evaluating allowable release rates from detention storage basins. Rainfall depths and durations published by NOAA Atlas 2 should continue to be applied to the design storm distributions for projected developed conditions. The 6-hour storm distribution should not be used for floodplain analyses or flood control structure design.

2.1 Sub-basins

Sub-basins were evaluated using the USGS 7½ minute quadrangle, twenty-foot contour mapping provided for the project and checked with the 2-foot contour mapping where available. Major watershed and sub-basin boundaries were established based on topographic and physical drainage boundaries, such as major roadways. Watershed boundaries were verified in the field. The watershed was divided into 356 sub-basins, with an average area of 113 acres, to convey each design storm. The largest sub-basin is 192 acres that was defined between an airport runway and Drennan Road along Marksheffel Tributary. There is no development in this sub-basin and no other feature to warrant subdividing. The smallest sub-basin is 30 acres that was defined by the State Highway 94 embankment along Strip Mine Tributary.

2.2 SCS Curve Number Loss

In accordance with DCM standards, for design purposes an antecedent moisture content of II (AMC II) was applied for determining runoff from a 24-hour storm. Tables 5-4 and 5-5 in the City of Colorado Springs and El Paso County Drainage Criteria Manual [DCM] were used for the definition of runoff curve numbers (CN) for various land use categories and hydrologic soil groups. A spreadsheet was developed in which each sub-basin was subdivided based on the four hydrologic soil groups. The weighted curve number for the watershed under existing development conditions is 71 with an average percent imperviousness of 4%. Information provided by the City of Fountain, City of Colorado Springs and El Paso County planning departments was vital in developing a composite map of future land development. Several large planning developments were utilized accounting for two-thirds of the watershed area. These include: Banning Lewis Ranch [27 square miles], City of Fountain Comprehensive Plan [7 square miles], West Fork Tributary 2003 DBPS [4 square miles], Rolling Hills Ranch [3 square miles], Lorson Ranch [2 square miles], and Norris Ranch [2 square miles], see Figure II-2.

In order to calibrate the HEC-HMS model to better match the stream gauge data for the 2004, 2005 and 2006 storms it was found that the AMC I moisture condition was more realistic than assuming a AMC II condition. A check of the antecedent moisture condition for the 2004, 2005 and 2006 events revealed that none of these storms was preceded by measurable rainfall in the seven days prior to the storm. It was therefore decided to utilize the AMC I moisture condition when calibrating the existing condition HEC-HMS model for the 2-year and 5-year storm events.

2.3 Results of Hydrology Analysis

2-year and 5-year Results

Results of the Jimmy Camp Creek hydrology analysis were separated between the frequent flood events (2-year and 5-year) and the rare flood events (10-year and 100-year). The original modeling effort followed the standard procedures as outlined in the City of Colorado Springs and El Paso County Drainage Criteria Manual. Results from this effort were favorable for the 10-year and 100-year events but were determined to be high for the more frequent events when compared to the gauged peak flows at Ohio Avenue.

Since the Jimmy Camp Creek watershed has a stream gauge with 30 years of record, the calibration effort was undertaken to better match the gauge analysis for the 2-year and 5-year flood events. In summary, the calibration effort can be outlined as follows:

1. Adjusted storm duration from 24-hour to 6-hour
2. Adjusted antecedent moisture condition from AMC II to AMC I
3. Adjusted Manning's roughness coefficient specific to tributary reaches to reflect timing to the gauge

The calibration effort produced a 2-year, 5-year model that results in less runoff volume and lower peak discharges that correlate to the gauged data. With a 30-year gauge record calibration of the 10-year and 100-year flow rates could not be determined as reliable and therefore the standard engineering procedures as outlined in the City of Colorado Springs and El Paso County Drainage Criteria Manual were applied.

10-year and 100-year Results

The hydrologic results of this study are believed to be accurate for the Jimmy Camp Creek watershed. The results obtained for the hydrology modeling compare well with previous studies. Individual sub-basin 100-year peak runoff rates were further analyzed on a cubic feet per second/acre basis for reasonableness. The following table provides a summary of the unit discharges for this evaluation. Typically in undeveloped watersheds, existing 100-year runoff rates can range from 0.5 – 1 cubic feet per second/acre. In fully developed, urban watersheds this range can increase to 1 - 4 cubic feet per second/acre depending on the intensity of the development. In general large watersheds, as this one, will only increase to the 1 to 2 cubic feet per second/acre range, while smaller tributaries and individual sub-basins can increase in the 2 to 4 cubic feet per second/acre range. Any individual sub-basins that were found outside of this range were reevaluated for errors, corrected if necessary, and recalculated to ensure the results are accurate and consistent.

Unit Discharges
Check of Results (100-yr)

Location	Existing (cfs/ac)	Future (cfs/ac)
Outfall to Fountain Creek	0.51	0.74
Peaceful Valley Road	0.63	0.95
Bradley Road	0.70	1.00
Drennan Road	0.62	1.08
Highway 94	0.82	1.16

Other nearby watersheds were also reviewed for 100-year comparisons on a cubic feet per second/acre basis. The 2003 DBPS for West Fork Tributary produced 1.5 cubic feet per second/acre for existing conditions and 2.1 cubic feet per second/acre for future development conditions. This is a 4.1 square mile basin. A more comparable drainage basin to Jimmy Camp Creek is the Sand Creek watershed, which has a drainage area of 54.1 square miles. The Sand Creek Drainage Basin Planning Study produced 0.49 cubic feet per second/acre for existing conditions and 0.75 cubic feet per second/acre for future, undetained conditions.

DBSP Table III-10 contained within this Executive Summary provides a summary of peak runoff rates at key locations throughout the study area. The table includes all frequencies analyzed for both existing conditions and future conditions. The increase in runoff volume between the existing and future development conditions is the direct result of the increase in impervious areas attributable to the urbanization of the watershed. The increase in volume is what needs to be mitigated for by the implementation of detention storage in the watershed, either on a regional or onsite basis. The greatest incremental increase in volume is realized for the more frequent storm events such as the 2-year and 5-year recurrence intervals.

2.1 Hydraulic Analysis Overview

Hydraulic analyses were conducted to determine the extent flooding along the major drainageways of the Jimmy Camp Creek watershed during a 100-year event assuming existing basin development conditions. The hydraulic analysis also focused on determining the capacity of existing hydraulic structures that may cross over the major drainageways of the Jimmy Camp Creek watershed. Field verifications of major roadway crossings and channel conveyance improvements were conducted and the general physical condition of the structure(s) noted. Finally an effort to "characterize" the existing major drainageway channel sections with respect to environmental resources and stream stability issues was conducted and is summarized in this section of the report.

Hydraulic analyses were conducted using the U.S. Army Corps of Engineers HEC-RAS program, version 4.0. Plan and profile drawings contained in the DBPS were compiled for the main drainageways of Jimmy Camp Creek and for the Corral, East Fork Jimmy Camp Creek, Strip Mine, Franceville and Marksheffel Tributaries. The drawings show the existing channel grade, major roadway crossings, 100-year discharge data, 100-year hydraulic grade line, 100-year flood boundary, stream characterization classifications, environmental resources and roadway crossings. **The floodplain data contained in the DBPS is not intended to replace the information presented in the City of Fountain, City of Colorado Springs and El Paso County Flood Insurance Studies, but should be used as a tool in the planning of the major urban drainageways.**

2.2 Reach Delineation

Reaches were delineated for various segments of Jimmy Camp Creek and its major tributaries. The reaches were determined based upon the existing physical condition of the low flow, floodplain, and overbanks along the drainageways. Descriptions have been prepared for each reach by means of field visits, which were conducted to ascertain more site-specific information related to existing drainageway conditions. An environmental review of the major reaches was also conducted. The delineation of reaches was carried in order to assist in the evaluation of channel treatments and eventually in the selection of the most feasible plan(s) for long-term stability of the major drainageways within the watershed.. The reach limits established for the major flow paths are as follows:

Jimmy Camp Creek

- Reach J1: Fountain Creek to Link Road
- Reach J2: Link Road to Confluence with East Fork Jimmy Camp Creek
- Reach J3: Confluence with East Fork Jimmy Camp Creek to Corporate Limits
- Reach J4A/B: Corporate Limits to Drennan Road
- Reach J5: Drennan Road to SH-94
- Reach J6: SH-94 to proposed Jimmy Camp Creek Reservoir Site
- Reach J7: Proposed Jimmy Camp Creek Reservoir to upstream limits of floodplain delineation.

East Fork Jimmy Camp Creek

- Reach EF1: Confluence of Jimmy Camp Creek to El Paso County Limits
- Reach EF2: El Paso County Limits to Meridian Road
- Reach EF3: Meridian Road to Upstream Limits of Floodplain Delineation

Marksheffel Tributary

- Reach M-1: Confluence with Jimmy Camp Creek to Drennan Road

Franceville Tributary

- Reach F1: Confluence with Jimmy Camp Creek to Drennan Road
- Reach F2: Drennan Road to Meridian Road

Corral Tributary

- Reach C1: Confluence with Jimmy Camp Creek to Drennan Road
- Reach C2: Drennan Road to Confluence with Stripmine Tributary
- Reach C3: Confluence with Stripmine Tributary to SH-94
- Reach C4: SH-94 to Upstream Limits of Floodplain Delineation

Stripmine Tributary

- Reach S1: Confluence with Corral Tributary to El Paso County Line
- Reach S2: El Paso County Line to Meridian Road

2.3 Hydraulic Structure Inventory

As part of the field investigation, the existing drainage facilities were verified and inventoried. The size, type, and general hydraulic condition were recorded for bridges, culverts, detention basins and miscellaneous drainage features that existing along the major drainageways were inventoried. Hydraulic capacities were estimated for the culverts and bridges over the major drainageways. An inventory of the major structures is presented on in the DBPS Table IV-2. Very limited segments of the major drainageways in the Jimmy Camp Creek watershed have been improved and most of the banks are unlined or naturally lined with vegetation. Where bank linings have been built they exist mostly at the approach and outlet sides of roadway crossings. The 100-year channel capacities were estimated using the HEC-RAS computer program.

2.4 Floodplains

The location of the 100-year floodplain is important since it denotes the limit of allowable encroachment. Often times the 100-year floodplain contains the higher quality riparian and wetland habitat areas. These areas are desirable areas to preserve when focusing on the alternative planning process. It is recommended that the land which contains the main channels of Jimmy Camp creek watershed have the 100-year floodplain limits verified at the time of development, using the hydrology summarized herein as part of the initial steps of land development planning. For areas where no floodplains have been delineated, either in this report or in the Flood Insurance Study, the 100-year floodplain should be required to be determined using methods similar to those applied in this study.

Floodplains for the 100-year existing condition discharge have been delineated for Jimmy Camp Creek, the East Fork Jimmy Camp Creek and the Corral, Franceville, Stripmine, and Marksheffel tributaries. The floodplain was estimated in order to assess where hydraulic inadequacies exist along the major drainageways. The analysis assumed rigid boundary conditions to exist along the channel cross-sections. The field inventory supplied roughness and bridge opening data for use in the HEC-RAS modeling.

The roadway crossings over the major tributaries of the Jimmy Camp Creek watershed have adequate capacity to convey the estimated 100-year discharge under the roadway. There are however several exceptions to this. The crossing at Peaceful Valley Road at Jimmy Camp Creek and over the East Fork do not have sufficient capacity to convey the 100-year discharge and it is predicted that the roadway would be overtopped. The existing culvert at Bradley Road and the East Fork convey only 85 percent of the estimated 100-year discharge, however improvements to the channel approach and outlet transitions would increase the capacity of this culvert and result in the preventing the roadway from being overtopped. The exiting culvert under Meridian Road and the East Fork are also inadequate and should be upgraded if Meridian Road is improved in the future. Finally the culverts under Marksheffel Road that carry the Marksheffel Tributary to the Jimmy Camp Creek drainageways are under capacity and the roadway would be overtopped if a 100-year release from the existing detention basin was to occur.

2.5 Environmental Resource Review

An environmental resource inventory for each of the major drainageways in the basin was conducted whereby a description of the existing wetland resources, wildlife habitats and endangered species issues that may be relevant during design and implementation of major drainageway and detention facilities. Topographic, soil survey and wetland inventory maps were used to indicate potential wetland resources prior to field visits in the summer and fall of 2006 to verify the current condition of the vegetation and hydrology. Aerial photography was also used to evaluate areas where access was prohibited. Environmental resources were mapped on the FIMS database obtained from the City of Colorado Springs Utility Department.

Information presented is for planning purposes only. Prior to construction of proposed outfall systems, detailed wetland delineation will need to be done to determine the precise boundaries of jurisdictional wetlands and waters of the U.S. that will be subject to regulation by the Army Corps under Section 404 of the Clean Water Act.

2.6 Jurisdictional Wetland and Waterways

The mainstem and all major tributaries of Jimmy Camp Creek mapped on the floodplain drawings are "blue lines" on the U.S.G.S. map and will need to be evaluated in regards to regulation of jurisdictional waters of the U.S. and adjacent wetlands by the Corps of Engineers. Plans to discharge dredged or fill material within the ordinary high water mark or adjacent wetlands may require a Department of the Army Permit under Section 404 of the Clean Water Act.

Irrigation ditches that empty into jurisdictional waters are considered jurisdictional waters of the U.S. subject to regulations, as are ponds and wetlands fed by canals. Drainage separation structures in the vicinity of the canals may also need a Department of the Army permit.

2.7 Potential ESA Issues

In regards to potential endangered species issues the current recommendation of the United States Fish and Wildlife Service U.S.F.W.S, is to compare the habitat of the study area with that required for the federally listed endangered (E) and threatened (T) species on the El Paso County Endangered Species List. The list currently contains the six following species: bald eagle (*Haliaeetus leucocephalus* T), black-footed ferret (*Mustela nigripes* E), greenback cutthroat trout (*Salmo clarki stomias* T), Mexican spotted owl (*Strix occidentalis lucida* T), Preble's meadow jumping mouse (Zapus hudsonius preblei T), and Ute ladies tress orchid (*Spiranthes diluvialis* T). With the exception of the Preble's meadow jumping mouse, each one of these species have special habitat requirements that are not met in the study area, such as open lake shorelines, perennial water, moist wet meadows, riverine sandbars or mudflats, high altitude habitat, cliffs, forested vegetation, thick riparian vegetation, or lake or river systems. Consistent with the U.S.F.W.S endangered species habitat requirements, no endangered threatened species is likely to occur in the area.

2.8 Environmental Resource Review Conclusions

Presented in the DBPS are the floodplain, environmental resources and stream classification marked as wetlands, waters of the U.S., open water, and irrigation ditches may be subject to U.S.A.C.E. regulations. Riparian ecosystems impacted in conjunction with permitted activities may also need replacement. Detailed wetland delineation will need to be done in areas where drainage outfall systems are proposed in potential jurisdictional areas and evaluated in relation to permitting requirements in affect at the time of construction.

2.9 Stream Characterization

Mussetter Engineering, Inc. (MEI), under subcontract to Kiowa Engineering Corporation, conducted this initial assessment of bankfull channel capacity at 10 locations within the Jimmy Camp Creek watershed. The purpose of the assessment was to determine whether there is a consistent relationship between the channel capacity and a flow of a specific frequency (1- to 2-year recurrence interval). However, in arid and semi-arid regions of the U.S., there is less likely to be a direct correlation between the channel capacity and a flow of a given recurrence interval because of the absence of continuous interaction between the flows and the channel boundary materials.

Flood-frequency and flow-duration curves were developed from the annual peak flow data (1976-2006) and the mean daily flow records (1976-2006), respectively, from the Jimmy Camp Creek at Fountain, Colorado (USGS Gage No. 07105900) that is located immediately downstream of the Ohio Street crossing. At the gauging station, the contributing drainage basin area of Jimmy Camp Creek is approximately 66.4 square miles.

The 10 sites within the Jimmy Camp Creek drainage basin were selected to encompass a reasonable distribution of drainage areas in order to test the hypothesis that the capacity of the channels was related to a particular flow magnitude that was in turn related to the contributing drainage area. Site selection was constrained to some extent by land access, but the selected sites range in size from 0.7 to 67.2 square miles. At each of the sites, a straight, single-channel reach with a reasonably well-defined channel cross section that was likely to contain the full range of low to moderate flows was selected for survey. Reach lengths varied from 100 feet to 417 feet. Prior to surveying the site, channel cross sections were identified and the top-of-bank stations on both sides of the channel were identified and the top-of-bank stations on both sides of the channel were identified with pin flags. Topographic (bank heights, materials, angles and continuity) and botanical (lower limits of perennial vegetation species) criteria were used to establish the top-of-bank stations at each cross section. The channel capacity is equivalent to the term "bankfull capacity" but there is no prior assumption of return period associated with use of the term.

3.0 Stream Characterization Conclusions

The results of this initial assessment of channel capacity in the Jimmy Camp Creek watershed indicate that there is not a statistically valid relationship between the capacity of the channel and the contributing drainage area that can be used to evaluate the magnitude of the low magnitude high frequency peak flows in the watershed. The primary reason for the lack of a relationship is most likely the fact that the flow regime at the sites located upstream of Link Road is ephemeral, whereas at the sites located downstream of Link Road the flow regime is perennial. The spatial distribution of the geologic and soil conditions within the elongated watershed appear to affect the magnitude of the flows and hence the size of the channels. The upper basin sites have relatively high unit discharges because of the presence of less permeable geologic and soil units, whereas the middle and lower basin sites where the soils are highly permeable have much lower unit discharges that are reflected in the smaller sizes of the channels. Given these conditions within the basin it is highly unlikely that the addition of more data will improve the relationship.

The measured bank-full capacities can provide guidance on the acceptable release rates from new development to better maintain historic channel characteristics. If the bank-full capacities as determined in this analysis are maintained then the existing channel sections can be preserved even in the developed basin condition. This could lead to significant savings in terms of future channel improvement costs however grade control will still be required to maintain the longitudinal invert gradients to stable levels.

3.1 Development of Alternatives

Alternative concepts were examined that address the existing and future stormwater management needs of the basin. Alternatives have been identified for the major drainageway and flow paths within the major sub-watersheds. Quantitative and qualitative comparisons are presented, and a recommendation made as to which concepts are most feasible to advance to preliminary design and eventually implementation. The general planning goals to be achieved during the alternative evaluation phase are:

1. Identify stormwater management methods and facilities that will reduce flood hazards and damages;
2. Identify stormwater management methods and measures that will prevent future flooding within the watershed and within in future urbanized areas.
3. Provide stormwater management within developing areas of the basin in order to reduce the detrimental effects of urban runoff;
4. Provide stormwater facilities that preserve and/or enhance the existing drainageway and areas adjacent to the drainageway that provide valuable environmental resource in the area;
5. Identify facilities which will minimize future operations and maintenance costs; and
6. Provide stormwater management facilities that will at least maintain and/or enhance the water quality characteristics of the basin.
7. Provide for stormwater conveyance facilities that are consistent with the intent of the City of Colorado Springs streamside ordinance so that the relationship of the stream to the development occurring adjacent to the major drainageways of the Jimmy Camp Creek watershed will provide multiple use and open space benefits to the future residents of the City. Planning goals were developed through an agency/individual stakeholder process. Common and/or mutual goals of the interested agencies were identified prior to the initiation of the alternative evaluation phase.

As part of developing the alternatives for storage and channel treatments to be recommended for the Jimmy Camp Creek basin, hydrology and hydraulic analyses were conducted. The results of these analyses produced conclusions that are beneficial in focusing the alternative development process. A few of the key findings of the hydrologic and hydraulic analyses were:

1. The rainfall analysis conducted for selected storms in the Jimmy Camp Creek basin shows that the higher frequency events such as the 2- and 5-year storms, are highly random in their coverage, location and duration. A wide array of storms can occur over the basin that can produce 2- and 5-year level rates of runoff as measured at the Ohio Avenue stream gage.
2. The calibration of the hydrologic model and associated analysis indicates that the higher frequency storms need to be evaluated using an antecedent moisture condition of I in order to achieve a reasonable correlation between the hydrologic model and gage data at Ohio Avenue for peak and volume. The calibration effort also shows that a shorter duration storm needs to be considered when evaluating the higher frequency events, as the 24-hour duration is not supported by the rainfall data analysis or the stream gage data.
3. The stream characterization analysis revealed that there is not a strong correlation between storm frequency and bankfull capacity mainly due to the physical nature of the watershed and its major drainageways. However the measured bankfull capacity can help to identify the discharges associated with the 2- to 5-year year events and associated sizing of low flow conveyance parameters for the major drainageways.

3.2 Alernative Concept Evaluation Parameters

Stakeholder meetings were held throughout the planning process in order to discuss the overall goals of the study and to solicit specific concerns from governmental agencies, individuals, major landowners and private community groups. One result of this coordination effort was the development of the following list of parameters that should be considered when evaluating alternative storm water management concepts:

-Flood hazard management	*-Open Space/recreation/trails*
-Flood control	*-Land use impact*
-Operation and maintenance	*-Stormwater quality*
-Sustainability	*-Environmental/habitat impacts*
-Right-of-way acquisition	*-Administration/ implementation*

By reviewing the relative impact of future storm water runoff upon the major drainageways, the evaluation parameters were ranked by importance relative to each other. As a result of the development and review of the evaluation parameters, the parameters viewed as being of high importance were flood control, opens space/recreation and trails, operations and maintenance, stormwater quality, environmental impact and sustainability. Those that have moderate importance were land use and administration and implementation. The high and moderate importance parameters were be used to screen each concept's relative impact upon each parameter and allow for the selection of a most feasible concept.

3.3 Watershed Storage System Alternatives

A review of the various methods to limit the impact of urbanization upon the rates of stormwater runoff were evaluated with respect to the key planning parameters as listed above. Based upon the technical work, field visits, and meetings with the interested agencies and individuals alternative storage concepts were developed.

As presented in the hydrology chapter of this report, it has been estimated that peak discharges and volumes will increase along all of the major drainageways of the watershed as a result of urbanization. A key impact that urbanization will have upon the basin hydrology is that "everyday" rainfall events will result in runoff that formerly would not have increased the peak discharge, the frequency, and the duration or the runoff event. Most of the major drainageways are now unlined and natural in their section. Increases in runoff peak and volume for the higher frequency storms will create greater instability in the existing natural sections. In combination with the decrease in the natural sediment supply caused by urbanization, the increase in the rates and duration of the higher frequency events will cause the major drainageways to become unstable. Detention schemes were analyzed in the alternative planning process in order to address this situation. Three sub-categories of detention storage were considered to be feasible within the Jimmy Camp Creek basin. These were:

Sub-Regional and Regional Detention
Onsite detention
Full-spectrum detention

A discussion related to the relative advantages and disadvantages for each of the general storage concepts is contained within the DBPS.

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Regional or sub-regional detention manages the increase in runoff volume due to urbanization at relatively few locations and therefore many segments of the receiving drainageways will carry un-detained discharges. While none of the detention concepts can reduce the total volume of runoff, regional or sub-regional detention if implemented will require that the major drainageways be protected from the detrimental effects of the increase in volume and associated peak discharges for all frequencies.

Onsite detention involves the provision of small storage areas that serve individual parcels or developments so that discharges to downstream drainageways are maintained at historic rates. This concept works best in small sub-watersheds where no regional sites are available or wherever there may be capacity constraints in existing downstream stormwater systems. This concept manages the increase in runoff volume due to urbanization at its point of origin. e than 40 acres in tributary area. El Paso County has required onsite detention when downstream conveyances are not available, a common occurrence in rural and developing urban areas or where concepts embodied in a regional planning study have not as yet been implemented. The City of Colorado Springs has required onsite detention to be implemented where downstream conveyances and capacity is not adequate, but in general does not encourage onsite detention storage.

Full spectrum detention has recently come to the forefront as a method system for urban storm water management. This concept addresses the problem outlined above under Onsite Detention with respect to the negative impact upon the receiving major drainageways. These facilities can serve small parcels as well as act on more of a regional basis. Full spectrum detention manages the increase in runoff due to urbanization by holding the increase volume over an extended period of time so as to not cause the release from each individual full spectrum basin to accumulate to peak levels greater than existing conditions. Depending upon land use full spectrum detention storage cannot practically serve tributary areas greater that around 300 acres. By releasing runoff from the storage pool at very low rates, the additive nature of releases similar to that from onsite basins can be mitigated for since the outlet hydrograph mimics the existing hydrograph in peak for all frequencies of runoff events, not only the 5-year and 100-year events. Water quality storage would have to be provided for separately in a sub-regional or regional detention concept. Fountain, Colorado Springs and El Paso County have each adopted criteria for FSD and is requiring that FSD be implemented on future land development projects.

The hydrology related to the impact that FSD can have on a watershed was analyzed as part of the development of the DBPS. Full spectrum storage facilities were analyzed for the 1.6 square mile Blaney Tributary in order to determine if FSD could in fact reduce peak discharges to historic rates for all frequencies. A multiple FSD system was modeled for the Blaney Tributary in order to assess the capability of a FSD system to maintain developed rates runoff to pre-development conditions for all frequencies. The results of this analysis are presented in the Hydraulic Technical Addendum to the DBPS. A methodology of sizing a FSD was developed that is based upon the City/County DCM. It was found that a multiple facility FSD detention system was able to maintain developed rates of runoff to at or below pre-development conditions for all frequencies. The analysis of FSD completed for this study provided confidence that it is a feasible concept and some guidance about how it could be implemented.

Feasible concepts were developed for the storage of urbanized runoff for each reach of the major drainageways and were evaluated as to each concept's compatibility or impact upon each of the evaluation parameters listed above. Relative impact was assigned to each concept as to low, neutral and high. Relative impacts have been judged between each for the three storage concepts. Tables that are contained in the DBPS summarize the evaluation of each of the three storage concepts. Based upon this qualitative ranking, FSD was found to be the most viable solution in addressing the impact of urbanized runoff within the Jimmy Camp Creek watershed.

3.4 Cost Comparison of Storage Alternatives

Though the cost to construct and acquire land for detention basins was not one of the parameters used to evaluate the relative impacts of each alternative storage concept, a cost comparison between a sub-regional, regional and FSD storage has been prepared. In order to compare the three storage concepts with respect to cost and land acquisition actual construction costs for regional and sub-regional detention storage basins was developed using data for seven detention basin ranging size from 11 to 205 acre feet. This data is summarized on Table V-4 contained in the DBPS.

The cost attributable to water quality for those regional and sub-regional detention basins where water quality storage was provided was taken out of the overall unit cost estimate. Since water quality storage is required in the City/County DCM, the total volume of water quality storage that would have to be provided offsite from the sub-regional or regional detention basins needs to be estimated. The average developed percent imperviousness for the Jimmy Camp Creek watershed was calculated to be 57.5 percent.

For the regional detention concept a total storage of 1,172 acre-feet (1,139 acres and 33 acres regional and sub-regional sized detention basins, respectively) was used to develop the total storage cost for the regional concept. For the sub-regional detention concept a total of 1,146 acre-feet (540 acres and 606 acres regional and sub-regional sized detention basins, respectively) was used to develop the total storage costs for the sub-regional concept. Using the unit costs and volumes described above the results were:

Regional system with off-site water quality storage:	**$43,121,500**
Sub-regional system with off-site water quality storage:	**$44,227,700**

In order to estimate the total storage required for the FSD system, the analysis prepared for the City and described previously in this report was used to determine the total cost of a FSD system. Since FSD storage basins provide water quality there is no need to account for the cost of offsite water quality storage when estimating the total cost for a FSD system. It was estimated that a total of 2,100 acre-feet of FSD storage would be required for the watershed by applying the unit full spectrum storage of .066 acre-feet per acre.

FSD system: **$51,117,000**

While FSD may be costlier and require more land as compared to the regional and sub-regional concepts, the following circumstances were taken into consideration in evaluating the storage concepts:

1. Because FSD manages the discharge of urban runoff to the major drainageways in such a way that resembles the pre-development condition, there will be less need to provide horizontal and vertical stabilization along the receiving drainageways as compared to the other storage concepts. Both the regional and sub-regional systems will require that extensive reaches of the major drainageways within the Jimmy Camp Creek watershed be enlarged and horizontally and vertically stabilized since they will be conveying fully developed runoff up to and between the detention basins. The 10 percent cost difference between the FSD and regional/sub-regional detention schemes will be exceeded by costs required to enlarge the channel and stabilize the banks along receiving drainageways in the regional/sub-regional detention scheme, costs that will not be incurred in a FSD system.
2. One of the major disadvantages of a regional/sub-regional system is that the storage facilities often lie offsite from the where development may be occurring, especially in the early stages of the development. This situation can cause extreme problems in the phasing of the infrastructure, and in the financing of the construction of an offsite facility. This can cause significant delays in the implementation of regional/sub/regional facilities and in the interim can subject the receiving drainageways to urbanized flows. This in turn forces the need to enlarge and stabilize drainageways that may also be offsite from the area of development and many times on ownerships lying downstream of the developing parcels.
3. The land requirement for of FSD is around 33 percent and 9 percent greater for the FSD concept as compared to the regional and sub-regional systems, respectively, the parcels associated with FSD will be much smaller in general (say 5 to 20 acres) than the parcels that may be needed for a regional or sub-regional facility (20 to 80 acres). The sites for regional and sub-regional sites are limited to relatively few locations within the watershed whereas FSD sites can be integrated within or very close by the location of development. This is particularly advantageous in the earlier stages of urbanization. Since regional and sub-regional systems have the inherent problems associated with phasing and implementation, establishing a timeframe for land acquisition is extremely difficult and the future cost of the land cannot be accurately determined in the context of a DBPS. Land for FSD facilities would be able to be acquired or dedicated through normal land development processes.
4. A regional or sub-regional system will almost certainly require that a detention storage and land acquisition fee be established for the basin. This is because a regional or sub-regional system will collect runoff from varying types of land uses and significant numbers of property owners. This may lead to property owner and developer concerns related to the establishment of an equitable fee system.
5. Should FSD be fully implemented and the result is that discharges remain at existing levels there may not need to be the need to revise those segments of Jimmy Camp Creek and its major tributaries that have had detailed flood plain studies that are presently shown in the City of Colorado Springs, City of Fountain and El Paso County flood insurance studies.
6. Because there is very limited impact upon peak discharges that would result from the implementation of a FSD storage concept, the existing environmental resources along the major drainageways will not be adversely impacted.
7. Although none of the proposed storage schemes reduce runoff volumes from developed areas, FSD provides some mitigation of increased runoff volumes by releasing the excess volume over an extended period of time and at less erosive flow rates.
8. Eventually development will significantly reduce the area from which sediment is made available for transport by the drainageways no matter which storage scheme is applied. However FSD will increase the likelihood that sediment transport rates will continue at pre-development conditions over a longer period of time.
9. The City of Colorado Springs presently has a MS4 permit with the State of Colorado. To be in compliance with its MS4 permit the City requires that water quality storage be achieved off-stream. FSD basins can be sited in most cases off-stream whereas regional detention storage cannot. Water quality storage would be required onsite in the regional or sub-regional detention alternatives.

3.5 Major Drainageway Conveyance Alternatives

At this time the majority of the major drainageway reaches of Jimmy Camp Creek and its major sub-tributaries are unimproved. Where channel stabilization measures have been constructed, they occur mostly at the approaches and exits at roadway crossings. As determined in the hydraulic analysis of the existing floodplains there are several locations, mostly within reaches J1 through J3, where the existing channel banks are not of sufficient height to contain the 100-year discharge without overtopping and causing areas of extremely wide floodplains. While this is not a problem for the watershed at present, these wide uncontrolled floodplains will have to be addressed as the land develops. Since it has been concluded that FSD is the most viable storage alternative to pursue, existing condition hydrology can be assumed when the sizing of major channel conveyances are carried out. Accordingly these two major drainageway concepts were evaluated.

Floodplain preservation: This concept involves leaving the floodplains along the receiving drainageways un-encroached and in their natural cross-section with stabilization of the low flow channel. The viability of this concept depends heavily upon the stability of a drainageways' existing section that is in turn related to the natural floodplain's width, velocity and depth of flow. .

Channelization: This concept involves reconfiguring the natural section to convey in a conventional trapezoidal channel the 2-year through 100-year rates of runoff through the watershed and outfall to Fountain Creek. Since the low flow area of the major drainageways is generally well defined, a benched trapezoidal section appears to be a feasible section to implement. This type of conveyance would be required to be configured to avoid or minimize the disturbance of existing vegetation. Where disturbances occur riparian habitat can be introduced on the benches of the channel section.

Grade control will be needed along all reaches in order to maintain a maximum longitudinal slope of approximately 0.4 percent. The spacing of grade controls will be dictated by the location of hydraulic structures such as bridges and culverts and as the gradient increases, most notably in the upper segments of Jimmy Camp Creek (reaches J6 and J7) and in reaches E3, S2 and C4. Presented on Table V-6 of the DBPS is matrix that summarizes the qualitative evaluations of the floodplain preservation and channelization concepts.

3.6 Drainageway System Alternatives Conclusions

Based upon the alternative evaluation process it is recommended that the both of the channel concepts be advanced for further consideration. The floodplain preservation concept should be considered the default alternative so that the beneficial effects of the floodplain preservation concept, such as flood storage and habitat preservation, are maintained and assured. In this regard the implementation of a floodplain preservation concept does not constitute a loss of developable land since developing within the flood fringe areas will reduce the potential for natural flood storage that could negatively impact the watershed in areas below such encroachments. The channelization concept should only be applied in those drainageways segments where flood damages could now occur and where the 100-year floodplain is wide and uncontrolled such as in the vicinity of Peaceful Valley Road.

The floodplain preservation concept is most applicable in the upper segments of Jimmy Camp Creek and the major sub-tributaries. Floodplains in these segments are much narrower and confined. As development proceeds adjacent to floodplains, it may be necessary to stabilize existing banks at outside bends to prevent lateral migration. Both of these concepts are made feasible because of the establishment of FSD in the basin. The increase in base flow will be a benefit to existing vegetative habitat along the low flow thread of the stream and will not only help to sustain existing riparian and wetland species but promote the spread of these same species over time. Cost comparisons have been provided in the DBPS for each of the channel alternatives.

The impact upon conveyance right-of-ways was also assessed for each of the storage alternatives. For the segment of Jimmy Camp Creek under analysis, the total acreage needed for a benched channel section regional detention was estimated at 50 acres. The floodplain acreage in this segment was estimated at and 85 acres for the FSD storage concepts. While a significant reduction in acreage could be afforded by the use of a benched channel section, the cost of earthwork associated with forming a benched section could drive the unit cost of a benched channel significantly higher as well.

Based upon the analysis described in the DBPS if FSD is implemented with floodplain preservation and low flow channel stabilization, the additional storage costs associated with FSD will be more than offset by the savings in major drainageway conveyance and grade control costs as compared to the regional detention scenarios.

3.7 Selected Conceptual Design Plan

The results of the conceptual design analysis are summarized in the DBPS. The alternative improvements were qualitatively evaluated, and presented to the project sponsors, stakeholders interested agencies and individuals through periodic public and technical progress meetings. Field review of specific areas of concern has been conducted in order to refine the channel treatments suggested for use along the major drainageways and flow paths.

Past and current versions of the City of Colorado Springs and El Paso County Drainage Criteria Manual were used in the development of the conceptual sections and plans for the major drainageways within the Basin. The criteria and methods summarized City/County Drainage Criteria Manual was supplemented by various other manuals. These were:

1. Urban Storm Drainage Criteria Manual, Volumes I, II, and III prepared by the Urban Drainage and Flood Control District.
2. City of Fountain Department of Public Works Standard Specifications and Subdivision Criteria Manual.

3.8 Hydrology

Presented on Table III-10 in the DBPS report and this Executive Summary are peak discharges for the 2-, 5-, 10- and 100-year recurrence intervals. The peak flow data for the **existing development** conditions were used to determine the extent of the 100-year floodplains and to size drainageway conveyances and road crossings. The discharges summarized on Table III-10 for the 5- and 100-year frequencies are presented on the profile of the conceptual design plans contained at the rear of this report. The 2- and 5-year recurrence interval discharges were determined using a 6-hour Type IIA storm pattern and an antecedent moisture condition of AMC-I. The 10 through 100-year discharges were determined using a Type II storm distribution. Estimation of existing condition flow rates at additional design points may need to be determined as more detailed studies are prepared in support of land development activities.

3.9 Detention Storage

The recommended conceptual plan for storage of urbanized runoff for the Jimmy Camp Creek basin is to provide full spectrum detention (FSD) basins. The storage facilities will have a wide range in storage volume, however based upon the analysis a storage volume of 50 acre-feet and a tributary area of approximately 150 acres, depending upon the proposed land use within a FSD watershed are considered as maximum parameters for planning purposes. Approximately 2,100 acre-feet of storage will be needed within the watershed at full build-out of the basin. Planning for the locations of FSD storage basins needs to be addressed during the **master development drainage plan** phase of a land development project. The rational for recommending that FSD be implemented in the Jimmy Camp Creek watershed was summarized in Chapter V of the DBPS.

Presented with the selected conceptual design plan drawings contained in the DBPS and this Executive Summary is a layout for a typical FSD. The outlet structure needs to be sized so as to release the EURV within a 60 to 70-hour period. The perforated plates used to control the discharge of the EURV can be sized using the method explained in Volume II of the DCM. The outlet structure also needs to be sized to limit the 5- and 100-year discharges to the existing development condition. The final layout and design for a FSD will be dependent upon the location of future roadways and the layout of major land developments. It should be encouraged that FSD basins be sited so that the design may take advantage of roadway embankments, natural depressions and sump areas and existing wetland and/or riparian areas. They should be sited whenever possible so that the can be comingled with open spaces within future master planned land developments and park sites. It is recommended that all of the FSD basins that will be constructed in the watershed become publically or quasi-publically (e.g., metropolitan districts) owned and operated as these structures form such a critical element of the stormwater management plan for the watershed.

3.8 Major Drainageways

In general, the floodplain preservation concept has been selected as the primary conveyance system for Jimmy Camp Creek and it major sub-tributaries. This conveyance system would encourage the preservation of the floodplains as depicted on the conceptual design plan and profiles. The floodplain shown on the conceptual plans was determined using the 100-year existing condition hydrology as summarized in Table III-10. Selective locations such as at outside bends of the floodplain and at approaches and exits of roadway crossings may need to be protected with soil/riprap bank linings. The location of selective bank lining has been shown on the selected conceptual design plans contained in the DBPS. Typical major drainageway details have been provided in the DBPS and this Executive Summary.

3.9 Sub-drainageways

The conceptual planning for the watershed also included the evaluation of sub-drainageways, that is, those drainageways that are not shown on the Conceptual Design Plan and Profiles and those drainageways that collect and convey runoff from sub-basins greater than 100 acres. Summarized on Tables VI-1 through VI-5 is design data for each sub-drainageway that collect and convey runoff from areas generally greater than 100 acres. The sub-drainageways will almost always lie downstream of a FSD storage basin.

4.0 Grade Control

Grade control structures have been conceptually sited along the major drainageways and appear on the Conceptual Design plan and profiles contained in the DBPS. These structures are required to achieve and/or maintain the design slope, or to maintain the invert of a channel that is proposed to remain natural. Grade control may be needed at approaches to roadway crossings in order to gain headroom for the culvert as it passes beneath the roadway. Sloping drops are recommended and should be constructed out of grouted boulders. Maximum drop height for the stabilization of the low flow channel associated with the floodplain preservation concept was limited to three feet.

4.1 Water Quality

Improvement of urban stormwater quality has become an important issue in drainage basin planning. Many pollutants are naturally associated with sediments that enter sensitive receiving waters. The pollutants are naturally occurring compounds that are carried to the drainageways in storm runoff. Other pollutants are the result of urbanization such as lawn chemicals, oil and grease, pet feces, lawn clippings and other items. The primary active water quality measure identified in this DBPS will be a capture pool inside each of the FSD basins. An advantage of the FSD basin is that it combines the water quality capture along with the EURV storage pool. The EURV should be determined using the methods outlined above and should have an outlet structure that will release the EURV volume over a 70-hour period.

4.2 Trails

As mentioned in the DBPS providing multi-use trails along the drainageways is desirable especially along the main stem of Jimmy Camp Creek and its major sub-tributaries. While providing access to the channels for maintenance, these trails could provide access to the other regionally planned trails, provide linkages through open spaces between smaller parks and opens spaces, and provide linkages between the opens spaces created by the FSD storage basins. Trails alongside or within a floodplain will need to be located so as to provide maintenance access to the low flow but will need to be planned so that they minimize or avoid impact to riparian vegetation that may exist within the floodplain subject to preservation. The layout of a trail along a drainageway should be carried out taking into account hydraulic considerations, utilities in the area, access to dedicated parks and roadway crossings. Trails can meander within the floodplain or channel benches as well.

4.3 Maintenance and Re-vegetation

Maintenance of drainageway facilities is essential in preventing long term degradation of the creek and overbank areas. Along the drainageways, clearing of debris and dead vegetation should be considered within the low flow area of the creek and its tributaries. Trimming and thinning of shrubs and trees should be carried out if greater visual and physical access to the floodplain and low flow area is desired. On the overbanks, limited maintenance of the existing vegetative cover is recommended. Yearly clearing of trash and debris at roadway crossings is also recommended to ensure the design capacity of the crossing, and to enhance the crossings for trail users if a trail exists. In reaches that are to be selectively lined or the floodplain is to be preserved maintenance activities should be carried out while minimizing the disturbances to native vegetation.

The maintenance of the appurtenances within FSD basins should be carried out twice a year at a minimum to assure proper functioning of the EURV outlet structure. Trash racks and perforated plates should be cleared of debris. Sediment that has accumulated in the micro-pool and pre-sedimentation basins should be removed bi-annually as well. It is recommended that the full spectrum detention basins if built in accordance with the design standards and criteria should become the long-term responsibility of a public or quasi-public entity. Proper function of the FSD's is a critical element of the overall plan for stormwater management within the Jimmy Camp Creek basin.

4.4 Right-of-way

For the most part the main channels within the watershed that pass through the developed portions of the basin should be contained within dedicated drainage tracts, easements or right-of-ways. For FSD basins the right-of-ways or tracts should at a minimum encapsulate the 100-year storage pool. The land underlying the facility should be dedicated to the appropriate public agency so that maintenance access is assured. For those segments of the drainageway where floodplain preservation is the recommended plan, a combination of open space dedication (such as parklands and greenbelts), in combination with a more narrow dedicated right-of-way along the low flow area of the drainageway should be obtained through the land development process.

4.5 Plan Implementation

The results of the analyses summarized in the DBPS represent a concept level design process. The selected plan improvements shown on the conceptual design drawings will be subject to refinement as the development of the land within the Jimmy Camp Creek Basin commences. The size and location of the channel conveyances will have to be determined based upon a higher level of engineering analysis that is typically carried out during the preparation of the master development drainage and final drainage planning reports. It is an underlying intent of the selected to plan to preserve to the greatest extent practical the existing condition 100-year floodplain and environmental resources that exist therein. It will be important that the major drainageway channel conveyances that have been identified in this DBPS be followed and major deviations from the concepts presented herein should be discouraged when land development applications are made to the City of Colorado Springs.

With respect to FSD as presented in this DBPS, the location of future FSD basins will be refined during the land development process. Guidelines for locating FSD's have been provided in previous sections of the DBPS. If implemented, FSD will result in the limitation of peak discharges released from developing areas to pre-development conditions. As such, the future major drainageway conveyances and road crossings need only to be designed to be able to carry the pre-development condition discharges. Consolidation of FSD sites should be encouraged in order to limit long-term maintenance costs so long as the intent of the FSD system is achieved. Implementation of the concepts in this DBPS will reduce the level of planning and engineering that will be required during later drainage planning phases associated with the land development process.

4.6 Cost Estimates

Presented on tables within the DBPS are costs estimates for the major drainageway conveyances for Jimmy Camp Creek and its major sub-tributaries within the City of Colorado Springs. There has been no cost estimate made for local storm sewer systems. An estimate for the cost to replace roadway crossings found to be deficient when the hydraulic analysis was prepared has also not been made in this DBPS. Unit costs applied when calculating the conveyance costs are prepared on the tables. The estimated cost of the FSD basins was presented in Chapter 5 of the DBPS. The cost and acreage data associated with FSD has been provided in the DBPS and used in the development of a storage fee. Since the effect of implementing the FSD alternative is to maintain rates of runoff to be conveyed by the receiving drainageways to pre-development conditions it is has been concluded to be reasonable to spread only the cost of the major drainage conveyances in amongst all un-platted property within Colorado Springs.

The total cost for future roadway culverts and bridges has not been made in this DBPS. This is primarily because the number and location of the future roadway crossing cannot be accurately determined at this time. All future roadway crossings should be sized to convey the pre-development condition discharge. There is therefore no additional cost associated with providing a greater carrying capacity because of increased runoff due to development.

4.7 Unplatted Acreage

Presented on Figure VII-1 of the DBPS are the jurisdictional limits and corresponding acreage of the three governmental entities in the Jimmy Camp Creek watershed. Presented on DBPS Figure VII-2 are the un-plattable acreage that lies within the City of Colorado Springs, City of Fountain and El Paso County. Using El Paso County Tax Assessor maps, plats and ownership records the amount of un-platted and developable acreage was estimated. From these records the following total un-platted acreages were determined:

City of Colorado Spring outside BLR	**148 acres**
City of Colorado Spring inside BLR	**13,341acres**
City of Colorado Springs Total	**13,489 acres**
El Paso County	**14,018 acres**
City of Fountain	**664 acres**

The plattable acreage shown on Figure VII-2 excludes the existing 100-year floodplains, large regional parks, school sites and public utility easement corridors Land that is already platted has not been accounted for in the estimate of the plattable acreage unless the platted parcel exceeded 15 acres in size. Most of these large acreage platted parcels occur within the County.

The weighted percent imperviousness was estimated for the entire watershed. Based upon the land use planning information accumulated and applied in this DBPS, the weighted percent imperviousness for the watershed was determined to be 57.5 percent.

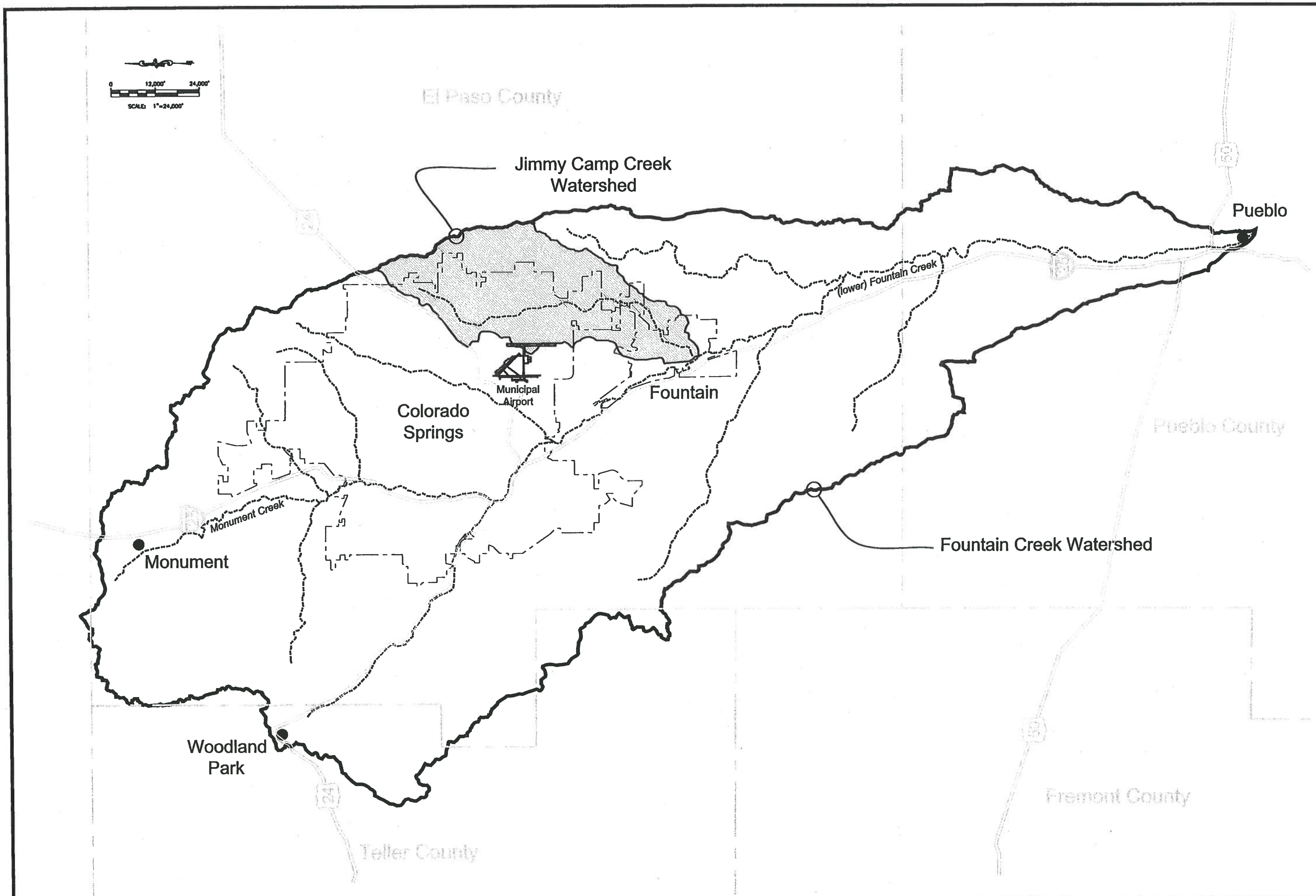
4.8 Unit Drainage Fees

Presented on Table VII-3 of the DBPS and this Executive Summary are the unit major drainageway and FSD storage fee calculations for the City of Colorado Springs. All of the improvements that were used in the calculation of the unit drainage costs are considered public facilities subject to maintenance by the Colorado Springs in accordance with this DBPS and applicable drainage criteria. The unit drainage costs can be used to structure a fee system for the Jimmy Camp Creek watershed to replace the present fee system that has been established using the 1987 Wilson DBPS. It is recommended that a drainage fee be established within each of the jurisdictions to cover the capital improvement costs associated with the stabilization of the major and sub-drainageways identified in this DBPS. Since FSD is the selected storage option for the watershed, it may be possible to have the fees associated with the unit drainage costs accumulate during the initial phases of land development until such time that major drainageway or sub-drainageway stabilization is needed. Having the drainage fund accumulate by not requiring a developer to install major drainageway improvements during the initial phase of the land development process will help the keep the drainage fund from becoming immediately in debt. It will also give the City time and some greater flexibility in focusing the capital improvement funds generated by the fee system. Managing the fees system in this way may also help the land development process by not front-end loading the very initial phases of development with the costs of major and sub-drainageway improvements that could very well be offsite from the land development activity itself.

The FSD storage cost can be used to develop a FSD storage fee. The unit storage fee can be assessed at the time of platting if the parcel subject to platting is so limited in size as to not to be feasible to site a regional FSD. In developing the FSD unit storage fee, 15 percent has been added to the unit acre-foot construction cost presented on Table V-4 of the DBPS. Fees that accumulate in the FSD storage fund could later be used to reimburse a property owner that would be required because of its size to construct and FSD. It is however preferable to construct the regional FSD's at the earliest possible time during the development of a sub-watershed so that the impact of develop runoff on the receiving drainageway is mitigated.

Because the land area within the watershed and that is within the City is owned by one major land holder, it may be feasible to "close" the basin to fees. This would then end the need to collect drainage and FSD fees at the time of platting land. Accordingly, no reimbursement for any public major drainageway or FSD facilities would occur.

A bridge fee has not been calculated for this watershed. This is primarily because the number and location of bridges cannot be accurately determined, and the fact that any bridge or major roadway crossing would only have to be sized to convey pre-development condition discharges. In this regard, the cost of a bridge or culvert associated with a future road is based on the need for transportation and not storm water conveyance. It may be necessary to establish some form of interim fee to cover the cost of reimbursements already established under the present Jimmy Camp Creek bridge fee system.



JIMMY CAMP CREEK WATERSHED
DRAINAGE BASIN PLANNING STUDY
VICINITY MAP
CITY OF COLORADO SPRINGS

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Table III-10
Hydrology Results - Peak Flows

Existing Conditions

			24hr - AMC2		6hr - AMC1	
Location	Area (sq.mi.)	Model ID	Q100 (cfs)	Q10 (cfs)	Q5 (cfs)	Q2 (cfs)
Outfall to Fountain Creek	67.11	DP-J1	22,094	9,443	438	112
Ohio Avenue	66.11	DP-J3	22,139	9,447	441	113
Link Road	60.93	DP-J9	21,878	9,310	447	114
Confluence with West Fork	59.77	DP-J12	21,875	9,296	451	116
Confluence with East Fork	53.92	DP-J16	21,784	9,243	455	122
Peaceful Valley Road	44.16	DP-J17	17,709	7,731	385	105
Confluence with Marksheffel Trib	41.99	DP-J21	17,361	7,667	386	108
Bradley Road	36.64	DP-J22	16,502	7,153	374	106
Confluence with Franceville Trib	36.19	DP-J23	16,422	7,119	377	108
Confluence with Corral Trib	31.60	DP-J24	15,382	6,834	378	110
Drennan Road	14.84	DP-J25	5,881	2,509	163	56
*** areal adjustment not applied to rainfall for drainage areas less than 10 square miles ***						
State Highway 94	9.62	DP-J31	5,031	2,300	210	76
Confluence with Blaney Trib	6.39	DP-J40	4,107	1,959	202	76
Jimmy Camp u/s of Blaney	4.67	DP-J41	2,773	1,245	116	48
Corral Tributary	8.25	DP-C4	6,212	2,885	197	52
East Fork Tributary	9.77	DP-E1	4,677	2,030	123	30
Marksheffel Tributary	5.18	DP-M1	1,916	832	42	12
Strip Mine Tributary	5.18	DP-SM2	4,627	2,451	248	98
Franceville Tributary	4.23	DP-F5	1,515	640	28	8
C and S Tributary	2.07	DP-CS1	1,770	898	72	19
Blaney Tributary	1.55	DP-B1	1,927	1,102	131	61
Ohio Tributary	1.22	DP-O1	661	268	4	0

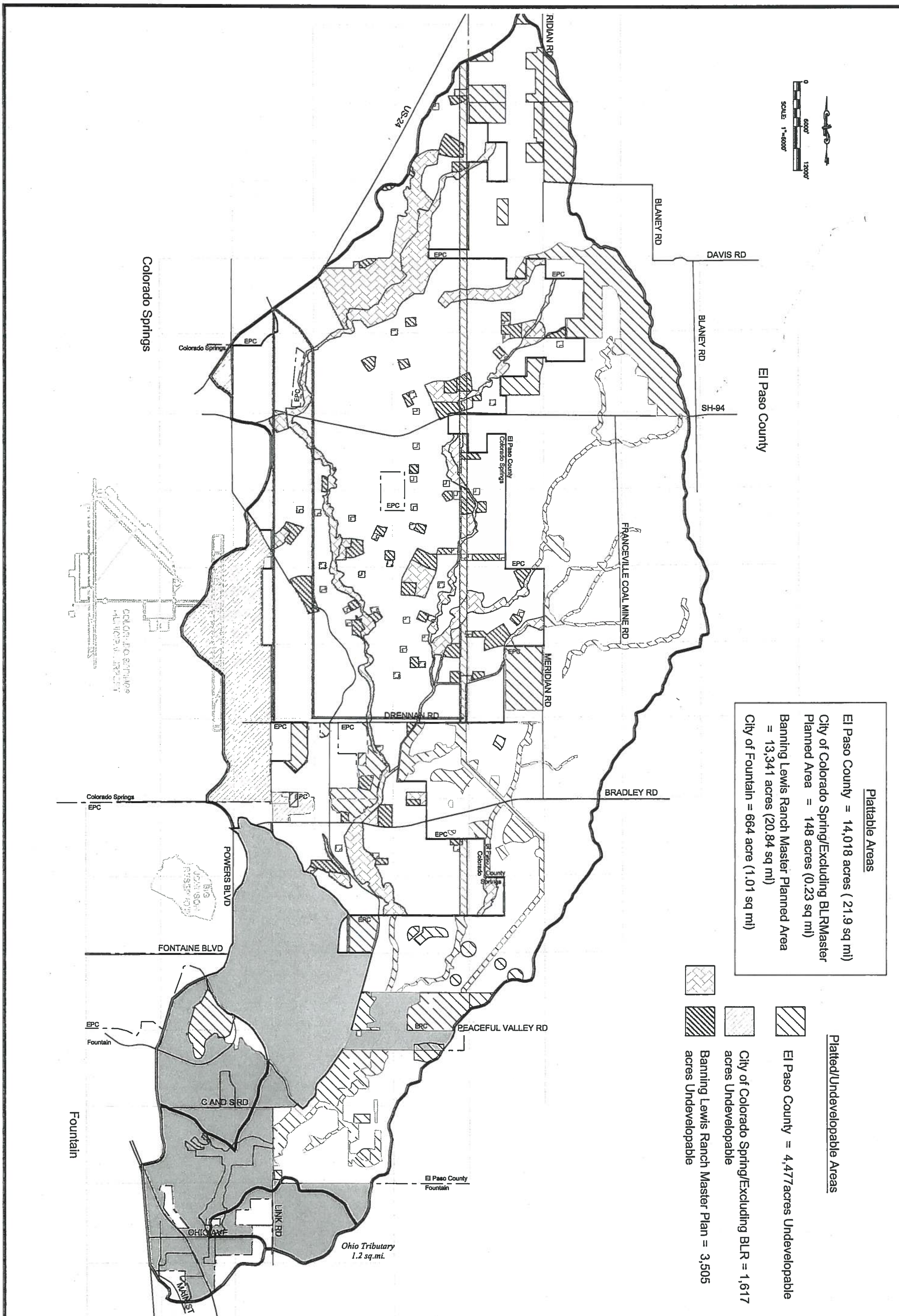
Future Conditions

	24hr - AMC2		6hr - AMC2	
Location	Q100	Q10	Q5	Q2
Outfall to Fountain Creek	31,986	15,806	7,293	4,525
Ohio Avenue	32,149	15,921	7,296	4,529
Link Road	31,934	15,836	7,235	4,517
Confluence with West Fork	32,064	15,897	7,232	4,521
Confluence with East Fork	32,547	16,080	7,221	4,521
Peaceful Valley Road	26,734	13,402	6,053	3,833
Confluence with Marksheffel Trib	26,531	13,371	5,963	3,783
Bradley Road	23,508	11,856	5,089	3,079
Confluence with Franceville Trib	23,413	11,812	5,071	3,069
Confluence with Corral Trib	22,741	11,473	4,946	3,004
Drennan Road	10,248	5,846	2,278	1,395
*** areal adjustment not applied to rainfall for drainage areas less than 10 square miles ***				
State Highway 94	7,135	3,613	1,532	926
Confluence with Blaney Trib	5,793	3,031	1,191	756
Jimmy Camp u/s of Blaney	4,150	2,003	791	486
Corral Tributary	7,274	3,497	1,383	827
East Fork Tributary	6,607	3,223	1,512	847
Marksheffel Tributary	6,254	3,830	1,404	1,037
Strip Mine Tributary	5,103	2,743	1,038	681
Franceville Tributary	1,927	824	324	172
C and S Tributary	2,695	1,459	435	291
Blaney Tributary	2,638	1,559	416	296
Ohio Tributary	1,566	796	193	121

Table VII-3: Jimmy Camp Creek Major Drainageway and FSD Storage Fees
Jimmy Camp Creek Drainage Basin Planning Study

Major Drainageway Unit Fee		
Major Drainageway Conveyances	$	63,160,818
Sub-drainageway Conveyances	$	24,772,830
Total	$	87,933,648
Un-platted acreage		13489
Major drainageway unit fee: $/acre	$	6,519

FSD Unit Storage Fee		
FSD Basin Costs w/15% engr and contigency	$	67,602,233
Total plattable acreage in basin		28171
Total plattable acreage in Colorado Springs		13489
Ratio of total plattable acreage in Colorado Springs		0.48
Share of storage costs	$	32,369,689
Storage fee: $/acre	$	2,400



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JIMMY CAMP CREEK WATERSHED
DRAINAGE BASIN PLANNING STUDY
PLATTABLE ACREAGE
CITY OF FOUNTAIN, CITY OF COLORADO SPRINGS, EL PASO COUNTY

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FIGURE
Fig VII-2

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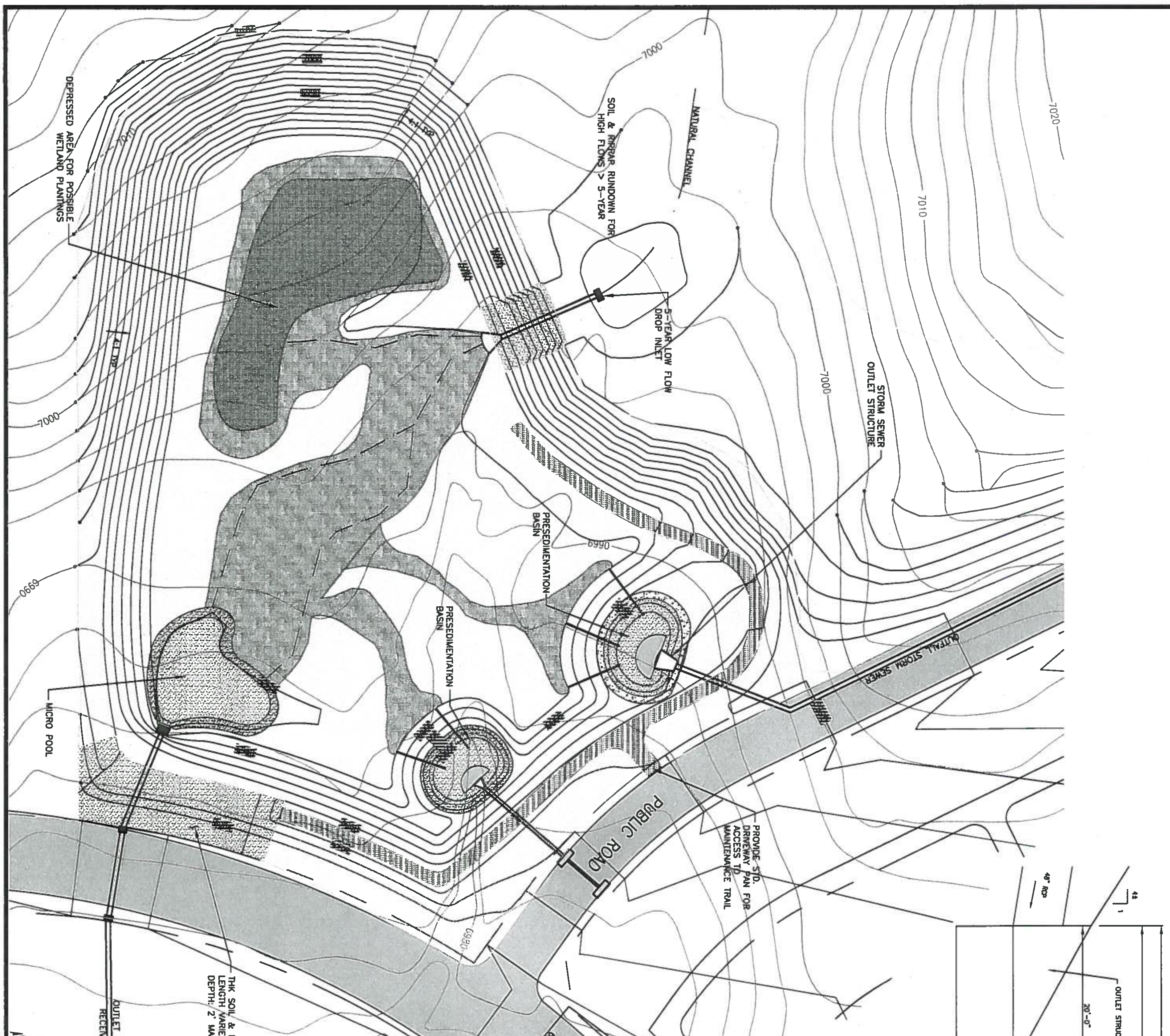

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JIMMY CAMP CREEK
DRAINAGE BASIN PLANNING STUDY
TYPICAL FULL SPECTRUM STORAGE BASIN
CITY OF COLORADO SPRINGS, COLORADO

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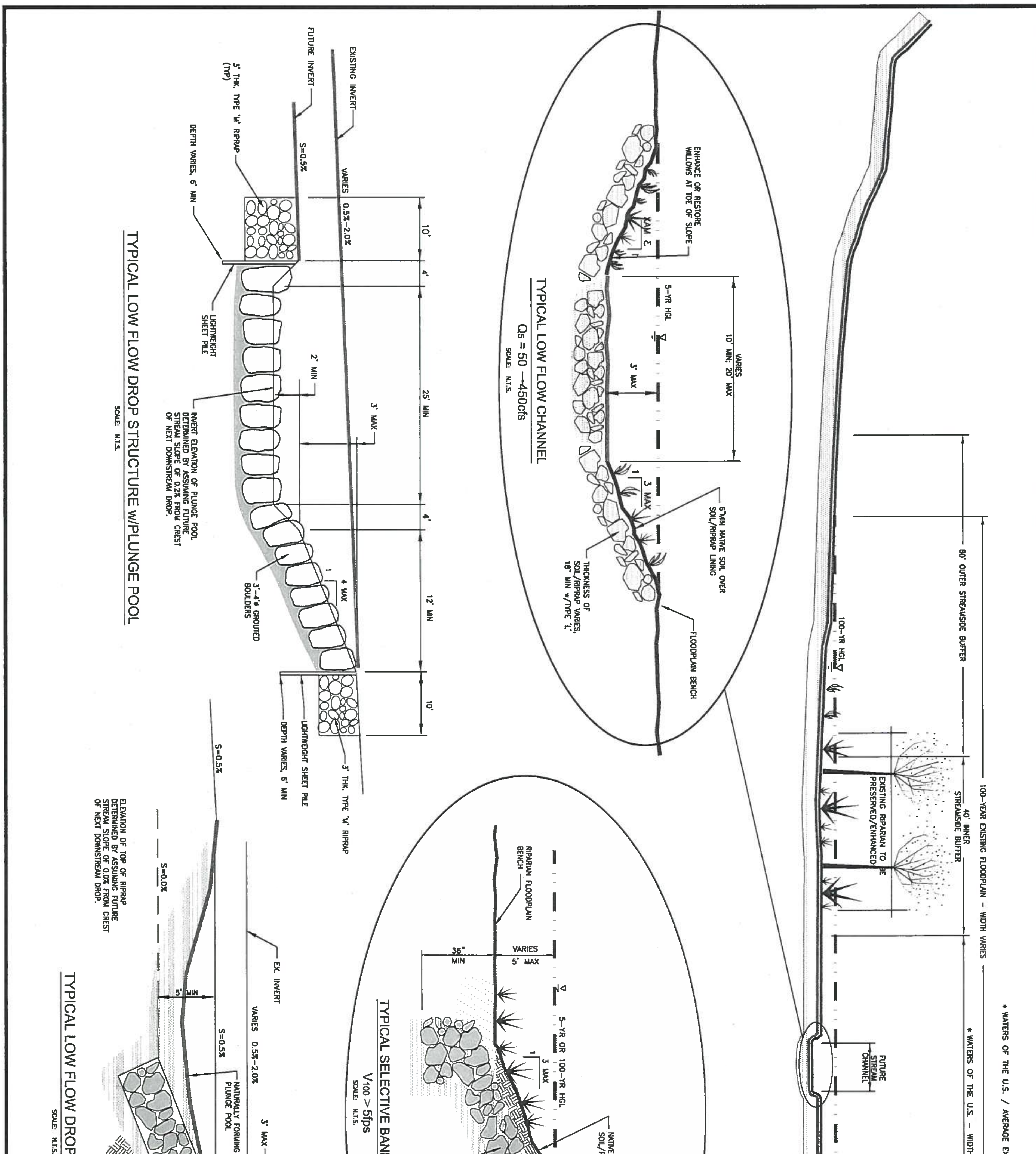

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JIMMY CAMP CREEK
DRAINAGE BASIN PLANNING STUDY
TYPICAL FLOODPLAIN PRESERVATION SECTIONS & DETAILS
CITY OF COLORADO SPRINGS, COLORADO

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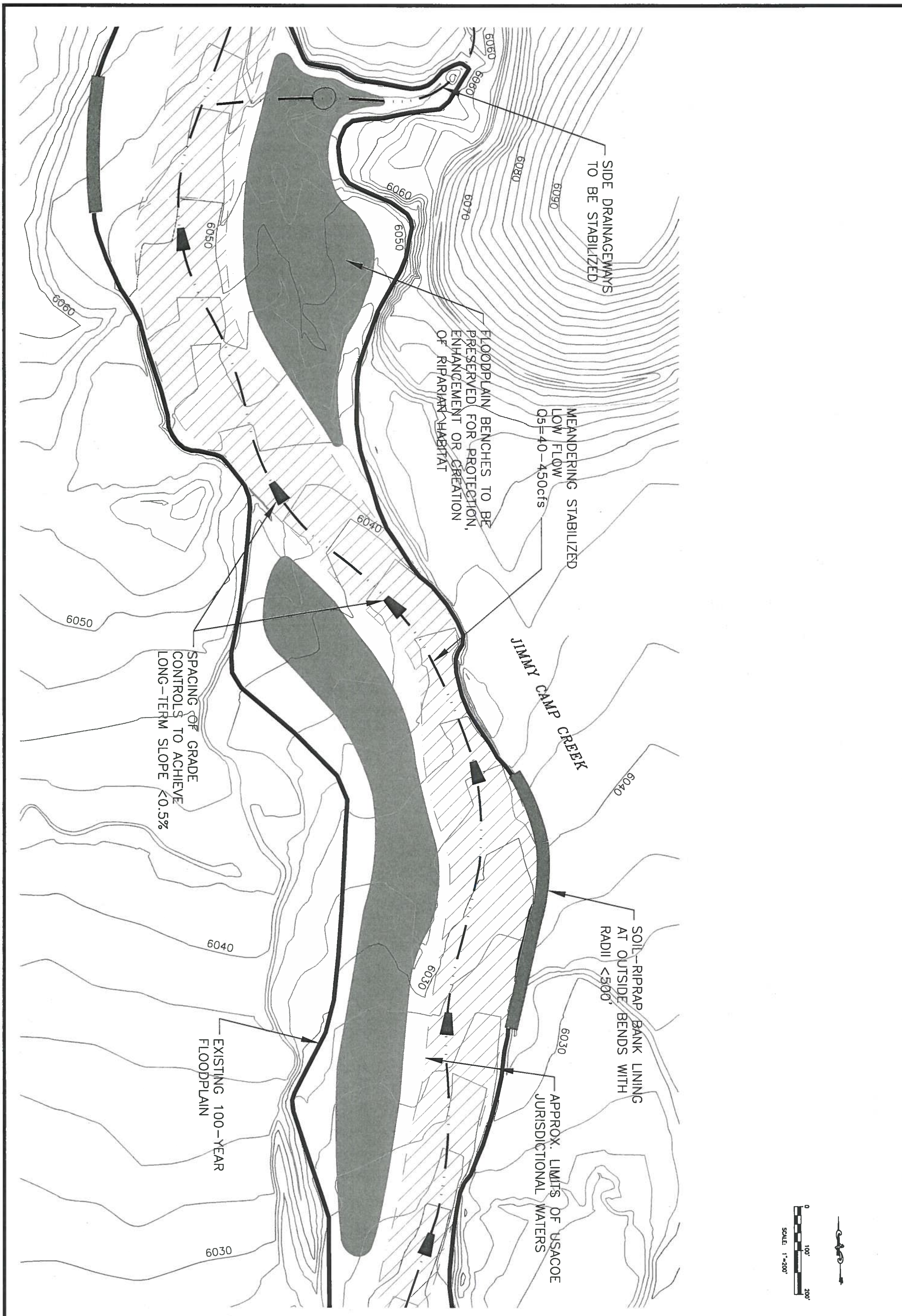

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SHEET 3

JIMMY CAMP CREEK DRAINAGE BASIN PLANNING STUDY

JIMMY CAMP CREEK

TYPICAL FLOODPLAIN PRESERVATION PLAN

CITY OF COLORADO SPRINGS, COLORADO

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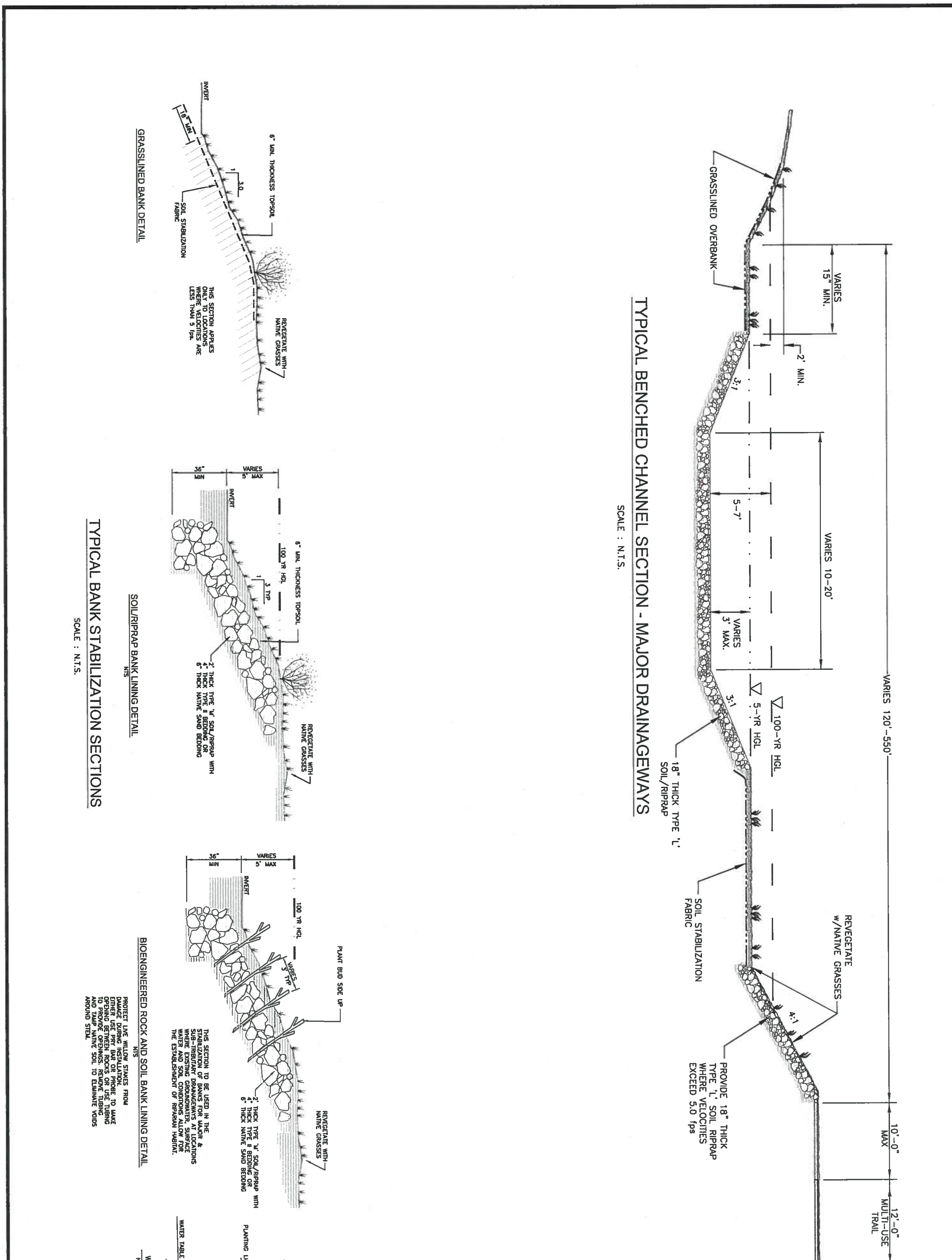

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JIMMY CAMP CREEK WATERSHED
DRAINAGE BASIN PLANNING STUDY
TYPICAL BENCHED CHANNEL SECTION & TYPICAL BANK DETAILS

CITY OF COLORADO SPRINGS, COLORADO

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