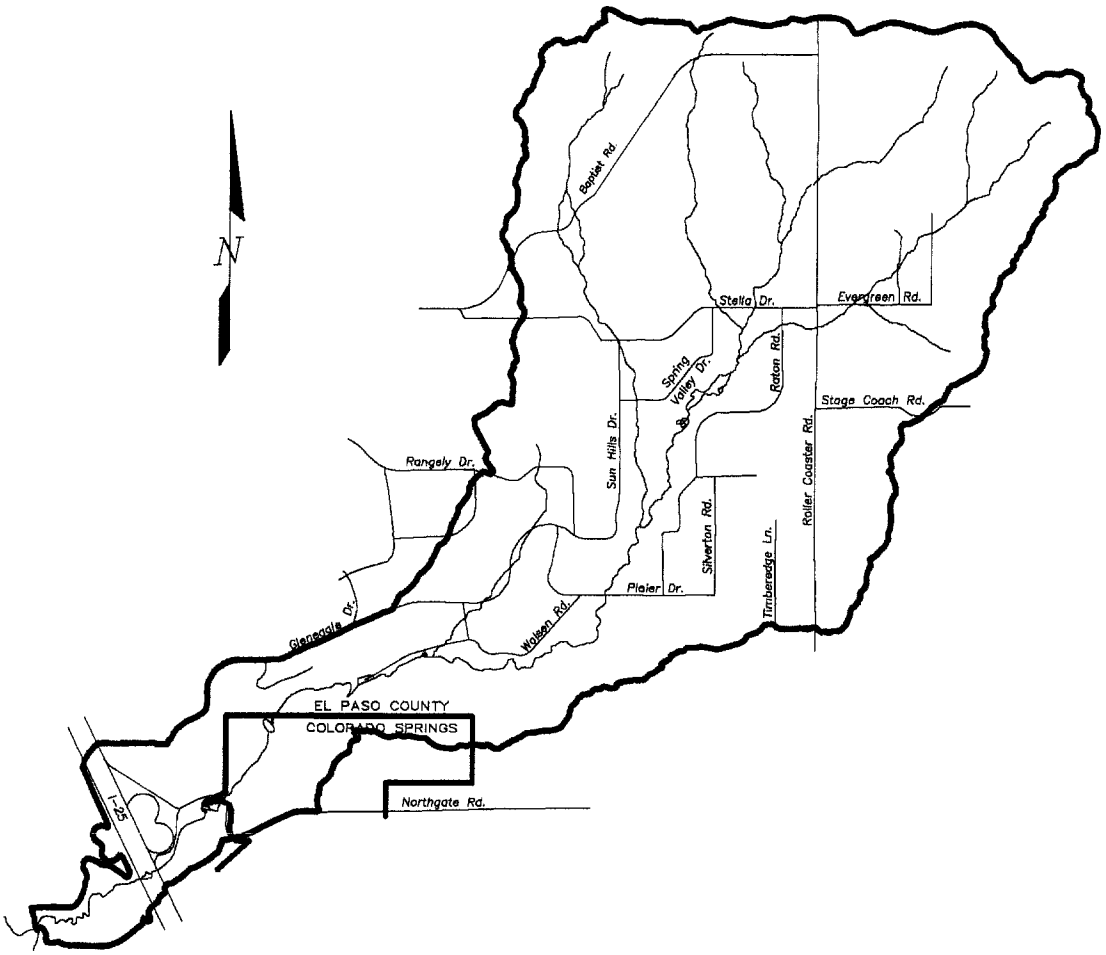
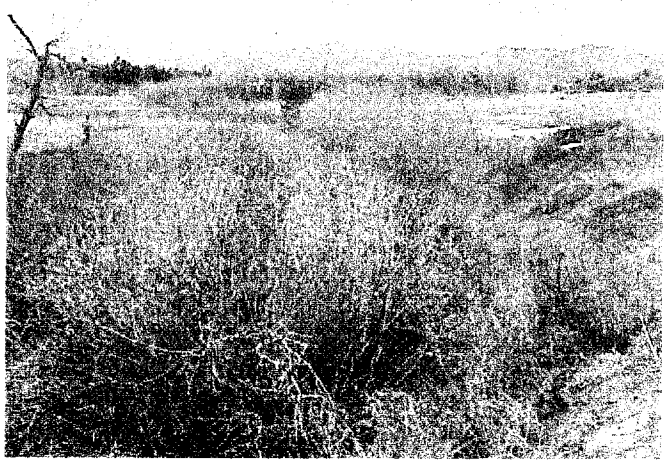
SMITH CREEK DRAINAGE BASIN PLANNING STUDY
CITY OF COLORADO SPRINGS
COUNTY OF ELPASO, STATE OF COLORADO
AUGUST 2002





J·R ENGINEERING

A Subsidiary of Westrian

4310 ArrowsWest Drive • Colorado Springs, CO 80907
719-593-2593 • Fax: 719-528-6613
www.jrengineering.com

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CITY OF COLORADO SPRINGS
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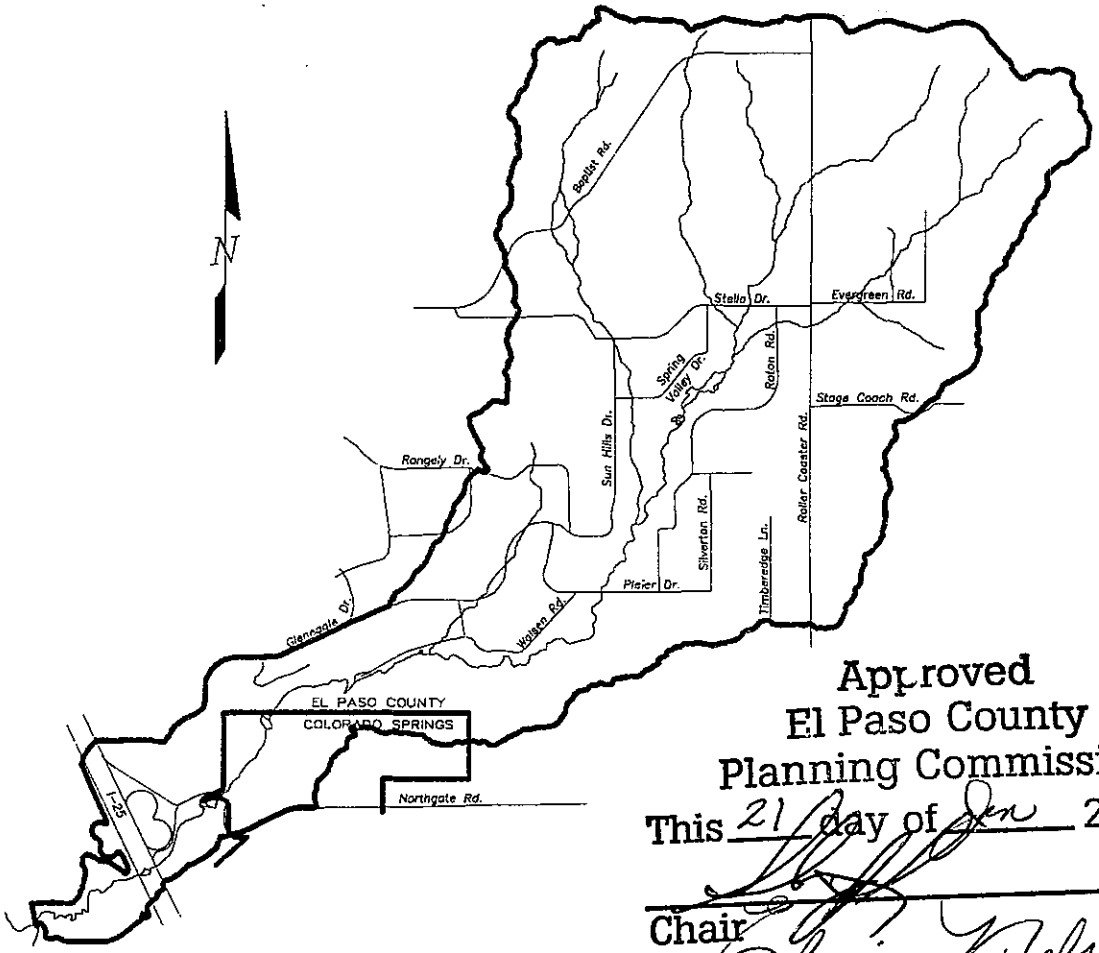
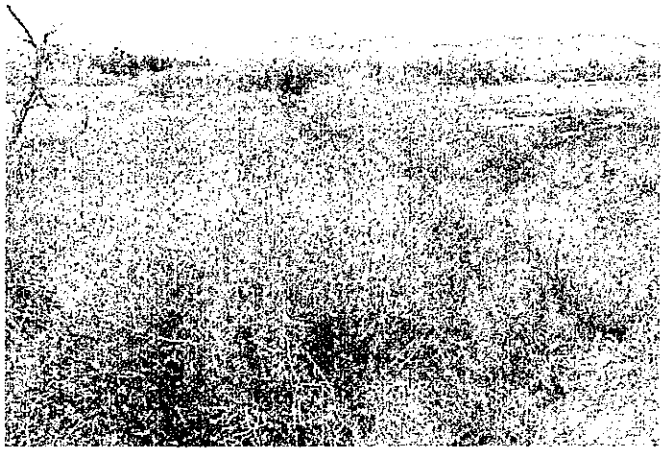
AUGUST 2002



Approved
El Paso County
Planning Commission
This 21 day of Jan 2003

Chair

Secretary



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Kenneth G. Rowberg
Planning Director

Carl F. Schueler
Assistant Director

El Paso County Planning Department

MEMORANDUM

February 10, 2003

TO: File: MP-02-002

FROM: Carl F. Schueler, Assistant Director CFS

RE: MP-02-002 – Smith Creek Drainage Basin Planning Study

This Drainage Basin Planning Study was adopted by the El Paso County PC, with the specific following notations:

NOTATIONS

1. Although this Drainage Basin Master Plan is adopted as a County Master Plan element pursuant to State Statute, the intent is not to use its land use assumptions as a justification for subsequent zoning and subdivision decisions.

2. Approved copies of this Plan should include a note to the effect that the location of proposed detention ponds are depicted for general planning purposes only. Specific sites should be further evaluated prior to any final location decisions. In particular, Pond RES 316 may not be feasible at its current location.

3. Additional hydrologic studies may be required to more accurately locate the existing and future 100-year floodplain boundaries; therefore, the proposed future 100-year floodplain boundaries as depicted may be subject to change. The proposed future 100-year floodplain boundaries should be corrected on Sheet 6 to match Sheet 10 and also should be field verified at these locations. Although it is recommended that these boundaries be used as the initial basis for establishing potential no-build area in new subdivisions, it is not recommended that they be used as the sole basis for amending the current FEMA flood insurance rate maps.

27 East Vermijo Avenue
Colorado Springs, Colorado 80903-2088
Web Site: www.elpasoco.com

(719) 520-6300
FAX: (719) 520-6322
E-mail: plnweb@elpasoco.com

El Paso County Development Services Department

Dick Anderwald, AICP
Director

Imad Karaki
Assistant Director

Paul Danley, PE
Engineering Manager

Mike Hrebenar
Customer Services Manager

Sarah Tresouthick-Koerner, ASLA
Planning Review Manager

Carl Schueler, AICP
Long Range Planning Manager

TO: City of Colorado Springs
Planning Commission
P. O. Box 1575
Colorado Springs, Colorado 80901

DATE: August 25, 2005

This is to certify that the following items were received on the above-referenced date:

Amendment to the El Paso County Master Plan – *Smith Creek Drainage Basin Planning Study*
Resolution No. MP-02-002 dated January 21, 2003

The enclosures pertain to the requirements set forth in Section 30-28-109, Colorado Revised Statutes, which state, in part:

> "The County Planning Commission shall certify a copy of its master plan, or any adopted part or amendment thereof or addition thereto, to the Board of County Commissioners of the County.
>
> "The County or regional planning commission shall certify such copies to the planning commission of all municipalities within the County or region."

For your information, Section 30-28-109 also states:

> Any municipal planning commission which receives any such certification may adopt so much of the plan, part, amendment, or addition as falls within the territory of the municipality as a part or amendment of or addition to the master plan of the municipality, and, when so adopted, it shall have the same force and effect as though made and prepared, as well as adopted, by such municipal planning commission.

Signature of Recipient

2880 International Circle
Colorado Springs, Colorado 80910
Web Site: www.elpasoco.com

Phone: (719) 520-6300
FAX: (719) 520-6695
Email: plnuweb@elpasoco.com

STATE OF COLORADO)
) ss
COUNTY OF EL PASO)

I, Elaine Nelson, Recording Secretary for the Planning Commission in and for the County of El Paso, State of Colorado, do certify that the attached is a true and accurate copy of an amendment to the El Paso County Master Plan, adopted by the Planning Commission on January 21, 2003:

Smith Creek Drainage Basin Planning Study

Resolution No. MP-02-002 dated January 21, 2003.

IN WITNESS WHEREOF, I have hereunto set my hand at Colorado Springs, Colorado, this 23rd day of August, 2005.

Elaine Nelson

Elaine Nelson, Recording Secretary
El Paso County Planning Commission

Approved
El Paso County
Planning Commission
This 21 day of Jan 2003

Chair

Secretary

AMENDMENT TO THE COUNTY PLAN (Approved)

Commissioner Salute moved that the following Resolution be adopted:

BEFORE THE PLANNING COMMISSION

OF THE COUNTY OF EL PASO

STATE OF COLORADO

RESOLUTION NO. MP-02-002

RECEIVED
AUG 17 2005
EL PASO COUNTY
CLERK TO THE
BOARD

WHEREAS, El Paso County, the City/ County Drainage Board and Picolan, Inc. requested approval of and amendment to the Master Plan by adoption of the Smith Creek Drainage Basin Planning Study, within the designated areas of the unincorporated area of El Paso County; and

WHEREAS, public hearings were held by this Commission on December 17, 2002, and January 21, 2003; and

WHEREAS, based on the evidence, testimony, exhibits, study of the master plan for the unincorporated area of the county, comments of the El Paso County Planning Department, comments of public officials and agencies, and comments from all interested parties, this Commission finds as follows:

1. That proper posting, publication and public notice was provided as required by law for the hearing of the Planning Commission.

2. That the hearing before the Planning Commission was extensive and complete, that all pertinent facts, matters and issues were submitted and that all interested parties were heard at that meeting

3. That all data, surveys, analyses, studies, plans, and designs as are required by the State of Colorado and El Paso County have been submitted, reviewed and found to meet all sound planning and engineering requirements of the El Paso County Subdivision Regulations.

4. That the proposal shall amend the Master Plan for El Paso County.

5. That for the above-stated and other reasons, the proposal is in the best interests of the health, safety, morals, convenience, order, prosperity and welfare of the citizens of El Paso County.

WHEREAS, Section 30-28-108 C.R.S. provides that a county planning commission may adopt, amend, extend, or add to the County Master Plan.

NOW, THEREFORE, BE IT RESOLVED that the Amendment to the Master Plan for El Paso County be approved for the following described unincorporated area of El Paso County by adoption of the Smith Creek Drainage Basin Planning Study as requested by El Paso County, the City/ County Drainage Board and Picolan, Inc.:

See attached Exhibit A

BE IT FURTHER RESOLVED that the following condition and notations shall be placed upon this approval:

CONDITION:

1. Section 30-28-109, C.R.S. requires the Planning Commission to certify a copy of the Master Plan, or any adopted part or amendment thereof or addition thereto, to the Board of County Commissioners and to the Planning Commission of all municipalities within the County. The Planning Commission's action to amend the Master Plan shall not be considered final until the applicant submits a minimum of ten (10) complete sets of the final documents and maps to the Planning Department and such documents and maps are certified by the Chairman of the Planning Commission and distributed as required by law.

NOTATIONS

1. Although this Drainage Basin Master Plan is adopted as a County Master Plan element pursuant to State Statute, the intent is not to use its land use assumptions as a justification for subsequent zoning and subdivision decisions.

2. Approved copies of this Plan should include a note to the effect that the location of proposed detention ponds are depicted for general planning purposes only. Specific sites should be further evaluated prior to any final location decisions. In particular, Pond RES 316 may not be feasible at its current location.

3. Additional hydrologic studies may be required to more accurately locate the existing and future 100-year floodplain boundaries; therefore, the proposed future 100-year floodplain boundaries as depicted may be subject to change. The proposed future 100-year floodplain boundaries should be corrected on Sheet 6 to match Sheet 10 and also should be field verified at these locations. Although it is recommended that these boundaries be used as the initial basis for establishing potential no-build area in new subdivisions, it is not recommended that they be used as the sole basis for amending the current FEMA flood insurance rate maps.

Commissioner Brown seconded the adoption of the foregoing Resolution.

The roll having been called, the vote was as follows:

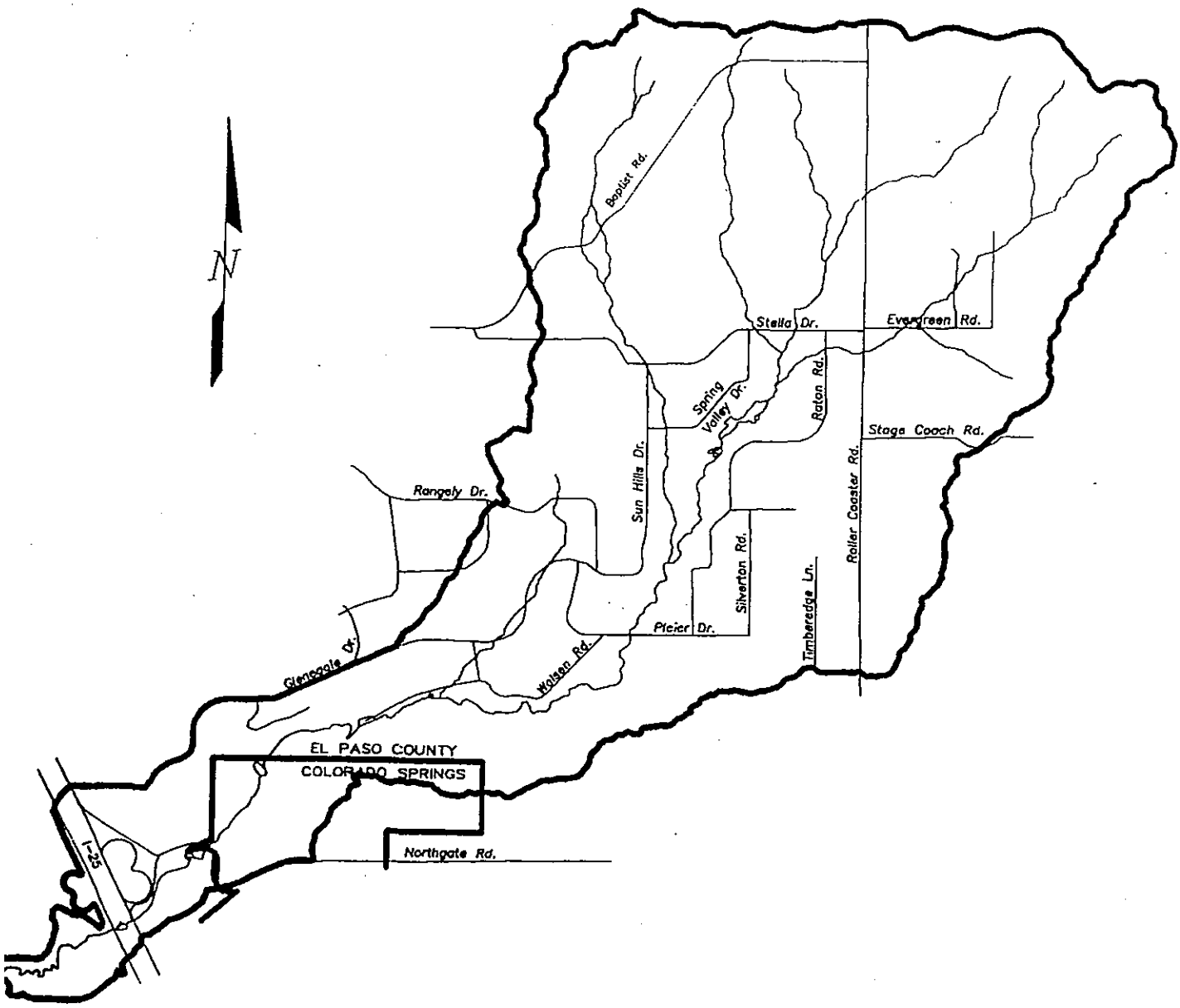
Commissioner Salute	aye
Commissioner Bell	no
Commissioner Wait	aye
Commissioner Brown	aye
Commissioner Amthor	aye
Commissioner Hisey	aye
Commissioner Roulier	aye
Commissioner Sery	no
Commissioner Bernstein	aye

The Resolution was adopted by a vote of 7 to 2 by the Planning Commission of the County of El Paso, State of Colorado.

Mr. Bell said his negative vote was cast because, even though the language is acceptable, the problem is not really addressed. By saying someone else is going to do it does not resolve the issue. In his opinion, it is not fair to approve it under those conditions.

Mr. Sery said he does not think current boundaries are correctly shown. Additional improvements have been made in the area and, based on what has been presented, the existing 100-year floodplain is probably not correct.

DATED: January 21, 2003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Evergreen Rd.
Spring Valley Dr.
Raton Rd.
Stage Coach Rd.
Sun Hills Dr.
Rangely Dr.
Roller Coaster Rd.
Silverton Rd.
Timberedge Ln.
Pleier Dr.
Glenogate Dr.
Holsen Rd.
EL PASO COUNTY
COLORADO SPRINGS
Northgate Rd.
I-25

RESOLUTION NO. 140-02

A RESOLUTION ADOPTING THE SMITH CREEK DRAINAGE BASIN PLANNING STUDY AND DESIGNATING THE STUDY AREA AS A CLOSED BASIN WITH NO DRAINAGE, BRIDGE, OR DETENTION BASIN/LAND FEES AND NO REIMBURSEMENT FOR CONSTRUCTED IMPROVEMENTS.

WHEREAS, JR Engineering on behalf of Piccolan, Inc. prepared the "Smith Creek Drainage Basin Planning Study", dated August 2002, and

WHEREAS, the Study recommends the drainage basin be considered a closed basin with no drainage, bridge or detention basin/land fees, and

WHEREAS, the Study recommends that all required improvements be constructed without eligibility for reimbursement, and

WHEREAS, City Engineering has reviewed the Drainage Basin Planning Study for conformance with City drainage criteria and accepts the Study and recommendations, and

WHEREAS, on July 18, 2002, the City/County Drainage Board approved Smith Creek Drainage Basin Planning Study as a closed basin with no drainage, bridge or detention basin/land fees and no reimbursement for constructed improvements.

NOW THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF COLORADO SPRINGS:

Section 1: The Smith Drainage Basin Planning Study, as prepared by JR Engineering, dated August 2002, is approved and adopted for use.

Section 2: The Study Area is a closed basin with no drainage, bridge, or detention basin/land fees and no reimbursement for constructed improvements.

Dated at Colorado Springs, Colorado this 27th day of August, 2002.

Mayor

ATTEST:

City Clerk

J·R ENGINEERING
A Subsidiary of Westrian

DRAINAGE BASIN PLANNING STUDY
FOR
SMITH CREEK

August 2002

Prepared for:

CITY OF COLORADO SPRINGS
AND EL PASO COUNTY
DEPARTMENT OF TRANSPORTATION
AND
PICOLAN, INC.
90 South Cascade Avenue, Suite 1300
Colorado Springs, CO 80903
(719) 381-8441

Prepared by:

JR ENGINEERING
4310 ArrowsWest Drive
Colorado Springs, CO 80907
(719) 593-2593

Job No. 8896.90

DRAINAGE BASIN PLANNING STUDY FOR SMITH CREEK

J·R ENGINEERING
A Subsidiary of Westrian

DRAINAGE REPORT STATEMENT

ENGINEER'S STATEMENT:
The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the City of Colorado Springs and County of El Paso for drainage reports and said report is in conformity with the El Paso County and City of Colorado Springs Drainage Criteria Manual.

Mike A. Bramlett, Colorado P.E. #32314
For and On Behalf of JR Engineering, LLC

Date

APPROVAL

The City of Colorado Springs City Council and Department of Public Works do hereby approve the contents of the attached Smith Creek Drainage Basin Planning Study. The Study shall be used as a guide for development of all drainage facilities within the study area.

Department of Public Works
(SEE ALSO ATTACHED MINUTES
OF THE CITY/COUNTY
DRAINAGE BOARD)

City Council

4310 ArrowsWest Drive, Colorado Springs, CO 80907
719-593-2593 • Fax: 719-528-6613 • www.jrengineering.com

DRAINAGE BASIN PLANNING STUDY FOR SMITH CREEK

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Technical Addendum – See Separate Report

EXECUTIVE SUMMARY

Acknowledgement

This study was originally prepared and issued for review in March 1996 by Muller Engineering Company, Inc. under contract with El Paso County. This work began in the fall of 1993 and was submitted in draft form in the winter of 1996. JR Engineering has used their information and built upon the original study and acknowledges the considerable effort that went into the original study. Muller Engineering Company, Inc., furnished the base maps and hydrological data for this study to JR Engineering electronically. Their willingness to share this data is greatly appreciated.

General

The report presents a plan for development of a drainage outfall system for the Smith Creek Drainage Basin. Due to the listing of the Preble's Meadow Jumping Mouse (Zapus hudsonius Prebleii) (Preble's) as a federally listed threatened species, the original study issued by Muller Engineering Company, Inc., dated March 1996, has been updated by JR Engineering to critically examine the alternatives.

The Smith Creek Drainage Basin encompasses 5.48 square miles, and this study encompasses the entire basin. Smith Creek is one of many basins tributary to the Monument Creek Drainage Basin. The basin is predominantly located in El Paso County. Only a small part of the basin, approximately 0.3 square miles (5% of basin) lies in an area that was annexed by the City of Colorado Springs. Also, a small portion of I-25 and the Air Force Academy are contained within the basin. All of these are located at the southwest end of the basin.

The primary objective of this study was to recommend solutions to existing drainage problems and any possible problems that may occur in the future due to development or natural forces. The plan is general enough in nature to allow for variation that would be better suited to individual development, but specific enough to insure that any variation would be properly integrated into the planned drainage system. The study provides El Paso County with a plan for implementing drainage improvements within the watershed in an economical yet beneficial manner. The plan also provides the opportunity to

establish a coordinated and integrated drainage system. When the City and County adopt the plan, it shall become a part of the countywide plan and be a standard for review of development submittals and ensure that proposed drainage improvements are consistent with the recommendations contained in the study.

Hydrology

The Smith Creek Drainage Basin was divided into 50 existing sub-basins and 53 future sub-basins. The principal drainageways in this basin are Smith Creek and five tributaries. Peak flow hydrographs were computed for each sub-basin, and then routed or combined with other hydrographs to get the desired hydrograph at design points. These computations were performed for existing and future land use conditions utilizing the U.S. Army Corps of Engineer's HEC-1 hydrologic model.

Hydraulics

A field investigation was conducted throughout the Smith Creek Drainage Basin to inventory the physical features and drainage structures and to determine the adequacy of the existing conveyance system. These physical characteristics in combination with the hydrology provided the primary input characteristics in the hydraulic analysis. Hydraulic computations were performed utilizing the U.S. Army Corps of Engineer's HEC-RAS water surface profile model to determine the existing and future 100-year floodplain limits for Smith Creek and its tributaries. The delineated floodplain boundaries are presented on the preliminary design plans in Appendix A.

Alternative Evaluation

The main stream of Smith Creek was divided into 10 separate reaches that differ by their own unique physiography and need for drainageway improvements. Three alternative plans for improvements, as listed below, were evaluated for each reach of Smith Creek and its tributaries:

1. No Action
2. Private On-site Detention in City portion only

3. Regional Detention with some On-site Detention (in City portion) using prudent line setbacks and limited Channel Stabilization

Preliminary Design

Smith Creek and its tributaries were evaluated on a reach by reach basis. The preferred alternatives were developed into a preliminary plan, which generally focus on partial channel stabilization along with public and private on-site detention facilities to attenuate future developed flows to existing rates. A set of 12 drawings illustrating the proposed master plan for the major drainageway improvements is included in Appendix A. A brief discussion of the key elements of the preliminary design on a reach by reach basis is presented in Section VI of this report.

Cost Evaluation of the Preliminary Plan

Quantities and costs were evaluated for the major drainageway improvements presented in the preliminary design. The cost for each improvement was divided into two categories: major drainageway costs and land acquisition costs for detention facilities. For the purpose of evaluating the basin fees, the costs were separated into creditable and non-creditable categories. Basin fees were evaluated based on County Resolution No. 99-383, Fees-1. Please refer to Appendix C for Basin Fee Information.

Fee Summary

A separate fee has been calculated for the City portion of Smith Creek and the County portion of Smith Creek.

City Basin Fees

The City/County Drainage Board has approved the Smith Creek Drainage Basin be a "no fee" basin. The administration of the Basin will be consistent with all City Ordinances, Subdivision and Construction Policies with the exception that no drainage or bridge fees will be due and subsequently

would not be reimbursable during the platting process. Upon adoption of the Study, interim fees collected to date will be disbursed as follows:

- $7,260.00 to the City of Colorado Springs for the Northgate Road realignment
- $142,493.86 to US Home
- Remainder to Picolan, Inc.

County Basin Fees

- Drainage Fee - $15,000.00 per impervious acre
- Drainage Fee (Land) - $2,862.21 per acre

Note: A maximum fee of $15,000.00 is allowed per impervious acre in the County. As shown in Appendix C, the actual cost per impervious acre in the County portion of the Basin is $16,889.00. Therefore, the limit on the drainage fee applies and the cap is set at $15,000.00 per impervious acre.

SECTION I
INTRODUCTION

Contract Authorization

On September 20, 1993, El Paso County contracted with Muller Engineering Company, Inc. for the provision of engineering services for a drainage basin planning study for the Smith Creek watershed. Specific project tasks were performed in accordance with the Agreement. This original study was not formally adopted by El Paso County, and on May 1, 2001, Picolan, Inc., contracted with JR Engineering, LLC, for the provision of engineering services to make final revisions to complete this study and resubmit it to the County, City and State agencies for approval.

General

The Smith Creek Drainage Basin consists of approximately 5.48 square miles that is tributary to Monument Creek at the "North Gate" to the U.S. Air Force Academy, located north of the City of Colorado Springs in El Paso County. Adjacent drainage basins to Smith Creek are the Black Forest, Black Squirrel, and Monument Branch basins. The basin's upper limit is at an elevation of approximately 7600 feet and a lower limit at Monument Creek of approximately 6575 feet. The Smith Creek Drainage Basin is predominantly within the jurisdiction of El Paso County. A small portion of the basin, approximately 0.3 (5% of total basin) square miles, lies in Colorado Springs. Also, a small portion of I-25 and the Air Force Academy are contained within the basin. All of these are located at the southwest end of the basin.

This planning study presents a conceptual design for the major drainageways in the basin. Improvements made in a specific location in the basin may require consideration of surrounding proposed facilities and improvements. Any project to be completed should bring into consideration the entire drainage system and its completed or planned facilities.

Existing Irrigation Facilities

At the writing of this report, no irrigation facilities are known to exist in the Smith Creek Basin. Portions of several historical irrigation waterways exist on City land but have been subsequently abandoned.

Existing / Proposed Utilities

The majority of the major utility corridors are along the main roads of the Smith Creek Basin. Since the exact locations of future utility placement are subject to change, each individual drainage facility designer should contact all of the appropriate utility agencies early in the design process. The majority of the drainage facility / utility conflicts are anticipated to be at the crossings of major roadways and the drainage channel.

Subsurface Investigations

A subsurface investigation was not performed specifically for this report.

Jurisdictional Agencies

A majority of the Smith Creek Basin is located within El Paso County with the remainder lying in the City of Colorado Springs. The City of Colorado Springs Department of Public Works and the El Paso County Department of Public Works have responsibility for implementation of the approved DBPS. The presence of the PMJM and emergent wetlands within the basin has required interaction with the Environmental Protection Agency, the U.S. Army Corps of Engineers, U.S. Fish and Wildlife and the Colorado Division of Wildlife. The presence of the U.S. Air Force Academy and Interstate 25 at the lower end of the basin has also warranted involvement from the United States Air Force and the Colorado Department of Transportation. Also involved in an advisory role are the various City and County Departments affected by the plan such as Environmental Services, Parks, Planning, and Utilities.

Scope of Work

The major tasks involved in the original Muller study are outlined as follows:

1. Acknowledgement of storm drainage criteria, data, and other information obtained from the County, Colorado Department of Transportation, U.S. Army Corps of Engineers, E.P.A., Colorado Department of Wildlife, U.S. Fish and Wildlife, Soil Conservation Service, State Engineer and other.
2. Delineation and characterization of sub-basins, obtaining of existing and future land use data, and utilization of this data in determining the basin hydrology and hydraulic capacity of drainage facilities.
3. Investigation and inventory of structures, pertinent physical features and environmental features.
4. Evaluation of the systems capability of intercepting and conveying runoff from the 10-year and 100-year design storms.
5. Evaluation, on a reach by reach basis, of drainage improvements and rehabilitation techniques bringing into consideration the input and desires of the County.
6. Screening of the techniques in order to arrive with the most feasible options for consideration in the final design.
7. Preparation of a preliminary design, with the selected improvements, including the 100-year existing and proposed floodplain delineation.
8. Preparation of preliminary design drawings and cost estimates for the recommended plan and documentation of key aspects of the project in the final report.

This revision to the original Muller Study was done under contract with Picolan, Inc., who was required to submit this report as part of the Northgate Annexation Agreement, dated June 9, 1998, with the City of Colorado Springs. This revision to the original report involved the following:

1. Update existing HEC-1 hydrology to reflect detention ponds built and land use changes that have occurred since the Muller report was issued.

2. Update proposed HEC-1 hydrology to reflect future land use changes, which have occurred since the Muller report was issued.
3. Establish a HEC-RAS model to replace the HEC-2 model that Muller originally ran, including updated field verified information on existing structures.
4. Run the 2, 5, 10, 50 and 100-year storms (see Technical Addendum) based on USAFA criteria to restrict these storms to historic.
5. Evaluate the new prudent line and drainage basin fee criteria from the County as it relates to this report.
6. Evaluate impacts of proposed improvements as related to the Preble's Meadow Jumping Mouse and the Western Museum of Mining and Industry.
7. Revise fees for the proposed improvements.
8. Re-evaluate fees based upon a separate City and County collection area.

Acknowledgement

Aerial photography for the upper portion of the basin outside of the limits of the F.I.M.S. mapping, a pencil manuscript of the basin area, and digitized contours for the stream reaches were completed by Reids Aerial Mapping. Thomas and Thomas completed an environmental inventory and a description of the existing vegetation and wildlife habitats within the Smith Creek watershed under contract with Muller Engineering.

Individuals with additional contributions to this revision of the D.B.P.S. include Tim Mitros, Dave Lethbridge, Grant Gurnée, Jon Dauzvardis, Allen Crockett, Janetta Shepard, Trent Miller, Luanne Rubey and Aaron Seal.

JR Engineering distributed copies of the revised Draft report and solicited input and comments from individuals listed in Appendix B. Input and correspondence from these individuals and their respective agencies can be found in Appendix D of this report.

SECTION II

ECOLOGICAL RESOURCES

General

The Smith Creek Drainage Basin has a wide variety of habitats. There are approximately 300 species of birds, waterfowl, small game, reptiles, fish and amphibians that utilize the varied ecological systems within the drainage basin. A list of the wildlife species is included in the Technical Report. The basin is comprised of a variety of high-quality ecosystems, including riparian, wetland, upland grasslands and montane. An environmental inventory is also included in the Technical Report. Please refer to the Technical Addendum for photos and locations of the various habitats.

The riparian/wetland ecosystems are concentrated primarily in the lower reaches of the basin. The riparian zones that surround the standing bodies of water provide critical wildlife habitat. The area of greatest habitat diversity extends from the area surrounding the Western Museum of Mining and Industry just east of I-25 to the confluence of Smith and Monument Creeks. The riparian/wetland zones are comprised of a wide variety of plant species that provide feeding and nesting grounds. The ponds within the basin also provide excellent habitats for many species of water birds, which both migrate and breed in the area.

Wildlife

There are two smaller mammals that have been identified by the Colorado Division of Wildlife and the Colorado Natural Heritage Program that are considered threatened or uncommon in Colorado. The Meadow Jumping Mouse, common in the northeastern United States and Canada, the sub-species of which (Preble's) occurs along our front range, is considered a federally listed threatened species. They are presently known to live on the grounds of the Air Force Academy and have been trapped on the Mining Museum property, the Northgate property and further upstream on Smith Creek. The mouse prefers high quality grass habitat along drainageways, usually with trees and

shrubs. The mouse hibernates in the fall and winter, so trapping efforts would need to be conducted May through August. The extent of the range is unknown at this time. Live trapping of the drainage basin would be necessary to determine its presence. The Smith Creek drainage represents one of several areas within the county that supports the Preble's Meadow Jumping Mouse and may, through habitat enhancements and additional research, expand the current known range of the mouse. All improvements within the planning area will need to address potential impacts to suitable habitat for the Preble's Meadow Jumping Mouse. In addition, any drainage enhancements should be designed to both minimize impacts to the mouse and enhance or expand existing habitat within the project area.

The Merriam shrew is the second species that is ranked common in its range but uncommon in Colorado. To determine its range, live trapping would also be necessary.

Several species of fish exist in the ponds and year-round, perennial portions of Smith Creek (see species list in Technical Addendum). The Colorado Division of Wildlife has expressed concern that the presence of Green Sunfish, a fish native to the Arkansas River Basin, may indicate the existence of other, migrated Arkansas River fish species. Of greatest concern among such migratory fish are the Arkansas Darter, a state-threatened species, and the Flathead Chub, a state species of special concern. While the Green Sunfish isn't listed as a threatened species, it may indicate the presence of the other two species. It should be noted, however, that a trapping or collection should be performed within the basin to determine the presence or absence of such state-listed species of fish. Design considerations will need to be employed in the suggested basin improvements that take into account all of the current species in the basin. The Department of Wildlife has provided alternatives in design philosophy including a V-shaped drop structure to allow fish migration and the sparing use of riprap to prevent channelization of the creek and the elimination of any holding pools. It is suggested that the Department of Wildlife concerns be fully addressed after a thorough aquatic species analysis and implemented in the perennial portions of the Smith Creek Basin. This will both identify habitat of specific importance and allow improvements in the ephemeral portion of the basin to be less cost prohibitive.

Although not endangered, the presence of the beaver in the Smith Creek drainage basin must be accounted for when analyzing hydraulic characteristics. The beaver and its associated practice of building dams could affect the routing of the creek and alter both the floodplain and ecosystem. Some benefits associated with dam building are their over-detainment of flows, their function as a drop structure controlling both velocity and grade in the creek, and the fertile marshes left after a dam is abandoned. However, the presence of beaver dams creates problems like nuisance flooding, poor aesthetics and a decrease in the efficiency of the designed storm and flow routing system. At the time of the field study for this report, no signs or effects of beavers were found to be inhibiting the creek.

It is suggested that a habitat analysis for the PMJM and those aquatic species of concern be performed so that appropriate measures are taken to maintain existing migratory characteristics. Several existing culverts within the basin have downstream inverts well above the natural channel bottom, preventing any fish from migrating upstream and causing the PMJM, if moving upstream, to cross by means other than the existing culvert. These areas should be analyzed to determine the level of existing habitat and what improvements, if any, could expand or improve the ecological resources in these areas. The Colorado Division of Wildlife has suggested the use of 3-sided box culverts to maintain a natural bottom at drainage crossings, which would further facilitate migratory patterns. Also suggested, as previously discussed, were V-notched drop structures that allow fish species to move upstream easily. It is proposed that, at the time of final design for any drainage improvement, the full habitat impact and appropriate methods of construction are further explored on a case by case basis.

Vegetation

The wetland and riparian habitats support a variety of shrubland and grassland species. A band of sandbar willow dominates the shrubland ecosystem. It usually occurs with sand and gravel substrates and a relatively high level of ground water. There is also a well-developed understory with a mix of herbaceous wetland species including grasses, sedges, horsetails and rushes.

The grassland habitats are primarily in the upper reaches of the basin. In these areas, there are a few inclusions of small riparian zones with some wetland species. These tend to be associated with areas of standing or ponding water.

Grassland and woodland vegetation communities dominate the upper reaches of the Smith Creek Drainage Basin. The stream channel is primarily grass-lined with major stands of ponderosa pines and scrub oak on the edges.

In the reaches below the pond located just north of the wastewater treatment lagoons, the communities change to riparian shrubland, dominated by dense immature willow saplings and a few sedges and grasses. This type of plant community is present along Smith Creek between the confluence with Tributary A and D. Just downstream of Tributary A, Smith Creek has older, more established vegetation, with a few mature willows and cottonwoods as overstory, yet a strong understory is comprised of grasses and sedges. There is an area upstream approximately 1,000 feet downstream of Tributary A that is comprised of emergent wetland species. Immature sandbar willows transitioning to more mature willows and finally to woodland species on the edges bind this area.

Upstream of the Western Museum of Mining and Industry the area has been heavily grazed, but there is evidence of immature willows, sedges and wetland grasses. East of I-25, the ponds are surrounded by mature riparian woodland that provided a very unique element in this drainage basin.

West of I-25 is a diverse combination of immature riparian shrubland, with herbaceous wetlands; grasses, sedges and rushes intermixed throughout the drainage profile.

Additional Information

For additional information on ecological resources present in the City portion of the Smith Creek Drainage Basin, please refer to the documents in the "References" section of this report prepared by Walsh Environmental Scientists, SWCA, Inc., and the Aquatics and Wetlands Company. For

additional information on ecological resources in the County portion of the basin (including the Preble's Mouse), refer to the "El Paso County Regional Habitat Conservation Plan for Preble's Meadow Jumping Mouse".

SECTION III

HYDROLOGY

Basin Characteristics

Smith Creek is a perennial stream at its confluence with Monument Creek due to springs and a wastewater treatment facility discharge located near the basin centroid. As such, the Creek has some wetland areas and riparian corridor characteristics. The stream originates in sandy pine covered forest typical of the local area known as the "Black Forest" and flows through a drainage area largely covered by woodland, pasture and brush. The development, which has occurred in the basin, varies from natural conditions to farm pasture and low density residential. In general, the basin retains a natural, rural Colorado appearance and function, which have only been minimally impacted by human development. The primary human impact to the Creek has been the construction of several wastewater lagoons with Smith Creek bypassed around them, road crossings and two on-stream stockwatering ponds held by dams. A small area of more intense residential development has developed along its northwest watershed with the Black Forest Drainage Basin.

The Smith Creek Drainage Basin drains in a westerly direction towards Monument Creek. Smith Creek and five tributary drainageways principally drain the basin. For this study, the tributary drainageways were designated as Tributaries A, B, C and D and the Pleier Road Tributary as shown on the basin maps (Figures III-1A and B).

Existing Land Use

In the existing condition, the basin can be generally broken down into two portions. The upper portion of the basin is primarily woods/forest and the lower portion is pasture and brush. In the upper portion of the basin, aside from the wooded area, there is a small area that is agricultural, a recreational park (Fox Run Park), and a residential area located on the west side just south of Becky Drive. The residential area consists of lot sizes no smaller than ½ acre. Other houses exist in the upper portion of the basin but are very scattered. This wooded area extends southwest to just north

of the wastewater treatment facility and extends east from Timberidge Road and Raton Road to the basin boundary. South and to the west of this area, the pasture and brush portion of the basin exists. Please see photographs in the technical addendum.

In the lower portion where pasture and brush are predominate, houses are randomly scattered throughout, except for one small area located on the west side of the basin and just south of Gleneagle Drive which consists of quarter acre lots and an apartment development, "Ridge Point Apartments", located east of Struthers Drive and south of Gleneagle Drive. Figure III-2 shows the land use for existing conditions.

Future Land Use

Future land use for the majority of the basin was based on information presented on the zoning map provided by El Paso County. The exception was the area in the basin within the city that is currently being planned for development. This city development consists of residential property with quarter-acre lots, and the other consists of commercial and business improvements. The commercial, business, and housing development areas are to be located in an area just northeast of I-25. Part of this area is located within the City of Colorado Springs and is planned for development.

All of the rest of the area within the basin, aside from that located below and including I-25 and the other ½ acre residential shown in the map, was designated on the zoning map as being rural residential (RR3 - lot sizes greater than 5 acres). In some of this area, the land has already been divided into lot sizes of 5 acres while in other areas no lots have yet been subdivided. For the hydrologic analysis, it was assumed that all of this area was platted with lot sizes of 5 acres. Figure III-3 shows the land use for future conditions.

Soils Description and Classification

Soil classifications and locations were obtained from the U.S. Department of Agriculture Soil Conservation Service El Paso County Soil Survey (SCS 1981). Soils are classified into four groups:

A, B, C and D. Soil group A has a low-runoff potential even when thoroughly wetted and consists of deep sand, deep loess and aggregate silts. Soil group B has a moderate infiltration rate when thoroughly wetted and consists of shallow loess and sandy loam. Soil group C has slow infiltration rates when thoroughly wetted and consists of clay loams, shallow sandy loam, soil high in organic content and soil usually high in clay. Soil group D has a high-runoff potential when thoroughly wetted and consists of soils that swell upon wetting such as heavy plastic clays, and certain saline soils.

The Smith Creek Drainage Basin is predominantly composed of soil group B (99%) though there is a single 25 acre area located near the centroid of the basin, which is composed of group C soil. The sub-basins, which contain portions of this soil group, are 313, 401, 403 and 405 of which none have more than 20% of their area consisting of this hydrologic soil group. In this basin, the dominant soils included in the soil group B are Kettle, Pring, and Tomah series soils (SCS, 1981), which make up 85% of the basin land area.

In general, each SCS soil type group possesses unique erosion characteristics with the looser, better drained soils being more susceptible to wind and runoff erosion. The denser, poor-draining soils, in general, withstand the effects of erosion better than the loose soils. As previously discussed, the vast majority of the Smith Creek Basin is Soil Type B, which, in general, has a slight to moderate hazard of erosion. The Kettle, Pring and Tomah series soils have slight to moderate, moderate and slight to moderate hazards of erosion, respectively.

Hydrologic Modeling

Introduction

The Hydrologic Analysis was undertaken to determine the peak flood discharge into Monument Creek and hydrographs for the 2, 5, 10, 50 and 100-year return periods reflecting both existing and future conditions. The U.S. Army Corps of Engineer's HEC-1 hydrologic model was used to

determine these flood rates (USACOE, 1990). The information obtained from this hydrologic analysis was utilized as input for the Hydraulic Analysis.

As previously indicated, Smith Creek Basin drains 5.48 square miles. This basin was sub-divided into 50 existing and 53 future sub-basins. The sub-basins are all approximately 100 acres or less in size as shown in Figures III-1A and III-1B. Field reconnaissance was undertaken to verify flow paths and boundaries.

Methodology

Peak flow rate and hydrographs for this study were computed using the SCS design storm method, which utilizes rainfall together with each sub-basin's physical characteristics to determine rainfall runoff for each sub-basin. The rainfall is obtained from standard published curves for this area (City of Colorado Springs and El Paso County Drainage Criteria Manual, 1987/NOAA Atlas II, Volume III). The physical characteristics of each basin are summarized by the drainage area, lag time and the curve number (CN). The inherent assumption is that a specifically defined rainfall frequency (the 2, 5, 10, 50 and 100-year in this case) produces the same frequency flood event.

Once all necessary information was obtained, the sub-basin hydrographs were computed and then routed to the confluence with Monument Creek. Sub-watersheds and routing elements are shown on Figure III-4a and III-5a, and the connectivity diagram and discharges are presented on Figure III-4b and III-5b. Five reservoirs were modeled for the existing conditions and ten reservoirs were modeled for the future condition. The mathematics of the hydrograph convolution and routing were accomplished using the computer model HEC-1. The routing technique utilized by HEC-1 was the Muskingum-Cunge for the stream flow and Modified Puls for the reservoir routes.

Rainfall

The rainfall event utilized for this design storm evaluation was the 24-hour SCS Type IIA temporal rainfall distribution. A uniform rainfall amount of 4.6 inches for the 100-year event, 4.0 inches for the 50-year event, 3.0 inches for the 10-year event, 2.6 inches for the 5-year event, and 2.0 inches for the 2-year event were applied over the entire drainage basin in accordance with Figures 5-4d and 5-

4e of the City of Colorado Springs and El Paso County Drainage Criteria Manual, (Colorado Springs/El Paso County, 1987) for both existing and future conditions. No rainfall reduction factor was utilized, as the basin is less than ten square miles in area.

Curve Numbers

The Soil Conservation Service (SCS), U.S. Department of Agriculture, has instituted a soil classification system that relates the drainage characteristics of soil groups to a curve number, CN (SCS, 1972 AND 1975). The SCS provides information on relating soil group type to the curve number as a function of soil cover, antecedent moisture condition, and land use type. CN values were determined for each sub-basin. For the Smith Creek Drainage Basin, the predominant hydrologic soil group was B with an antecedent moisture condition of II. The CN values differ between the existing and future conditions primarily to reflect the changes in the land use. Based on existing land use, zoning and known development plans, the basin is expected to change generally from an undeveloped pasture/woodland to low density residential. This is reflected by a 7% increase in the average basin CN from existing to future conditions (65 to 70). Tables illustrating the determination of the CN values are presented in the Technical Report.

Lag Time

Lag time is a parameter that reflects the basin's size, shape, slope and routing characteristics. The lag time was separately computed for each sub-basin. Lag is the time from the center of mass of excess rainfall to the peak rate of runoff. It is computed as 0.6 times the "Time of Concentration" (T_c) and is expressed in hours. Time of concentration is the time it takes for runoff to travel from the hydraulically most distant part of the watershed to the point of reference. It is computed as the sum of the overland flow time (initial runoff time) and channelized flow time (travel time). Overland flow consists of a sheet flow component as water flows over the ground surface, and a shallow flow component as water collects. Overland flow is limited to a maximum 1,000-foot length for undeveloped conditions and a maximum 300-foot length for developed before it becomes channelized into physically obvious intermittent/ephemeral drainage paths. Overland flow time was computed using the formula $T_c = 1.87\ (1.1 - C_{10})\ L^{0.5}\ S^{-0.33}$ and shallow flow was extracted from Peak Flow in Colorado, Figure 3-1 (SCS 1984) using slope and ground surface characteristics. Once

overland flow has become fully channelized, standard velocity relationships or the Manning's formula, where channel dimensions could be estimated, were used to determine channel flow times for each conveyance element.

Separate lag times were computed for each sub-basin for both existing and future land use conditions since development activity can change the physical characteristics that determine the lag time. The lag time calculations are presented in the Technical Report.

Routing Characteristics

Necessary data for the routing computation in the HEC-1 model was the routing length, slope, Manning's "n" value, and an input of the general shape of the stream in consideration. The method used in the routing was the Muskingum-Cunge routing.

For each route, the streams were assumed to be trapezoidal in shape. Manning's "n" values were determined for each routing element. Consideration was given to the condition of each channel, such as the soil types, degree of stream irregularity, variation of channel cross section, relative effect of obstructions, vegetation and degree of meandering (Chow, 1959). Calculations of the Manning's "n" used in the original Muller analysis are presented in the Technical Report. The Muller values were reduced in this new analysis after further research on land uses and field verification of channel characteristics.

Results

A baseline HEC-1 model was developed to model the existing land use and drainage system. The results of the model with the described data showed that the peak flows of Smith Creek at its confluence with Monument Creek were 85 cfs, 319 cfs, 548 cfs, 1400 cfs and 2,069 cfs for the 2, 5, 10, 50 and 100-year return periods, respectively.

The baseline model was modified to reflect the existing drainage system with the fully developed future land use condition (Alternative 1). The results showed that the peak flows at the confluence with Monument Creek were 119 cfs (40% increase), 404 cfs (27% increase), 678 cfs (24% increase),

1614 cfs (15% increase) and 2,312 cfs (12% increase) for the 2, 5, 10, 50 and 100-year return periods, respectively.

For this study, it was concluded to concentrate on not having an adverse effect in discharge at the confluence with Monument Creek since the Air Force Academy is the affected downstream property owner. Consequently, it was necessary in the alternative evaluation to consider regional detention facilities to detain the 2, 5, 10, 50 and 100-year fully developed peak discharges to existing rates. Two regional detention facilities were selected from the alternative evaluation to be included in the recommended plan. An HEC-1 model was developed to reflect the hydrology of the drainage improvements for the recommended plan with the fully developed future land use condition. The results of the model showed that the 2, 5, 10, 50 and 100-year peak flows at the confluence were 87 cfs, 303 cfs, 544 cfs, 1395 cfs and 2,059 cfs respectively, which was negligibly different, from a hydrologic standpoint, than the existing peak discharge rate. A comparison of the 2, 5, 10, 50 and 100-year peak discharges for the existing drainage system with existing land use conditions is tabulated in Figure III-4b. A comparison of the 2, 5, 10, 50 and 100-year peak discharges for the three future alternatives is tabulated on Figure III-5b.

SECTION IV
HYDRAULICS

General

A hydraulic analysis was undertaken to evaluate the distribution of flow, determine areas covered by water during flooding events, and related characteristics of the water flow in the channel and overbank areas along Smith Creek and its tributaries. While the hydrologic computations define the rate of flow for floods of selected frequencies at various points within the drainage basin, the hydraulic computations reflect dynamic conditions of the water flowing downstream as affected by the channel size, subsurface roughness, structures along the channel, channel vegetation, and similar physical characteristics. The physical characteristics of Smith Creek and its tributaries in combination with the peak flood discharge rates described in the "hydrology" section of this report, therefore, provide the primary input characteristics to the hydraulic analysis, and the basis for evaluating the hydraulic adequacy of the outfall system.

Physical Feature and Drainage Structures Inventory

A field investigation was conducted throughout the entire drainage basin to inventory physical characteristics and drainage structures. The inventory established a basis to define the areas in need of improvements, and determine the adequacy of the conveyance channel and existing structures (i.e., culverts, drainage structures, dams, etc.). The inventory also identifies the areas where stream bank and bed erosion exists, and where other physical problems have resulted due to the stream hydraulics. A tabulation of this inventory is presented in the Technical Report along with photos taken in April 2001.

Smith Creek is well defined from its confluence with Monument Creek upstream to the Wastewater Treatment Facility where channel vegetation consists of native grasses and shrubs. From the confluence with Tributary A to the Wastewater Treatment Facility, the stream banks of Smith Creek are minimally eroded at the tops of the banks. Upstream from the Wastewater Treatment Facility to

Smith Creek's confluence with Tributary C, no base flow exists and the surrounding vegetation abruptly changes to a more forested setting. All of the five tributaries of Smith Creek also do not have any base flow (ephemeral). Their channel and surrounding vegetation consist of native grass and turn more forested toward their upper limit.

Floodplain Delineation

Hydraulic calculations were performed on Smith Creek and its tributaries to determine the existing and future floodplain limits. This was accomplished by utilizing the U.S. Army Corp of Engineer's HEC-RAS water surface profile program (USACOE, 1990). For this study, Smith Creek was divided into separate reaches corresponding to the designations as shown on Figure V-1, and described in the "Preliminary Plan" section of this report. The original HEC-2 computations by Muller Engineering considered each reach between structures separately. JR Engineering converted and combined Muller's HEC-2 reaches and culvert data into one HEC-RAS model. The delineated existing and future floodplain boundaries can be seen on the preliminary plan and profile sheets in Appendix A.

SECTION V
ALTERNATIVE EVALUATION

General

An integrally key element of the original planning study was the configuration of alternative development plans from which to choose a single most acceptable plan for preliminary design. This involved a lengthy interactive series of discussions and evaluations with the study group and El Paso County, as well as input from interested citizens from the public meetings. The purpose was to compile, evaluate, and recommend solutions to current and expected drainage problems within the Smith Creek Drainage Basin.

During the review of the original alternatives, new criteria was evaluated and used to determine the alternative selected. Firstly, the USAFA's requirement for no peak flow increase in the developed 2, 5, 10, 50 and 100-year storm events was a factor not previously evaluated. Secondly, the existence of the Preble's Meadow Jumping Mouse within the channel influenced the location of facilities within the study.

Alternatives Configuration/Analysis

Based upon the inventories and hydrologic results, Smith Creek and its five main tributaries were divided into physically similar reaches for evaluation of drainage handling alternatives. The reach limits are depicted on the Recommended Improvement Map, Figure V-1. Three alternatives were configured which cover the full range of conceptually feasible options for drainage handling. These are:

Alternative One: No Action

This alternative increased historic peak flows at the USAFA boundary in the developed condition; therefore this alternative was not chosen.

Alternative Two: Detention within City of Colorado Springs Developments Only

This alternative involves the implementation of onsite detention for each of the proposed developments within the City of Colorado Springs. This alternative was evaluated to see if restricting flows by using onsite detention on the city developments could reduce flows to historic levels for the entire basin at the confluence. Flows at the USAFA were increased above historic peak levels in the developed condition; therefore this alternative was not chosen.

Alternative Three: Regional Detention with some Onsite Detention using Prudent Line Setbacks and Limited Channel Stabilization

This alternative involves implementing regional detention, onsite detention, prudent line setbacks and limited channel stabilization. Due to the presence of the Preble's Meadow Jumping Mouse, the County's establishment of a prudent line criteria and the prediction by the El Paso County Planning Department that this basin will maintain a rural residential character, this alternative was developed. This alternative evaluated the existing culverts and proposed upgrades where necessary in keeping with the City and County criteria. In addition, no increase was allowed for the 2, 5, 10, 50 and 100-year developed storm peak flow at the confluence. Channel improvements are strategically placed in locations where public or private facilities would be in danger if the creek migrated. Many of the originally suggested improvements from the Muller study were removed and replaced with a prudent line setback.

The prudent line setback was used based upon the criteria set forth by the "Draft March 13, 2001 Prudent Line Addendum for Unincorporated El Paso County Only". The presence of the Preble's Mouse, the heavily vegetated channel, the natural beauty of the channel, the rural character of the area and the relative stability of the channel were all considered in choosing this approach.

This alternative was the chosen alternative due to the fact that 2, 5, 10, 50 and 100-year peak flows at the USAFA were restricted to historic levels.

Detention Facilities

Six different detention facilities were studied in the original Muller study. Reservoir 612 (RES612) was concluded to be viable as a regional facility in the Muller study. Reservoir 612 was chosen over others because of its better capability to detain more water due to the favorable surrounding topography. However, due to environmental impacts to the Prebles Mouse, this is no longer an option. JR Engineering evaluated other locations that appear to have less environmental impacts. The objective was to evaluate detention requirements so that the peak flow for the future condition would not be larger than the existing condition at the confluence. After simulating these combinations through the HEC-1 model, it was concluded that incorporating regional detention facilities at nodes 407 and 316 (refer to Figure III-1b) along with onsite detention at nodes 701, 613, 617, 618, 615, 605, 605A, 103 and 101, once developed, to restrict flow to historic levels was the most appropriate configuration. These detention facilities can be seen on the Recommended Improvements Layout Map, Figure V-1, and were included in the hydrology and hydraulics analysis.

It should be noted that if development activity in the basin changes to a more dense, intensely developed pattern than currently planned, it may be necessary to institute a more proactive drainage improvement plan similar to Muller's report's Alternative Three or a more intensely structural drainage facilities alternative. Upon the proposal, if any, of denser land uses within the basin, it is suggested that this DBPS be revisited and, if applicable, revised to reflect any changes in the basin drainage.

SECTION VI

PRELIMINARY DESIGN

General

A meeting was held with the City and other involved entities to determine a recommended plan of improvements for the basin based on the alternative concepts described in the original Muller study. The preferred current Alternative 3, which constitutes prudent line setbacks and partial channel stabilization along with regional detention facilities and onsite detention to detain future developed flows to existing rates, is the recommended plan in this revised study. The recommended plan was further evaluated and incorporated in the preliminary design presented in Appendix A.

The following is a brief discussion of the key elements of the Smith Creek Basin and recommended improvements on a reach-by-reach basis. The reach designations used for the report are a combination of the nomenclature used in the original Muller report and new reaches created for computer modeling by JR Engineering. This arises since the Muller study created reaches that, in general, spanned areas of Smith Creek from hydraulic structure (pipe, culvert, etc.) to hydraulic structure, forming several pieces that, at times, were not continuous. The Muller reaches are identified in the design drawings as the reach name ("SC01", for example) with no parentheses. The designations used by JR look at Smith Creek in a contiguous manner and the reaches cover areas from tributary to tributary (SC01 goes from Monument Creek to Tributary A, SCO2 goes from Tributary A to the Pleier Road Tributary, etc.). This approach was used for computer modeling purposes and allowed greater ease in calculations since there were fewer pieces. The JR reaches are designated on the design drawings as the reach name in parentheses. The original Muller report has 15 total reaches (ten on Smith Creek and one for each tributary). The JR report has 13 reaches (seven on Smith Creek, one for each tributary and one for the wastewater treatment plant).

The original Muller designations were retained since they laid the basic backbone for the hydrological study. Since all of the existing computer data from Muller was set up in this fashion, it

remains as the foundation of the report. The reader is referred to the design plan and profile drawings in Appendix A, as necessary, to supplement the following discussion.

While the preliminary plan varies from reach to reach due to the unique physiographic characteristics of each, the reaches are linked by common components that provide continuity. This continuity is reflected by common improvements proposed throughout the basin, such as check structures, riprap channel protection, and adequately sized culverts. Riprap channel protection was proposed at locations where stream banks are currently eroded, and where there is the potential for erosion-based damage to public facilities as a result of larger developed flow rates and velocities. Riprap protection was also proposed at the downstream end of culverts. Culverts were sized using the El Paso County and City of Colorado Springs Drainage Criteria Manual (Colorado Springs/El Paso County, 1987). The majority of the existing culverts in the basin are inadequately sized to comply with criteria. Some proposed culvert replacements in this analysis require the use of multiple pipes as opposed to using one larger pipe. This was done so that, to the fullest extent possible, the existing roadways and crossings could maintain their existing grade. The prudent line setback concept was used for the entire basin upstream of the City/County boundary. The prudent line was not established in this report. However, each property that develops adjacent to the creek will be required to do a prudent line analysis per the county criteria. The portion of the basin within the city will not require this analysis. In addition, environmental analysis and determinations as required by the Army Corps of Engineers and/or US Fish and Wildlife Service may be required of development.

Reach Description

Smith Creek Reach 1 – SC01 (Page 2 of 13 in Design Drawings)

This reach extends from the Smith Creek confluence with Monument Creek upstream to Smith Creek's crossing with the southbound lanes of I-25. The majority of this reach is located on the U.S. Air Force Academy grounds and thus any improvements necessary in the conveyance channel are not the responsibility of El Paso County. It may be noted, though, that there are portions of the stream

bank that are being cut by stream movement and may in the future be in need of protection. Riprap channel protection is suggested on the downstream end of the I-25 bridge.

Smith Creek Reach 2 – SC02 (Page 2 of 13 in Design Drawings)

This reach extends from the southbound lane of I-25 upstream to Smith Creek's crossing at North Gate Road. The section between the north and southbound lanes of I-25 has minimal signs of erosion to the channel, and thus the only suggested improvements are riprap protection at the outlets of a storm sewer and the I-25 bridge. The Colorado Department of Transportation has indicated that the existing double barrel 10-foot by 10-foot reinforced concrete box culverts underneath the southbound and northbound lanes of I-25 are adequately sized for a 100-year flood. From the northbound lane of I-25 upstream to the Western Museum of Mining and Industry entrance road, the velocities within the main channel are erosive (in excess of 7 feet per second) yet the velocities in the overbanks are not. Due to the existence of the Preble's Mouse habitat in this reach and the Western Museum of Mining and Industry's plan for building an interpretive exhibit at this location, no hard lined channel improvements are recommended at this time. Also, this area of I-25 is currently under analysis for a proposed interchange between the interstate, existing Northgate Road and the future extension of Powers Boulevard. Therefore, any improvements in this portion of the reach would be negated by future construction. Erosion is not currently evident along this reach. It is thought that the existing stock ponds on the Western Museum of Mining and Industry property aid in attenuating the peak flows. If erosion begins to become an issue, natural channel stabilization is suggested in the form of plantings over buried riprap. It should be noted that an I-25 interchange is currently under study by CDOT, which has the ability to alter future activity within Reach 2.

The existing culvert underneath the Western Museum of Mining and Industry entrance road is grossly undersized. It was originally suggested in the Muller report that the entrance road be relocated to connect to North Gate Road on the south side of Smith Creek. After speaking with the Museum director about the historic nature of this road and the proposed alternatives, the horizontal relocation of this connection was not considered to be feasible. However, some of the structures on the Mining Museum property (the east and west bunkhouses, the east and west barns, and the modern main Museum building) are shown in the 100-year floodplain based upon the hydraulic model used

for this study and may be in danger of inundation during the 100-year storm event due to the undersized culvert. Per conversations with the Museum director, large storm events in recent history have not caused any adverse effects on the Mining Museum property and no structures appear to have been damaged due to inundation by water. It is therefore suggested that, when deemed feasible and necessary, grading operations around the entrance road to the Museum be performed such that flows will be channelized in the vicinity of the undersized culvert and pass into the downstream channel of Smith Creek. This will prevent flows from causing shallow flooding in the low areas on which the Museum currently exists and remove the previously mentioned historic structures from any danger of flooding. Due to the preliminary nature of this report, it is suggested that these improvements be analyzed in detail at the time of final engineering and the floodplain be modified accordingly. (See Map in Appendix for further detail)

The Reynolds Ranch, part of the Western Museum of Mining and Industry's property, has been listed on the Colorado State Register of Historic Properties since September 10, 1997 (see Appendix D for information).

Basin 701, the only proposed commercial development within the county is shown to have a privately owned and maintained on-site detention pond (RES701). This facility is required in order to limit peak flows to the USAFA to historic levels. Outfall analysis of the existing culvert under Interstate Highway 25 will be required of the developer of this parcel.

Smith Creek Reach 3 – SC03 (Pages 2 and 3 of 13 in Design Drawings)

This reach extends from North Gate Road upstream to the second stock watering pond designated as RES610 in the hydrologic modeling (refer to Figure III-4b). The 100-year floodplain in this reach is widespread but does not encroach upon houses or roads. This area is to become dedicated open space (see sheet 12 of 13). It is anticipated that the open space dedication will take place in 2002. In some locations, the channel slopes are steep and subject to degradation and erosion. This reach has become part of a Preble's Mouse mitigation plan for the Northgate development. Proposed habitat mitigation for the Preble's Mouse is currently taking place in this area under U.S.F.W. Application No. 199830164 and Army Corps of Engineers Section 404 Permit. Consequently, biological

stabilization in the form of "Biolog" drops and revegetation is proposed along this reach. In addition, it is proposed that the RES612 overflow be stabilized using riprap covered with topsoil and vegetation. The existing 54" x 39" culvert beneath North Gate Road is grossly undersized. It is suggested that the culvert be replaced in accordance with County and City criteria (Colorado Springs/El Paso County, 1987). At the writing of this report, a double barrel 10-foot by 10-foot reinforced concrete box culvert is proposed at this location.

The existing pond (RES612) located midway in the reach is proposed to have its overflow biologically stabilized. Originally, the Muller study proposed the raising of this dam and expanding this facility as a regional pond. This is no longer feasible due to the impact this would have on the Preble's Mouse. This existing pond will be owned and maintained by the City of Colorado Springs Parks Department once it is dedicated. This dedication is anticipated to take place in 2002.

Smith Creek Reach 4 – SC04 (Pages 3 and 4 of 13 in Design Drawings)

This reach extends from the stock watering pond (RES610) upstream to the confluence with Tributary A. The 100-year floodplain in this reach begins to narrow and does not encroach upon houses, nor overtop Walsen Road along the north side of the creek. As long as Walsen Road is not overtopped and the velocities remain non-erosive, no improvements are proposed in the reach. (NOTE: The JR Engineering HEC-RAS model considers Smith Creek between the Monument confluence and Tributary A as Reach SC01.)

Smith Creek Reach 5 – SC05 (Page 4 of 13 in Design Drawings)

This reach extends along Smith Creek from Tributary A upstream to Pleier Road. The 100-year floodplain is narrow and for the most part contained within the channel. In this reach, there are sections where the side slopes are eroded and steep. Consequently, it is suggested that the eroded banks adjacent to Walsen Road be protected with riprap in order to protect the road. The culvert outlets of Pleier Road are to be protected with riprap. Originally, in the Muller study, 10 check structures were recommended along this reach with additional bank stabilization. Due to the presence of the Preble's Mouse in the vicinity of this area, and the use of the prudent line setbacks, 8

of these check structures are no longer recommended. Two check structures, downstream of the riprap bank protection are recommended to protect Walsen Road.

As noted on the preliminary plan drawing, there are two private property access roads that cross Smith Creek in this reach. These culverts are grossly undersized per County criteria. In their existing state, neither culvert is adequately sized to pass the mean annual flood without overtopping the road. Since the road crossings are for private use, and there is no apparent property damage that would result from the backwater effects, it was concluded to not include any rehabilitation work to these culverts in the Preliminary design. However, it is recommended that the crossing either be eliminated or be replaced with culverts adequately sized per County requirements. In the event the culverts need to be replaced or removed, the private property owner shall be responsible for the cost.

Smith Creek Reach 6 – SC06 (Page 5 of 13 in Design Drawings)

This reach extends from Pleier Road upstream to the confluence with Tributary B. As with SC05, the majority of the 100-year floodplain is contained within the natural channel. For this reach, it is suggested that the eroded banks be cut back to a 4:1 slope and protected with vegetation in the vicinity of the proposed regional detention facility. This vegetation should factor into account the possible presence of the Preble's Meadow Jumping Mouse and any beneficial plant species that could enhance the environment and habitat are suggested pending live trapping verification. A double barrel 10-foot by 10-foot reinforced concrete box culvert is proposed to replace the existing 36" and 60" C.M.P.'s in Pleier Road.

This reach contains the first regional detention facility of the two suggested for the basin. This facility is proposed to be a dry pond located just upstream of the existing private drive with embankment (see photo # 22 in Technical Addendum). This detention pond (RES407) will have a volume of 15.5 acre-feet (not including water quality volume) and a staged release of $Q_2 = 56$ cfs, $Q_5 = 243$ cfs, $Q_{10} = 482$ cfs, $Q_{50} = 1103$ cfs and $Q_{100} = 1882$ cfs. This facility will require the removal of the existing undersized culvert at the drive and the removal and rebuilding of the driveway embankment. Two feet of freeboard is recommended. Due to the preliminary nature of this drainage facility, no specifics on this regional pond are contained in this report. At the time of final design and

construction, matters such as land acquisition and final build-out will facilitate a more precise design process. (NOTE: The JR Engineering HEC-RAS model considers Smith Creek between Tributary A and the Pleier Road Tributary as SC02 and from the Pleier Road Tributary to Tributary B as SC03.)

Smith Creek Reach 7 – SC07 (Page 5 of 13 in Design Drawings)

This reach extends from the Tributary B confluence upstream to the Wastewater Treatment Facility. The hydraulics for this reach of the channel are similar to SC06 with the majority of the 100-year floodplain contained within the natural channel. To protect the bends from eroding further, it is proposed that the eroded bank be cut back to no steeper than 2.5:1, and riprap be placed at the toe of the banks as shown. (NOTE: The JR Engineering HEC-RAS model considers Smith Creek between Tributary B and the outlet of the Wastewater Treatment Facility as SC04.)

Smith Creek Reach 8 – SC08 (Pages 5 and 6 of 13 in Design Drawings)

This reach extends from the Wastewater Treatment Facility upstream to the confluence with Tributary C. The channel is not very distinct in this reach, and flooding during the 100-year event is wide spread. This is the location for the second regional detention facility (RES316). A dry pond upstream of the existing well house with a volume of 10.3 acre-feet (not including water quality volume) and a staged release of Q_2 = 42 cfs, Q_5 = 163 cfs, Q_{10} = 325 cfs, Q_{50} = 771 cfs and Q_{100} = 1219 cfs is proposed. Two feet of freeboard is recommended. (NOTE: The JR Engineering HEC-RAS model considers Smith Creek between the Wastewater Treatment Facility outlet and Tributary C as SC05.)

Smith Creek Reach 9 – SC09 (Page 6 of 13 in Design Drawings)

This reach extends from the Tributary C confluence upstream to the confluence with Tributary D. The 100-year floodplain in this reach is fairly narrow, due to the diminished tributary runoff. The channel is not so eroded that it is in need of protection. The only suggested improvement is one drop structure at the existing horseshoe shaped cut location. (NOTE: The JR Engineering HEC-RAS model considers Smith Creek between Tributary C and Tributary D as SC06.)

Smith Creek Reach 10 – SC10 (Page 6 of 13 in Design Drawings)

This reach extends from the Tributary D confluence upstream to Roller Coaster Road, which is the upstream hydraulic limit of this study for Smith Creek. From Tributary D to Stella Drive, the 100-year floodplain is narrow and channelized. However, from Stella Drive to Roller Coaster Road through Fox Run Park, the 100-year floodplain is for the most part widespread and shallow. Riprap channel protection is suggested just downstream of the culvert at Stella Drive. The culverts at Stella Drive and Roller Coaster Road are proposed to be replaced. The Stella Drive culvert is inadequate per County criteria and the suggested replacement size is an 8-foot by 6-foot reinforced concrete box culvert. Although Roller Coaster Road and its crossing with Smith Creek are not contained within the limit of study of this drainage report, it was considered necessary to size a proposed replacement structure that properly meets county criteria. It is proposed to replace the existing 24" R.C.P. culvert with a 4-foot by 6-foot box culvert. The culverts within Fox Run Park, although undersized in some cases, are not recommended to be replaced at this time. The floodplain through Fox Run is broad and shallow and does not affect any major structures. Due to the open space nature of the park, no widespread damage would be anticipated in a major storm event and is considered to be a viable option compared with the costs of upgrading the storm system. This is in keeping with the drainage criteria manuals. It is suggested that if any construction of major structures is undertaken in the park a cost evaluation be performed to determine the economic feasibility of a storm upgrade. (NOTE: The JR Engineering HEC-RAS model considers Smith Creek between Tributary D and the limit of study as SC07. All tributaries maintain the original Muller nomenclature.)

Tributary A – TA01 (Page 7 of 13 in Design Drawings)

This reach extends from its confluence with Smith Creek (just downstream of Walsen Road) upstream to its third crossing of Sun Hills Drive, which is the upstream limit of study for Tributary A. From the confluence to slightly upstream of Shelty Road, the channel is steep and the 100-year floodplain is channelized. This channel appears to be stable and well vegetated.

Tributary A crosses five roads. All five of these culverts are inadequately sized per County criteria. The proposed culvert sizes are 60" reinforced concrete pipes under Walsen and Shelty Roads, triple barrel 48" reinforced concrete pipes under Sun Hills Drive crossing #1, triple barrel 36" reinforced

concrete pipes under Sun Hills Drive crossing #2, and a 7-foot by 4-foot reinforced concrete box culvert under Sun Hills Drive Crossing #3. Under the current condition, the 100-year runoff will overtop the roads and cause spatially varied flow and shallow flooding along the roadways parallel to the drainageway. The main objective of the proposed improvements is to eliminate the flooding along the roadway and contain the runoff in the channel.

Tributary B - TB01 (Page 8 of 13 in Design Drawings)

This reach extends from its confluence with Smith Creek (1/4 mile upstream of Pleier Road) to 2,000 feet upstream of Stella Drive, which is the upstream limit of study for Tributary B.

The 100-year floodplain between its confluence and Spring Valley Drive, for the most part, is widespread and shallow. Upstream of Spring Valley Drive the flow is channelized and the 100-year floodplain is not excessively wide. In this portion of the reach, 9 check structures are suggested for streambed protection. It is proposed that the culverts underneath Spring Valley Drive and Stella Drive be replaced with larger culverts sized per County criteria. It is suggested that the Spring Valley Drive culvert be replaced with a 60" reinforced concrete pipe, and the Stella Drive culvert be replaced with an 8-foot by 4-foot reinforced concrete box culvert. Downstream of this culvert, riprap is suggested for channel protection.

North of Stella Drive, the streambed has migrated to the west into adjacent private property. It is recommended that the stream be stabilized to protect the existing homes.

Tributary C - TC01 (Page 9 of 13 in Design Drawings)

This reach extends from its confluence with Smith Creek (1/4 mile downstream of Stella Drive) upstream to Fools Gold Road, which is the upstream limit of study for Tributary C. Drainage from the area tributary to Tributary C is scattered throughout the basin with many small and undefinable drainage paths. This is most apparent upstream of Roller Coaster Road where the runoff does not concentrate enough in one drainage path to define the limits of flooding during the 100-year storm. The runoff begins to be channelized downstream of Roller Coaster Road. It is suggested that the existing culvert underneath Roller Coaster Road be replaced with triple barrel 30" reinforced

concrete pipes. At Raton Road, there is an existing culvert that is grossly undersized per County criteria. Runoff spatially diverts 250 feet south where it overtops the road. To eliminate the flow from overtopping Raton Road in the future, it is suggested that the Raton Road culvert be replaced with triple barrel 36" reinforced concrete pipes and a swale be excavated to help channelize the flow to the culvert. Downstream of Raton Road, the drainageway is more definable. For this section, it is suggested that 12 check structures be installed for bed protection.

Tributary D - TD01 (Page 10 of 13 in Design Drawings)

This reach extends from its confluence with Smith Creek (just downstream of Stella Drive) to ¼ mile upstream of Stella Drive, which is the upstream limit of study for Tributary D. Hydrologically, there is a small quantity of runoff tributary to the basin. Because of this, there is no need for bed protection in the drainageway. Presently, what little flow there is will partially overtop Stella Drive with the majority being routed along Stella Drive to Smith Creek. Currently, there is no culvert under Stella Drive. It is suggested that a swale be excavated along the north side of Stella Drive to carry the flow to Smith Creek. A 36" reinforced concrete pipe culvert is suggested for the Fox Run entrance crossing.

Pleier Road Tributary - PR01 (Page 11 of 13 in Design Drawings)

This reach extends from its confluence with Smith Creek near Pleier Road upstream to Silverton Road, which is the upstream limit of study for the reach. Hydrologically, there is a small quantity of runoff tributary to this reach. For the most part, drainage is shallow and scattered throughout the basin with many small and undefinable drainage paths. Runoff does not concentrate enough upstream of Raton Road in one drainage path to define the limits of flooding during the 100-year storm. Consequently, no major drainageway improvements are proposed for this reach.

Wastewater Treatment Plant – WWTP (Page 5 of 13 in Design Drawings)

This reach extends from its confluence with Smith Creek (1/2 mile upstream of Smith Creek/Tributary B confluence) to the outlet of the Wastewater Treatment Plant approximately 270 feet north of the confluence. This reach, although small, was created to account for the Wastewater Treatment Plant effluent in the computer models. No improvements are suggested for this reach.

Wetland and Preble's Mouse Habitat Protection

Wetlands serve a vital role in controlling floods, maintaining groundwater supplies, trapping sediments and pollutants, purifying water and providing essential habitat areas. The Clean Water Act, 33 CFR 320.4(b)(1), states that "wetlands constitute a productive and valuable public resource, the unnecessary alteration or destruction of which should be discouraged as contrary to public interest." Protection and enhancement of the remaining wetlands should be regarded as a priority in any improvement alternatives. In addition, any construction within or adjacent to the channel may require a US Fish and Wildlife consultation concerning the presence of the Preble's Mouse. The "El Paso County Regional Habitat Conservation Plan for Preble's Meadow Jumping Mouse" (RHCP) is the County's guideline document in regard to these matters. Prior to planning any development in the Smith Creek Basin, the developer will need to consult the RHCP for necessary agency involvement and approval.

When evaluating and granting a permit request to impact wetlands or Preble's Mouse habitat, the Corps of Engineers must conclude, according to the Section 404 guidelines and consultation with other regulatory agencies, that no practicable and less damaging alternative to the proposed activity exists and that "...the benefits of the proposed alteration outweigh the damage to the wetlands resource." It is therefore incumbent to promote an improvement program that examines practicable alternatives (including "no action") and avoids all activity in wetland and Preble's Mouse habitat areas wherever possible. Where avoidance is impossible within the public interest and least damaging alternative parameters, the regulatory guidelines provide for an opportunity to establish a mitigation program to offset or compensate for an anticipated loss of wetlands and Preble's Mouse habitat. Best Management Practices (BMP's) specific to working within the Preble's Mouse Protection Areas (MPA's) shall be strictly adhered to. These BMP's can be obtained from the El Paso County Department of Transportation or the El Paso County Environmental Services Department.

Typically, a mitigation program (such as the El Paso County RHCP) might include one or a combination of the following: (1) replacing lost wetland and Preble's Mouse habitat area and function by creating new wetlands and Preble's Mouse habitat elsewhere on the site or, as a less

desirable alternative, at an off-site location; (2) upgrading the condition of deteriorated wetlands and Preble's Mouse habitat that are in danger of further degradation or loss; (3) acquiring off-site wetland and Preble's Mouse habitat properties to be held, in perpetuity, as protected open space; or (4) making a financial contribution to a land trust or other entity to be used for land acquisition and protection purposes. Options involving creating or upgrading wetlands and Preble's Mouse habitat would be accompanied by a plan to effectively ensure the long term success and function of such areas. At the writing of this report, Picolan Inc. is involved in a mitigation program for the (1) option by replacing habitat or upgrading habitat elsewhere in the Northgate development.

Stormwater Quality

Stormwater quality issues were considered in the conceptual design of this drainage basin planning study. Certain improvements such as non-bypass detention facilities and the preservation of wetland bottom, grass-lined open channel systems were included in the preliminary design. Although the proposed regional detention ponds were sized for detention of flood events, they were not analyzed as stormwater quality detention systems. Stormwater quality enhancements will be required to be incorporated during final design. El Paso County and the City of Colorado Springs have prepared basin-wide "Section 208" plans to be in accordance with the Environmental Protection Agency guidelines set forth in Section 208 of the Federal Water Pollution Control Act Amendments of 1972. The general objectives of these plans are to establish policies, programs, and appropriate regulatory guidelines to limit non-point pollution to ground and surface waters resulting from development, abate existing pollutant loadings to the best extent possible, and integrate water quality considerations in the management of stormwater runoff and flood control.

The planning for water quality management of stormwater runoff should be implemented during final design and construction of the recommended improvements and new developments within the basin. Stormwater quality measures should be considered to reduce the entry of pollutants into stormwater at or near their source, such as preventing and controlling erosion during construction and reducing improper disposal of household toxins in conjunction with public awareness programs. Due to the broad scope of this report, specific water quality improvements are not suggested at this

time. It is recommended that, at the time of final design for each drainage improvement, the appropriate water quality measures be implemented.

Operation and Maintenance

All proposed drainage facilities will require the appropriate, responsible agency to have access for maintenance and inspection purposes. This will require acceptable travel corridors to the facilities for City or County crews. As property is platted within the basin, maintenance access to the channel will therefore be required. This can be accomplished by establishing easements through private property and over the established channel setbacks for proper access. Proposed regional detention facilities will require land acquisition and the costs associated with the purchase of this land. Maintenance access routes have been preliminarily shown in the maps in the appendix and may be revised if necessary. Final design of easements is left to the County/City and developer of final determination. More access locations may be required by the County at the time of final design.

Maintenance of stormwater routing facilities is necessary to assure proper operation of the facilities as designed prior to the arrival of the design flood. Clogging of culverts, detention basin outlets, and storm sewer facilities, including inlets and piping, can reduce capacities to below the design peak flows, thus reducing the provided level of protection. It is recommended that a debris and sediment removal plan be implemented within the Smith Creek Basin. Again, it is suggested that the appropriate plans be determined and implemented at the time of final design.

Routine inspection and maintenance of all improvements should be implemented. This should include, but not be limited to: inspection and maintenance of detention pond berms, outflow works and spillways, and the structural condition of all storm sewers and open channel facilities. The implementation of a routine inspection and maintenance program should improve safety concerns, reduce potential for major rehabilitation work of drainage facilities, and keep the level of protection against flooding similar to that as designed.

Construction Sequencing

Generally, it is recommended that the proposed major drainageway facilities be constructed from downstream to upstream as much as possible. This is also true for the detention basins to be constructed before development occurs upstream. Increased runoff from new developments without proper detention or downstream conveyance capacity could result in more frequent flooding downstream. In addition, the USAFA requirement for no increased peak runoff mandates that these regional detention facilities be in place prior to development.

The regional detention facilities (RES407 and 316) will be built under the following criteria. RES316 will be required for developments in Basins 201, 203, 217, 219, 209, 211, 213, 207, 205, 301, 303, 215, 315, 313, 311, 309, 307 and 305. RES407 will be required for developments in Basins 101, 103, 105, 107, 109, 111, 401, 403, 405, 407, 501, 503, 505, 507, 509, 511, 601, 603, 605, 607, 609, 611, 613 and 615. It is recommended that any development falling within areas tributary to these ponds be allowed to detain flows requiring 0.5 acre-feet or less in storage volume in a temporary on-site facility. Any development requiring more than 0.5 acre-feet of detention storage will be required to construct the applicable regional facility as part of its acceptance by the county. If several smaller developments requiring 0.5 acre-feet or less in storage are constructed, the development that is responsible for the cumulative sum of tributary storage to surpass 50% of the proposed volume of the regional facility will be responsible for the construction of the regional facility. Please refer to the design drawings and reach descriptions in this report for the proposed regional facility storage volumes.

Initially, it is suggested that the improvements proposed for locations where the streambed and banks are currently threatened with erosion be implemented first. Two locations where this is occurring the most are in reaches SC05 and SC06. Another critical area of improvement is the replacement of the existing culverts grossly undersized per County criteria. Currently, even during the more frequent events, runoff will overtop the road and the potential exists for flood damage and erosion at these locations. Next on the list for implementation would be completing the remainder of the streambed and bank stabilization improvements (i.e. check structures and riprap and/or vegetation bank

protection). In general, the more rapid the development taking place, the more rapid the need for the implementation of all of the improvements.

Phase II Stormwater Regulations

Currently, the City of Colorado Springs and El Paso County are in the process of adopting new criteria concerning stormwater management. These new criteria will be known as the Phase II Stormwater Regulations. At the writing of this report, the new regulations were not officially adopted and were not accounted for in this DBPS. All proposed facilities in this report will be subject to the Phase II regulations at such time as they are officially adopted and implemented.

SECTION VII

COST EVALUATION OF THE PRELIMINARY PLAN

General

Quantities and costs were evaluated for the major drainage improvements presented in the preliminary design on the plan and profile drawings in Appendix A. These improvements include the replacement of inadequately sized culverts, storm sewers, flattening of eroded channel banks and placement of riprap for channel protection, regional detention facilities to attenuate the peak discharges from fully developed conditions to existing rates, and the construction of check and drop structures for streambed stabilization. Costs for the proposed improvements were conceptually estimated using the unit costs in Table VII-1.

Improvement Costs and Estimated Fees

The cost for each improvement was divided into the following categories: major drainageway costs and land acquisition costs for the detention facilities. All of the costs for the construction related items have incorporated 5% for contingencies, 10% for engineering and 5% for wetland/mouse habitat permitting in the total construction budget. No allowances were included for legal and administrative costs. Utility relocation costs were included in the unit costs of the drainage and bridge improvements, since few relocations are anticipated to be required in the basin. The cost of the Smith Creek Drainage Basin Planning Study was incorporated in the major drainageway costs. Please refer to Appendix C for fee calculation information.

For the purpose of evaluating the basin fees, the costs were separated into creditable and non-creditable categories. The creditable costs represent drainage improvements that, if paid for and constructed by the developer, could be reimbursed by either the City or the County as part of a master planned drainage basin. The creditable costs would subsequently be offset by drainage fees paid on a per-acre basis in connection with the development of a subdivision within the basin. Non-creditable costs represent drainage improvements that would be the sole responsibility of the party

responsible for their construction. Examples of this include a developer needing to construct a particular improvement to handle only the additional drainage created by this proposed development. More typically, non-creditable costs are indicated as county responsibility in the fee summary.

SECTION VIII

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:kd/889690/DBPS rev 052202

APPENDIX A

PRELIMINARY DESIGN DRAWINGS

SMITH CREEK DRAINAGE BASIN PLANNING STUDY

CITY OF COLORADO SPRINGS, COUNTY OF EL PASO, STATE OF COLORADO

PRELIMINARY PLAN

AUGUST 2002

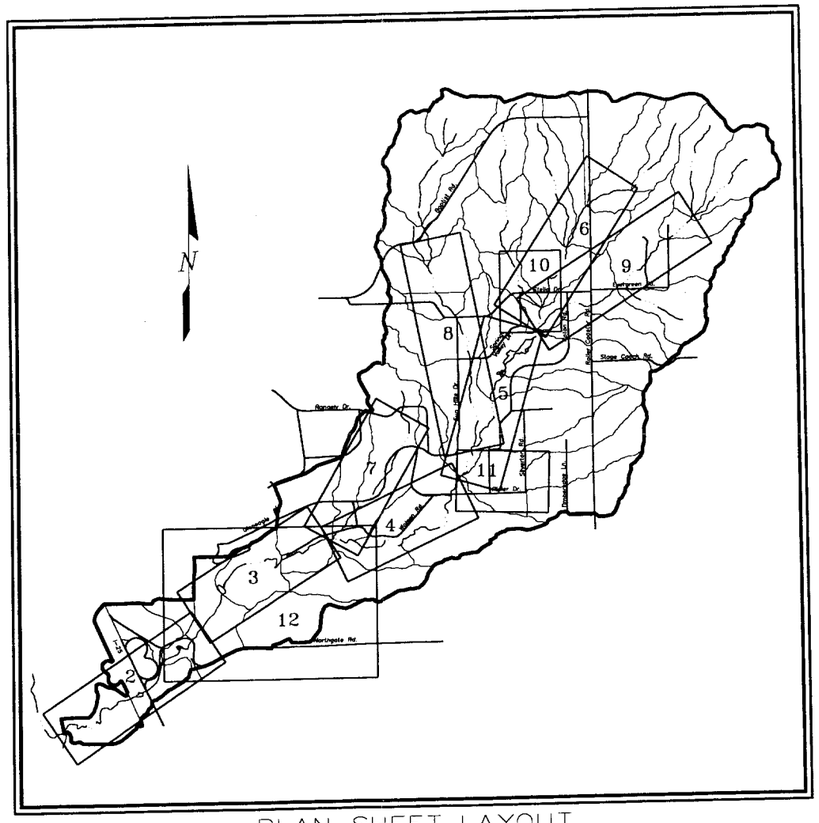
LEGEND FOR PLAN AND PROFILE SHEETS

PLAN

- 50+00 — STATION LINE
- 100-YEAR FUTURE FLOODPLAIN — ALSO, FLOODPLAIN FOR EXISTING PHYSICAL CONDITION CLOSELY MATCHING FLOODPLAIN ASSOCIATED WITH THE FUTURE IMPROVEMENTS AS PROPOSED PER THIS PRELIMINARY PLAN EXCEPT WHERE OTHERWISE SHOWN
- 100-YEAR EXISTING FLOODPLAIN — WHERE NONCOINCIDENT WITH FUTURE CONDITIONS
- ZONE OF SHALLOW FLOOD LIMITS
- EXISTING THALWEG (FROM FIMS MAPPING)
- PRUDENT LINE
- CHECK STRUCTURE
- CUT BACK BANK AND PROTECT WITH VEGETATION
- RIPRAP CHANNEL PROTECTION
- RIPRAP TOE PROTECTION
- CUT BACK BANK AND PROTECT TOE WITH RIPRAP
- SC01 — MULLER REACH IDENTIFIERS
- (SC01) — JR ENGINEERING REACH IDENTIFIERS USED IN BASIN MODELING

PROFILE

- FUTURE STREAM BED
- EXISTING STREAM BED — WHERE THE EXISTING BED DOES NOT CHANGE IN FUTURE CONDITIONS THE EXISTING STREAM BED IS SHOWN.
- PROPOSED ROAD EMBANKMENT
- EXISTING ROAD EMBANKMENT
- 100-YEAR FUTURE WATER SURFACE PROFILE — FUTURE AND EXISTING CONDITION WATER SURFACE PROFILES MAY CONCIDE IN WHICH FUTURE IS DELINEATED.
- 100-YEAR EXISTING WATER SURFACE PROFILE
- CHECK STRUCTURES
- 705 — ROUTING ELEMENTS USED IN MODELING
- 705 — DESIGN POINTS USED IN MODELING
- 612 — DETENTION PONDS USED IN MODELING



PLAN SHEET LAYOUT

SCALE: N.T.S.

SHEET INDEX

SHEET NO.	TITLE
1	TITLE SHEET
2–11	PLAN AND PROFILE SHEETS
12	PLAN VIEW– CITY IMPROVEMENTS
13	DETAIL SHEET

GENERAL NOTES:

1.) THESE DRAWINGS ARE FOR MASTER PLANNING PURPOSES AND REPRESENT PRELIMINARY ENGINEERING. ALTERNATIVES TO THIS OUTFALL SYSTEM MAY BE CONSIDERED BY EL PASO COUNTY PROVIDED THE ALTERNATIVE OFFERS EQUAL HYDROLOGIC RESPONSE AND HYDRAULIC CAPACITY AND STREAM STABILITY. THE ALTERNATIVE MUST COMPLY WITH ALL REQUIREMENTS OF EL PASO COUNTY OR OTHER LOCAL, STATE AND FEDERAL AGENCIES HAVING JURISDICTION OVER THE AREA BEING DEVELOPED. THESE DRAWINGS SHALL NOT BE USED FOR CONSTRUCTION

2.) UTILITIES SHOWN ARE BASED ON INFORMATION SUPPLIED BY LOCAL UTILITY DISTRICTS AND UTILITY COMPANIES. ALL LOCATIONS ARE APPROXIMATE. VERIFY ALL LOCATIONS AND DEPTHS DURING FINAL DESIGN.

3.) DRAINAGE FACILITIES ARE PROPOSED ON THE PLANS AND ARE BASED ON FUTURE HYDROLOGIC CALCULATIONS FOR THIS MASTER PLAN.

4.) EXISTING DRAINAGE SYSTEM LOCATIONS ARE SCHEMATICALLY DEPICTED ON THE DRAWINGS.

5.) REGIONAL DETENTION POND SIZES SHOWN ARE APPROXIMATE AND SHOULD BE VERIFIED DURING FINAL DESIGN. THE FINAL DESIGN OF ALL DETENTION FACILITIES SHOULD CONSIDER WATER QUALITY MEASURES AND EMERGENCY OVERFLOWS, INCLUDING EMERGENCY OVERFLOW REQUIREMENTS, EROSION PROTECTION, AND SURFACE RELIEF ROUTES.

6.) RIPRAP EROSION PROTECTION SHOULD BE PLACED AT ALL CULVERTS, BRIDGES, STORM SEWER OUTLETS AND CERTAIN INLETS, AND ALL OTHER LOCATIONS WHERE CONDITIONS DICTATE THIS

7.) HEADWALLS AND WINGWALLS SHOULD BE INCLUDED FOR ALL CHANNEL CROSSINGS IN ACCORDANCE WITH COLORADO DEPARTMENT OF TRANSPORTATION STANDARDS.

8.) THIS PLAN DOES NOT INDICATE LIMITS OF EXISTING WETLANDS OR EXISTING PREBLES MEADOW JUMPING MOUSE HABITAT. BOTH WILL NEED TO BE ESTABLISHED AND PERMITS OBTAINED FROM THE US ARMY CORPS OF ENGINEERS AND USFW PRIOR TO CONSTRUCTION. THESE PLANS ARE A PLANNING TOOL AND NOT INTENDED TO BE USED AS FINAL CONSTRUCTION DOCUMENTS.

PREPARED BY:

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SMITH CREEK DRAINAGE BASIN PLANNING STUDY

COVER SHEET

SHEET 1 OF 13

JOB NO. 8896.90

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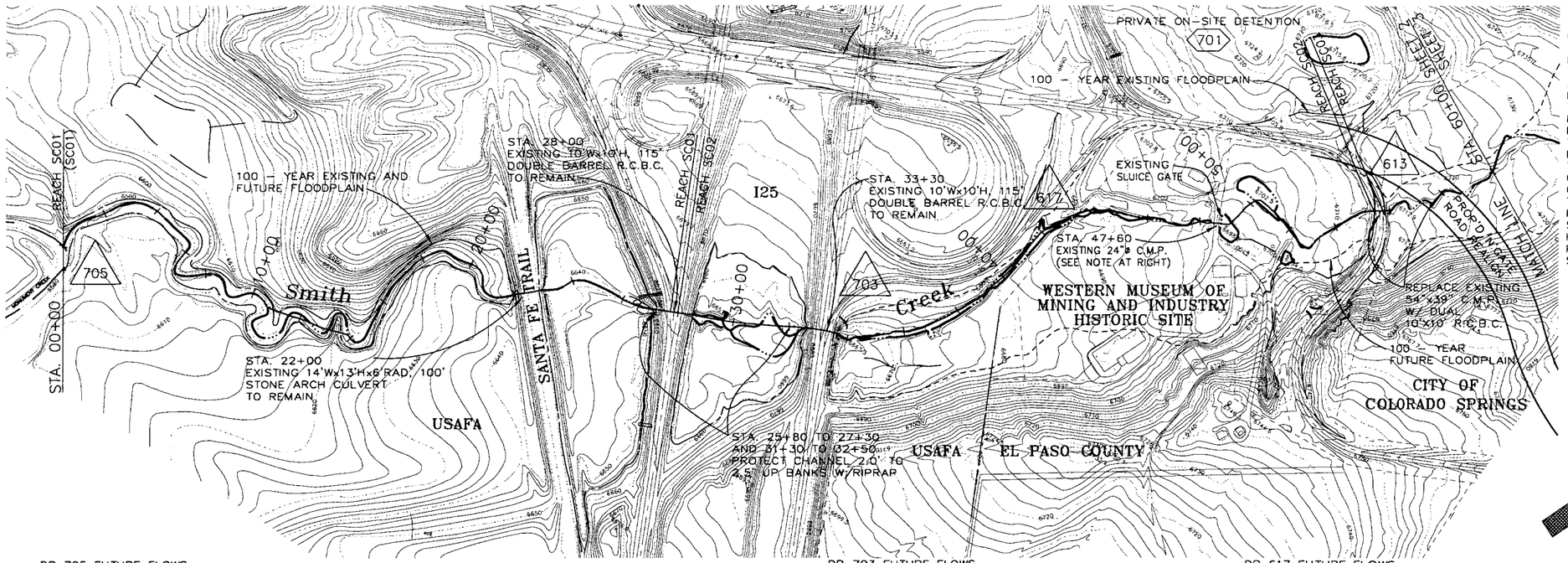
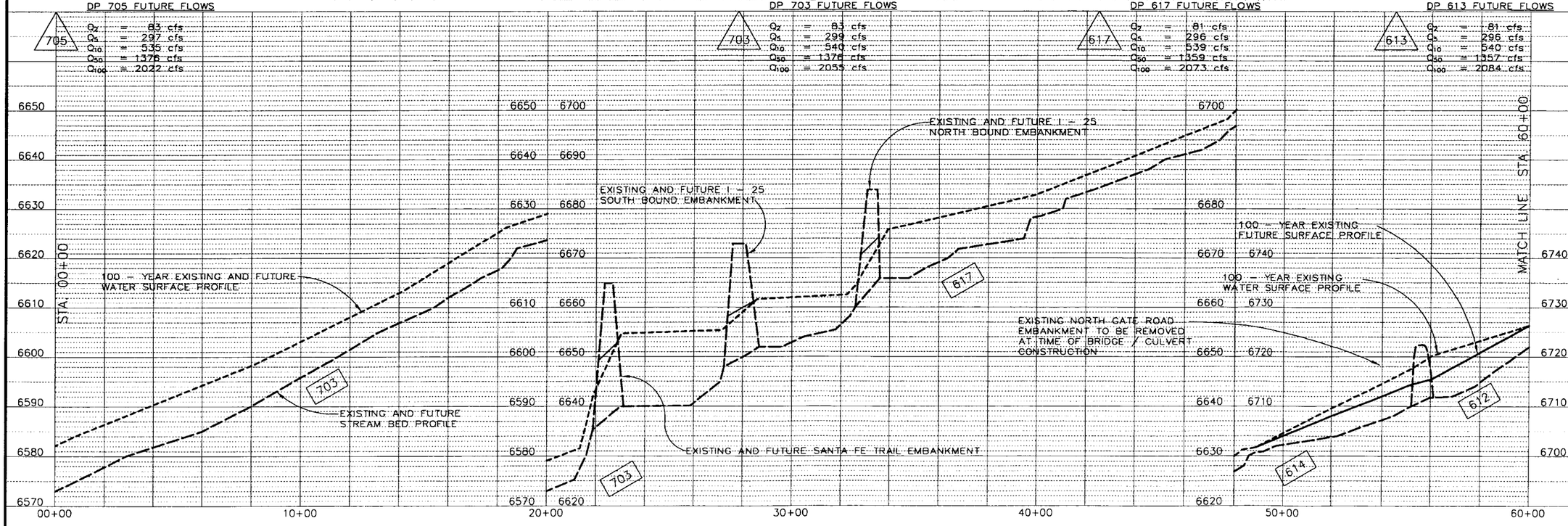


NOTE: THE EXISTING 24" DIAMETER CULVERT UNDER THE ACCESS ROAD TO THE MINING MUSEUM IS GROSSLY UNDERSIZED PER COUNTY CRITERIA. THERE IS NO APPARENT PROPERTY DAMAGE AT THIS LOCATION. DUE TO THE HISTORIC NATURE OF THIS SITE, AND THE HISTORIC USE OF THIS ROAD, AND AFTER SPEAKING WITH THE MUSEUM DIRECTOR, IT IS RECOMMENDED THAT THE CULVERT REMAIN WITH THE UNDERSTANDING THAT PERIODIC FLOODING OF THIS LOCATION MAY OCCUR. AT SUCH TIME THAT IT IS DEEMED FEASIBLE OR NECESSARY, GRADING OPERATIONS ARE RECOMMENDED IN THIS AREA TO MODIFY THE FLOODPLAIN AND REMOVE EXISTING STRUCTURES FROM INUNDATION HAZARD. A NEW CULVERT SIZED PER COUNTY CRITERIA IS ALSO SUGGESTED.

DP 705 FUTURE FLOWS	DP 703 FUTURE FLOWS	DP 617 FUTURE FLOWS	DP 613 FUTURE FLOWS
Q_2 = 83 cfs	Q_2 = 83 cfs	Q_2 = 81 cfs	Q_2 = 81 cfs
Q_5 = 297 cfs	Q_5 = 299 cfs	Q_5 = 296 cfs	Q_5 = 296 cfs
Q_{10} = 535 cfs	Q_{10} = 540 cfs	Q_{10} = 539 cfs	Q_{10} = 540 cfs
Q_{50} = 1376 cfs	Q_{50} = 1376 cfs	Q_{50} = 1359 cfs	Q_{50} = 1357 cfs
Q_{100} = 2022 cfs	Q_{100} = 2055 cfs	Q_{100} = 2073 cfs	Q_{100} = 2084 cfs



NOTE:

CREEK BOTTOM PROFILE PER MULLER ENGINEERING STUDY.

PREPARED UNDER MY DIRECT SUPERVISION FOR AND ON BEHALF OF JR ENGINEERING

LUANNE D. RUBEY, COLORADO P.E. # 32339 DATE

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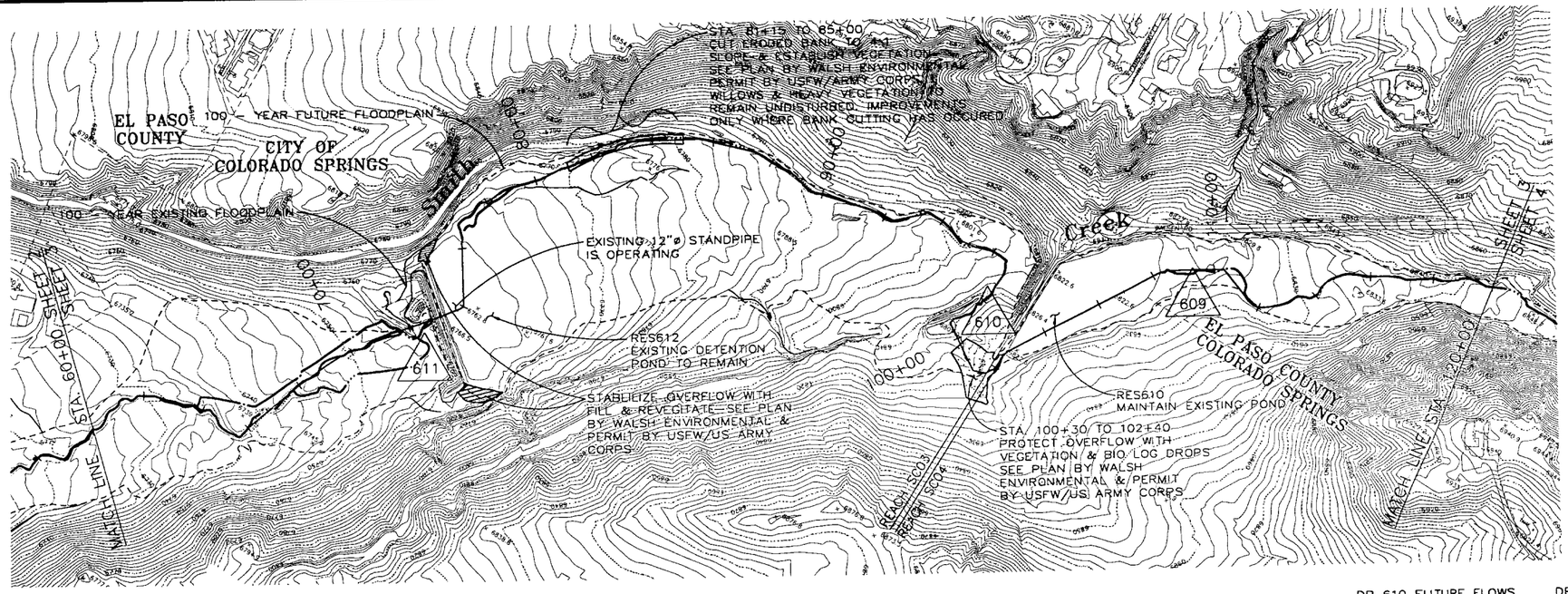
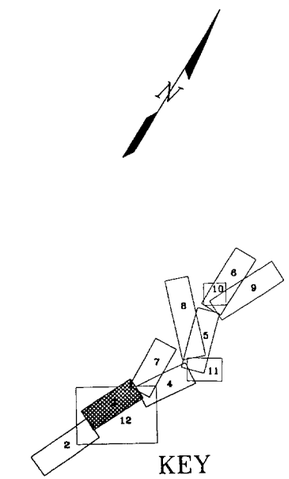
SMITH CREEK
DRAINAGE BASIN PLANNING STUDY

PRELIMINARY PLAN AND PROFILE
STA 00+00 TO STA 60+00

SHEET 2 OF 13

JOB NO. 8896.90





DP 611 FUTURE FLOWS

611

Q_2	=	75 cfs
Q_5	=	284 cfs
Q_{10}	=	526 cfs
Q_{50}	=	1352 cfs
Q_{100}	=	2040 cfs

DP 610 FUTURE FLOWS

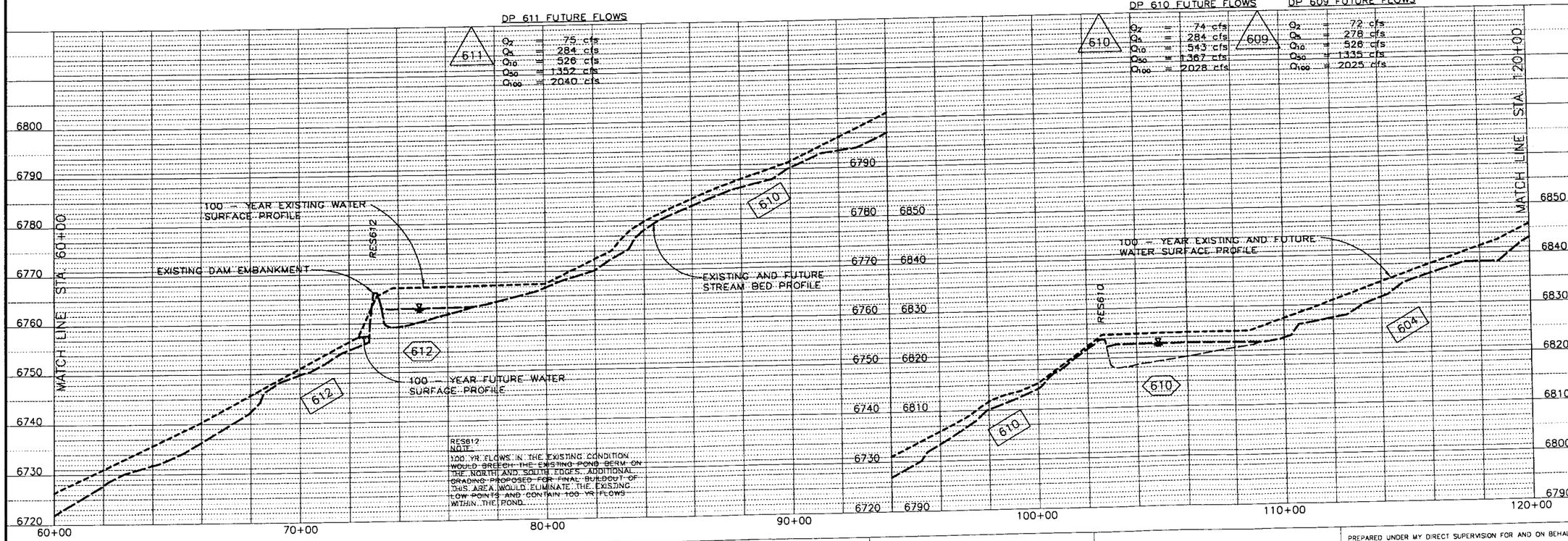
610

Q_2	=	74 cfs
Q_5	=	284 cfs
Q_{10}	=	543 cfs
Q_{50}	=	1367 cfs
Q_{100}	=	2028 cfs

DP 609 FUTURE FLOWS

609

Q_2	=	72 cfs
Q_5	=	278 cfs
Q_{10}	=	526 cfs
Q_{50}	=	1335 cfs
Q_{100}	=	2025 cfs



NOTE:

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CHECKED BY	

SMITH CREEK
DRAINAGE BASIN PLANNING STUDY

PRELIMINARY PLAN AND PROFILE
STA 60+00 TO STA 120+00

SHEET 3 OF 13

JOB NO. 8896.90

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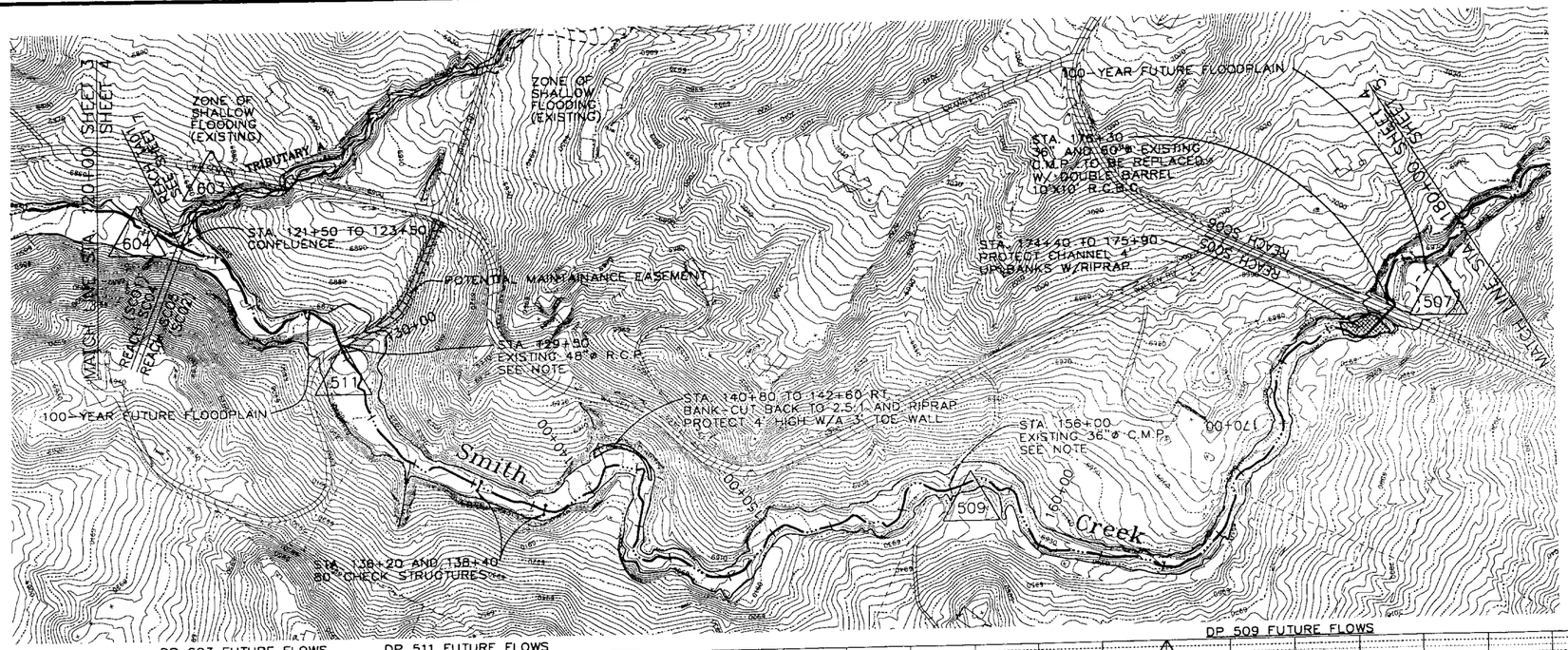
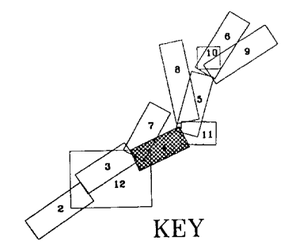


NOTE: TWO PRIVATE PROPERTY ACCESS ROADS CROSS SMITH CREEK AT STA. 129+50 AND STA. 156+00. THE EXISTING CULVERTS BENEATH THESE ROADS ARE GROSSLY UNDERSIZED PER COUNTY CRITERIA. SINCE THE ROADS ARE FOR PRIVATE USE, AND THERE IS NO APPARENT PROPERTY DAMAGE THAT WOULD RESULT FROM THE BACKWATER EFFECTS, IT WAS CONCULDED TO NOT INCLUDE ANY REHABILITATING WORK TO THESE CULVERTS IN THIS PRELIMINARY PLAN. HOWEVER, IT IS RECOMMENDED THAT THE CULVERTS EITHER BE ELIMINATED OR REPLACED WITH ADEQUATELY SIZED CULVERTS. IN THE EVENT THE CULVERTS ARE IN THE NEED TO BE REPLACED, OR REMOVED, THE PRIVATE PROPERTY OWNER SHALL BE RESPONSIBLE FOR THE COST AND THE WORK SHALL BE PERFORMED IN ACCORDANCE WITH COUNTY REQUIREMENTS.



DP 603 FUTURE FLOWS

Q_2	= 17 cfs
Q_5	= 52 cfs
Q_{10}	= 83 cfs
Q_{50}	= 176 cfs
Q_{100}	= 241 cfs

DP 511 FUTURE FLOWS

Q_2	= 66 cfs
Q_5	= 260 cfs
Q_{10}	= 495 cfs
Q_{50}	= 1250 cfs
Q_{100}	= 1891 cfs

DP 604 FUTURE FLOWS

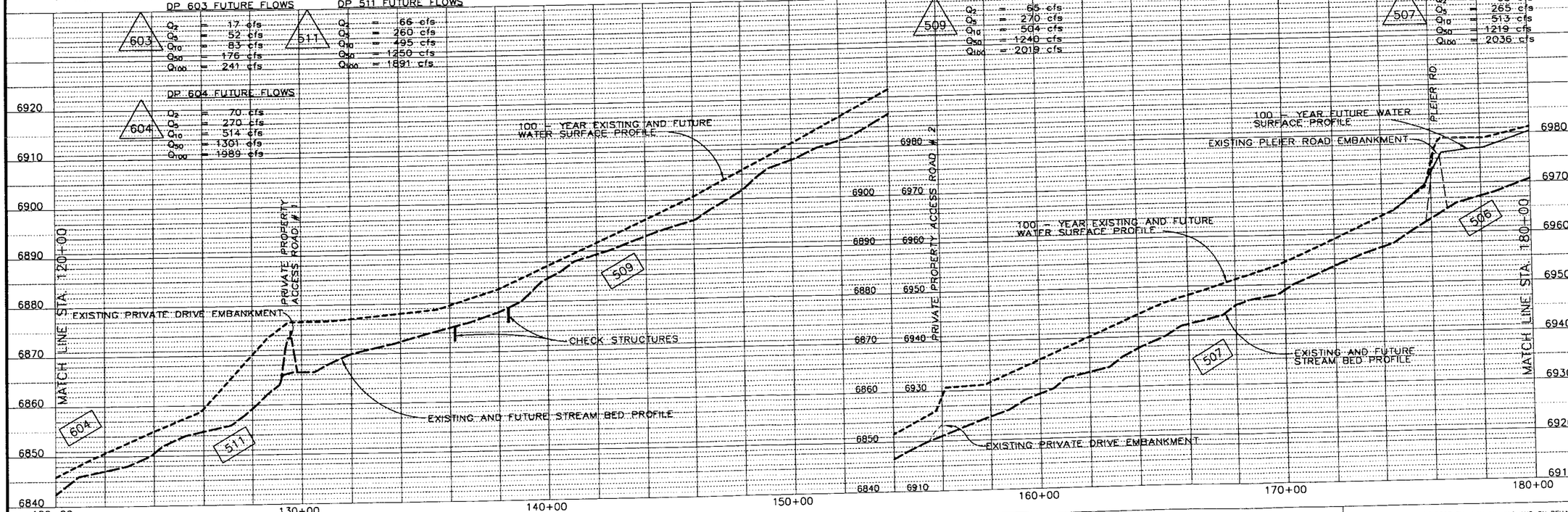
Q_2	= 70 cfs
Q_5	= 270 cfs
Q_{10}	= 514 cfs
Q_{50}	= 1301 cfs
Q_{100}	= 1989 cfs

DP 509 FUTURE FLOWS

Q_2	= 65 cfs
Q_5	= 270 cfs
Q_{10}	= 504 cfs
Q_{50}	= 1240 cfs
Q_{100}	= 2019 cfs

DP 507 FUTURE FLOWS

Q_2	= 63 cfs
Q_5	= 265 cfs
Q_{10}	= 513 cfs
Q_{50}	= 1219 cfs
Q_{100}	= 2036 cfs



NOTE:

CREEK BOTTOM PROFILE PER MULLER ENGINEERING STUDY.

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LUANNE D. RUBEY, COLORADO P.E. # 32339 DATE

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CHECKED BY			

SMITH CREEK
DRAINAGE BASIN PLANNING STUDY

PRELIMINARY PLAN AND PROFILE
STA 120+00 TO STA 180+00

SHEET 4 OF 13

JOB NO. 8896.90

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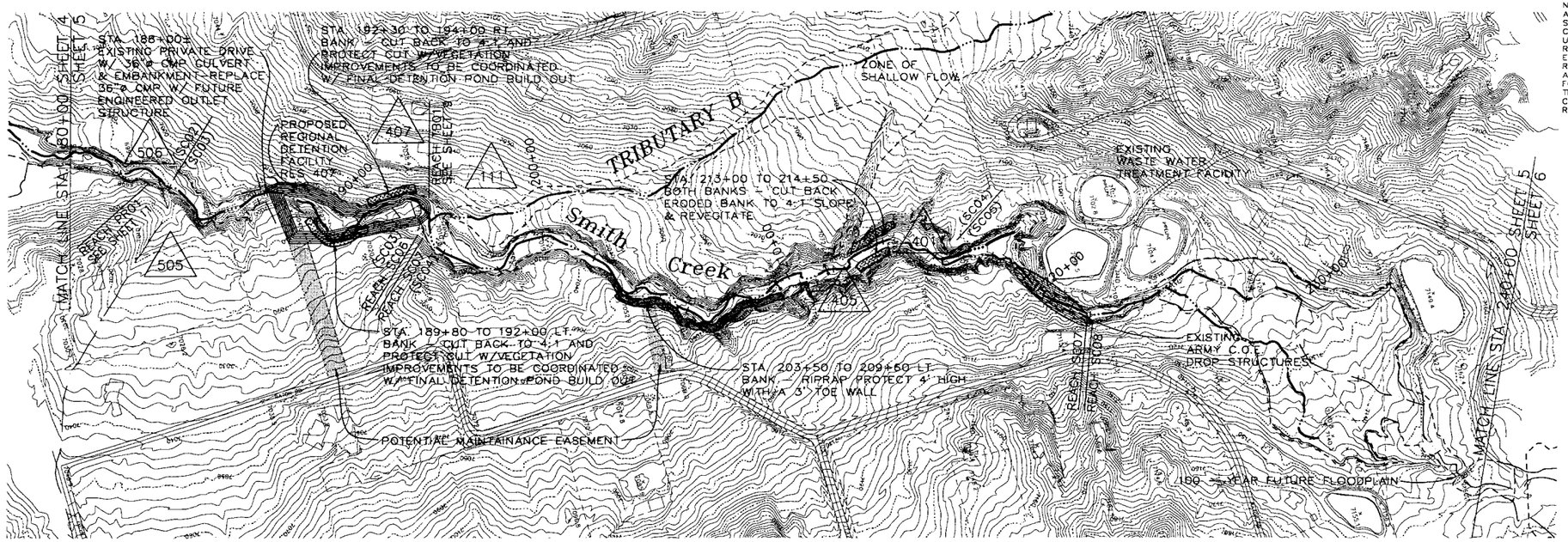
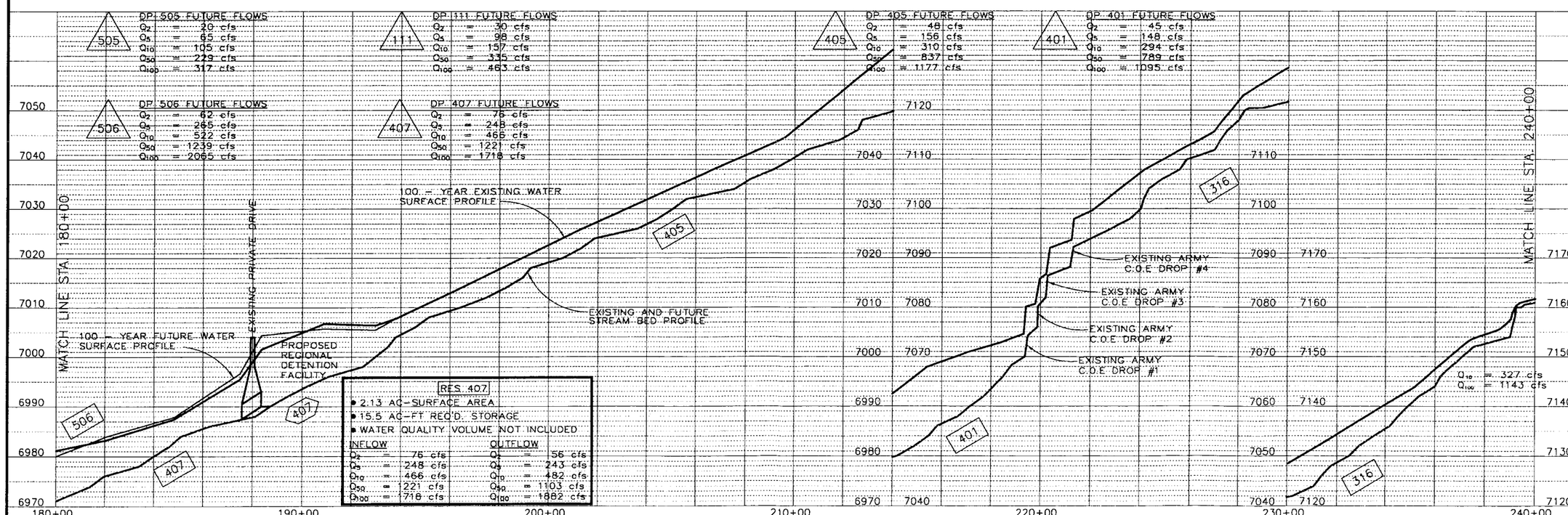


NOTE:
A PRIVATE PROPERTY ACCESS ROAD CROSSES SMITH CREEK AT STA. 188+00. THE EXISTING CULVERT BENEATH THIS ROAD IS GROSSLY UNDERSIZED PER COUNTY CRITERIA. IT IS RECOMMENDED THAT THIS DRIVEWAY EMBANKMENT BE REBUILT AND THE PROPOSED REGIONAL DETENTION FACILITY BE CONSTRUCTED AT THIS LOCATION. THIS LOCATION WAS CHOSEN FOR A REGIONAL POND DUE TO THE FACT THAT THE EXISTING DRIVEWAY EMBANKMENT IS CURRENTLY ACTING LIKE A DETENTION POND RESTRICTION.



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SMITH CREEK
DRAINAGE BASIN PLANNING STUDY

PRELIMINARY PLAN AND PROFILE

STA 180+00 TO STA 240+00

SHEET 5 OF 13

JOB NO. 8896.90

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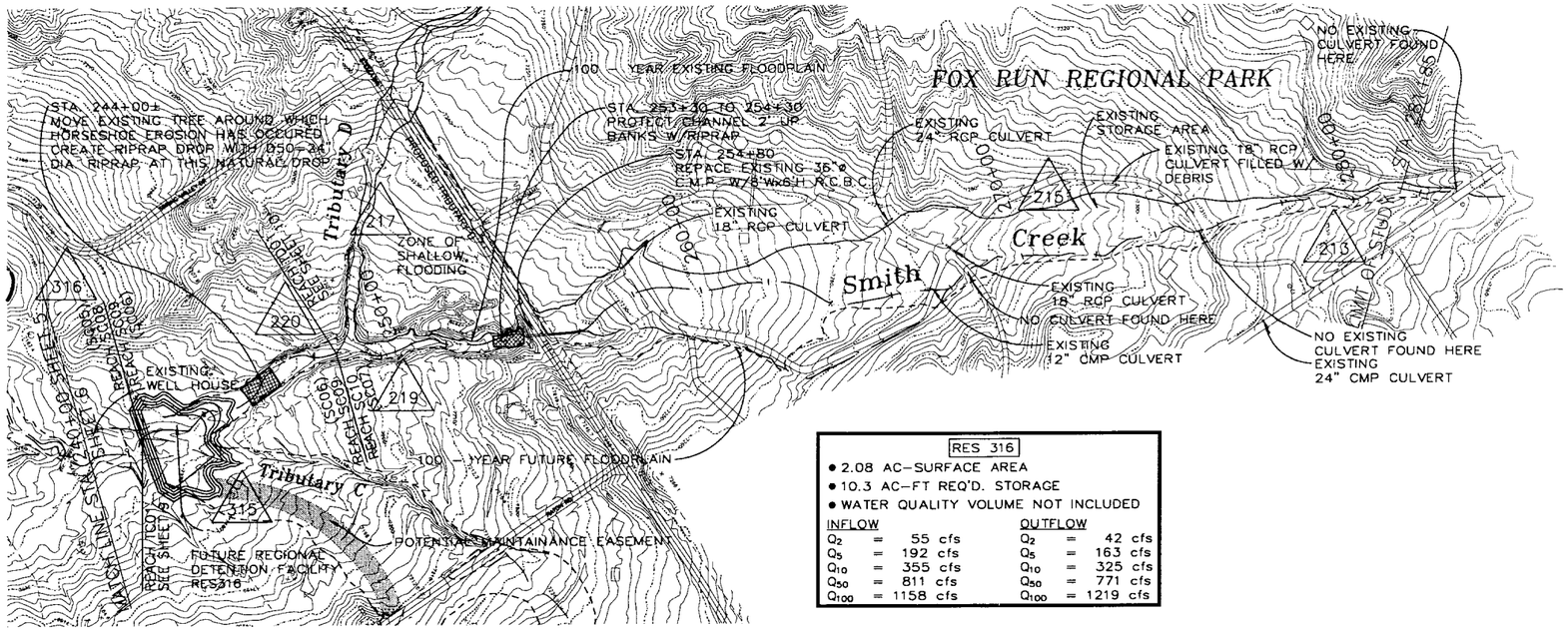
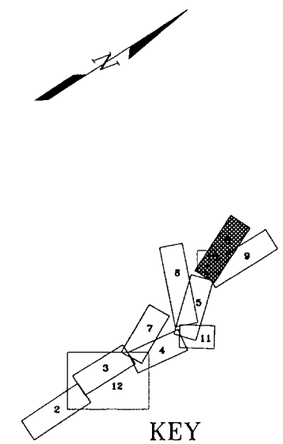


RES 316

- 2.08 AC-SURFACE AREA
- 10.3 AC-FT REQ'D. STORAGE
- WATER QUALITY VOLUME NOT INCLUDED

INFLOW			OUTFLOW		
Q_2	=	55 cfs	Q_2	=	42 cfs
Q_5	=	192 cfs	Q_5	=	163 cfs
Q_{10}	=	355 cfs	Q_{10}	=	325 cfs
Q_{50}	=	811 cfs	Q_{50}	=	771 cfs
Q_{100}	=	1158 cfs	Q_{100}	=	1219 cfs

NOTE:
SOME OF THE CULVERTS WITHIN THE FOX RUN REGIONAL PARK APPEAR TO BE UNDERSIZED. IN ADDITION, REGRADING AT THE EXISTING STORAGE AREA APPEARS TO HAVE BLOCKED OR DIVERTED FLOW FROM ITS ORIGINAL COURSE, WITHOUT NEW TOPOGRAPHIC INFORMATION, IT IS NOT POSSIBLE TO REEVALUATE THIS AREA.
PER SECTION 6.3.1 OF THE DRAINAGE CRITERIA MANUAL, "SOME TYPES OF FACILITIES, SUCH AS PARKS DO NOT REQUIRE HIGH LEVELS OF PROTECTION AND PERIODIC FLOODING IS ACCEPTABLE SUBJECT TO APPROVAL BY THE CITY/COUNTY." AT THIS TIME, NO IMPROVEMENTS ARE PROPOSED WITHIN FOX RUN REGIONAL PARK.



DP 315 FUTURE FLOWS
Q_2 = 35 cfs
Q_5 = 112 cfs
Q_{10} = 187 cfs
Q_{50} = 427 cfs
Q_{100} = 599 cfs

DP 217 FUTURE FLOWS
Q_2 = 3 cfs
Q_5 = 16 cfs
Q_{10} = 32 cfs
Q_{50} = 93 cfs
Q_{100} = 139 cfs

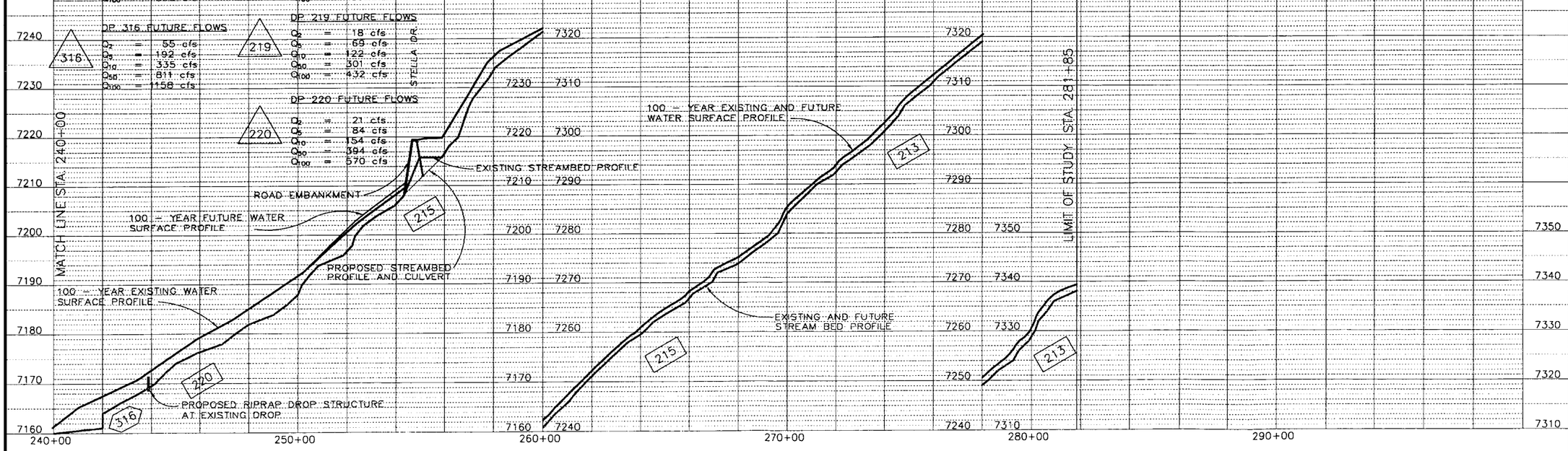
DP 215 FUTURE FLOWS
Q_2 = 18 cfs
Q_5 = 69 cfs
Q_{10} = 118 cfs
Q_{50} = 275 cfs
Q_{100} = 389 cfs

DP 213 FUTURE FLOWS
Q_2 = 14 cfs
Q_5 = 49 cfs
Q_{10} = 79 cfs
Q_{50} = 175 cfs
Q_{100} = 243 cfs

DP 316 FUTURE FLOWS
Q_2 = 55 cfs
Q_5 = 192 cfs
Q_{10} = 335 cfs
Q_{50} = 811 cfs
Q_{100} = 1158 cfs

DP 219 FUTURE FLOWS
Q_2 = 18 cfs
Q_5 = 69 cfs
Q_{10} = 122 cfs
Q_{50} = 301 cfs
Q_{100} = 432 cfs

DP 220 FUTURE FLOWS
Q_2 = 21 cfs
Q_5 = 84 cfs
Q_{10} = 154 cfs
Q_{50} = 394 cfs
Q_{100} = 570 cfs



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SMITH CREEK
DRAINAGE BASIN PLANNING STUDY

PRELIMINARY PLAN AND PROFILE
STA 240+00 TO STA 281+85

SHEET 6 OF 13
JOB NO. 8896.90

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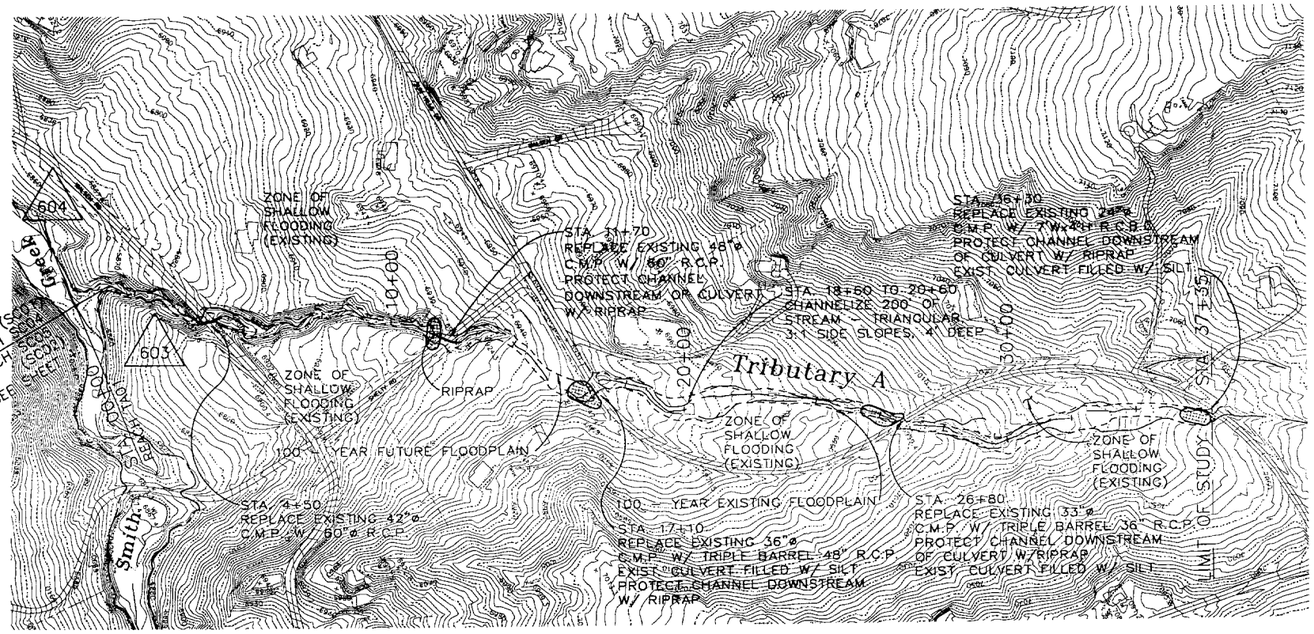

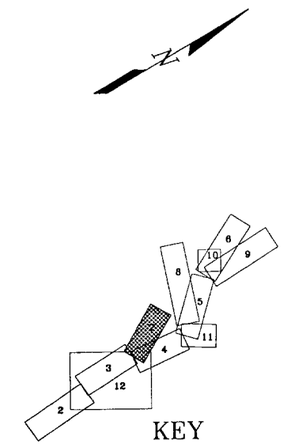

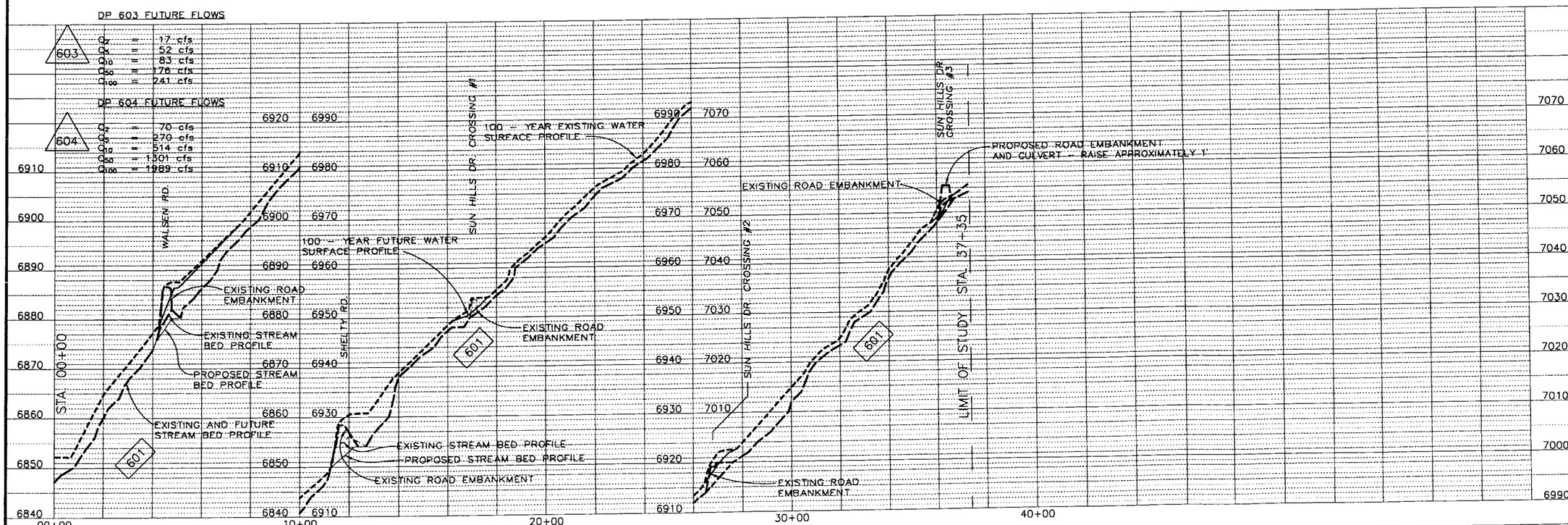

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SMITH CREEK
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SHEET 7 OF 13

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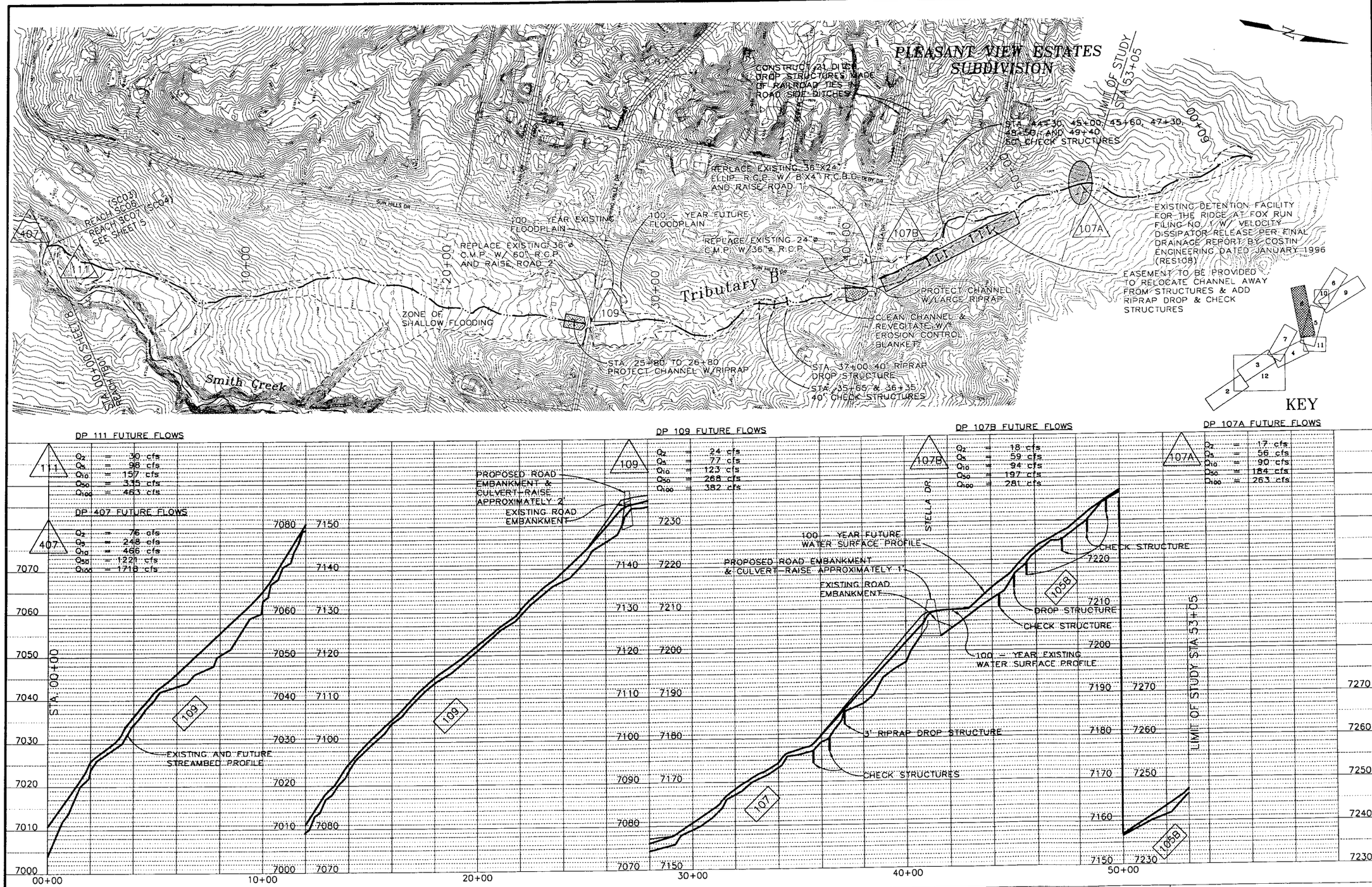

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LUANNE D. RUBEY, COLORADO P.E. # 32339 DATE

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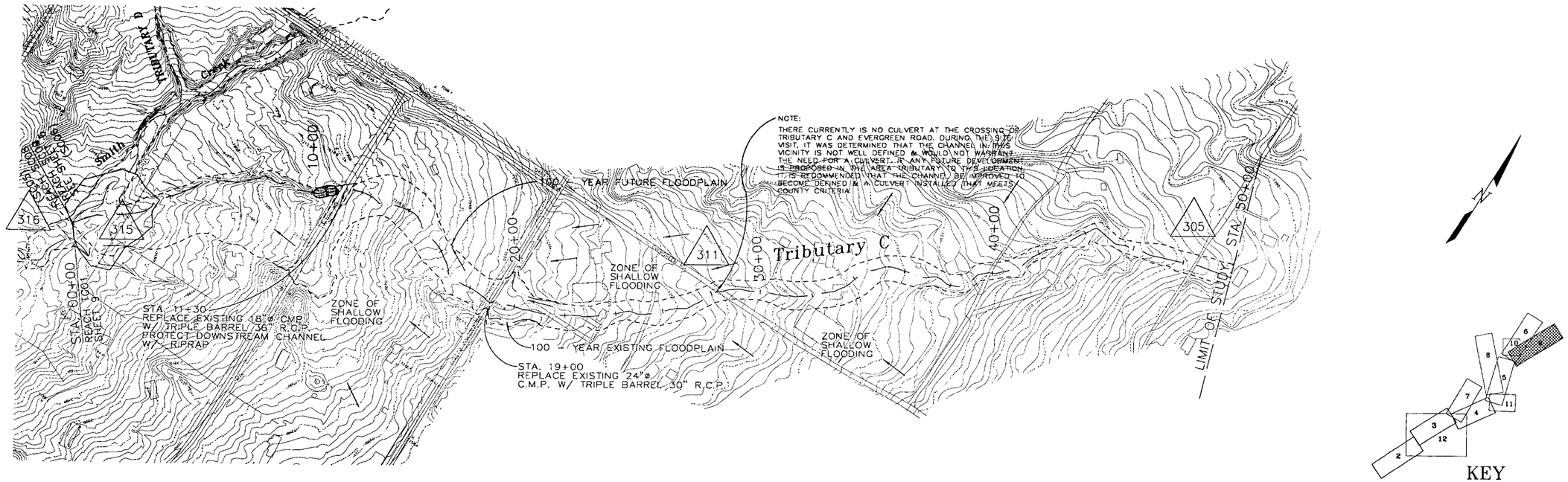
SMITH CREEK
DRAINAGE BASIN PLANNING STUDY

PRELIMINARY PLAN AND PROFILE
STA 00+00 TO STA 60+00

SHEET 8 OF 13

JOB NO. 8896.90



NOTE:
THERE CURRENTLY IS NO CULVERT AT THE CROSSING OF TRIBUTARY C AND EVERGREEN ROAD. DURING THE SITE VISIT, IT WAS DETERMINED THAT THE CHANNEL IN THIS VICINITY IS NOT WELL DEFINED & WOULD NOT WARRANT THE NEED FOR A CULVERT. IF ANY FUTURE DEVELOPMENT IS PROPOSED IN THE AREA TRIBUTARY TO THIS LOCATION, IT IS RECOMMENDED THAT THE CHANNEL BE IMPROVED TO BECOME DEFINED & A CULVERT INSTALLED THAT MEETS COUNTY CRITERIA.

DP 315 FUTURE FLOWS

315

Q_2	=	35 cfs
Q_5	=	112 cfs
Q_{10}	=	187 cfs
Q_{50}	=	427 cfs
Q_{100}	=	599 cfs

DP 316 FUTURE FLOWS

316

Q_2	=	55 cfs
Q_5	=	192 cfs
Q_{10}	=	335 cfs
Q_{50}	=	811 cfs
Q_{100}	=	1158 cfs

DP 311 FUTURE FLOWS

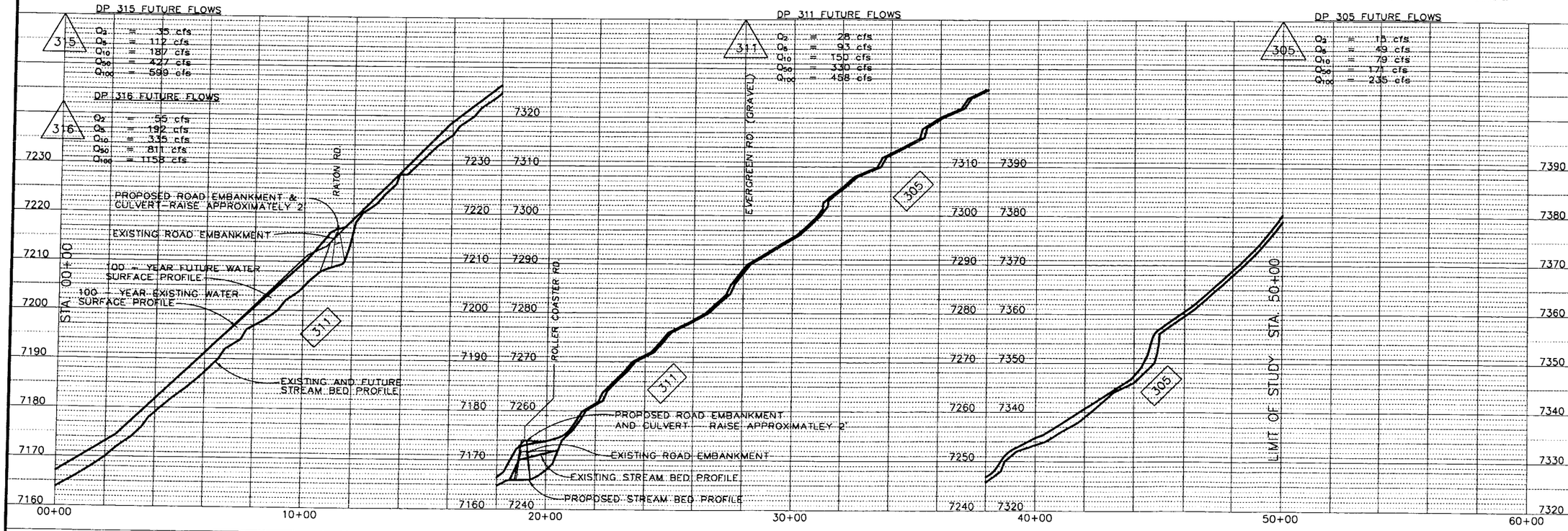
311

Q_2	=	28 cfs
Q_5	=	93 cfs
Q_{10}	=	150 cfs
Q_{50}	=	330 cfs
Q_{100}	=	458 cfs

DP 305 FUTURE FLOWS

305

Q_2	=	13 cfs
Q_5	=	49 cfs
Q_{10}	=	79 cfs
Q_{50}	=	171 cfs
Q_{100}	=	235 cfs



NOTE:
CREEK BOTTOM PROFILE PER MULLER ENGINEERING STUDY.

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SHEET 9 OF 13

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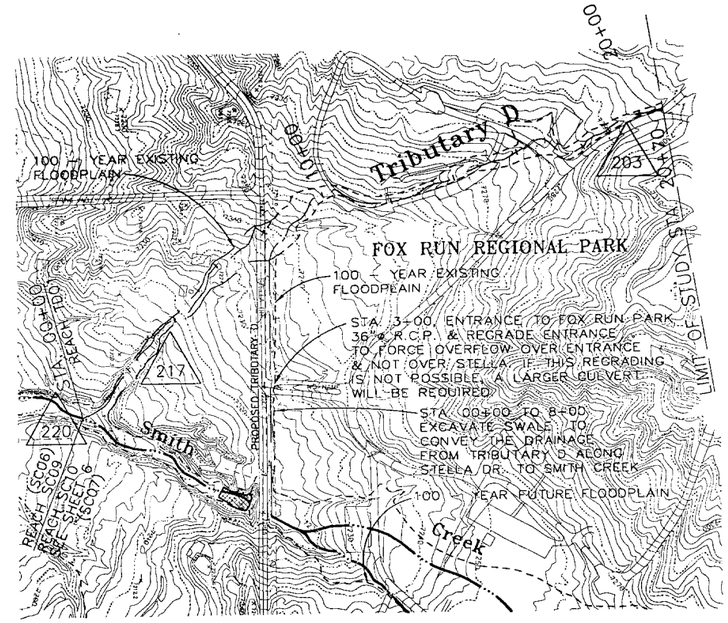
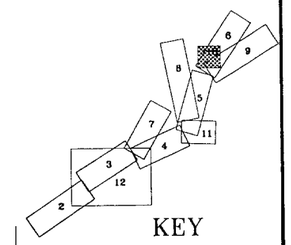
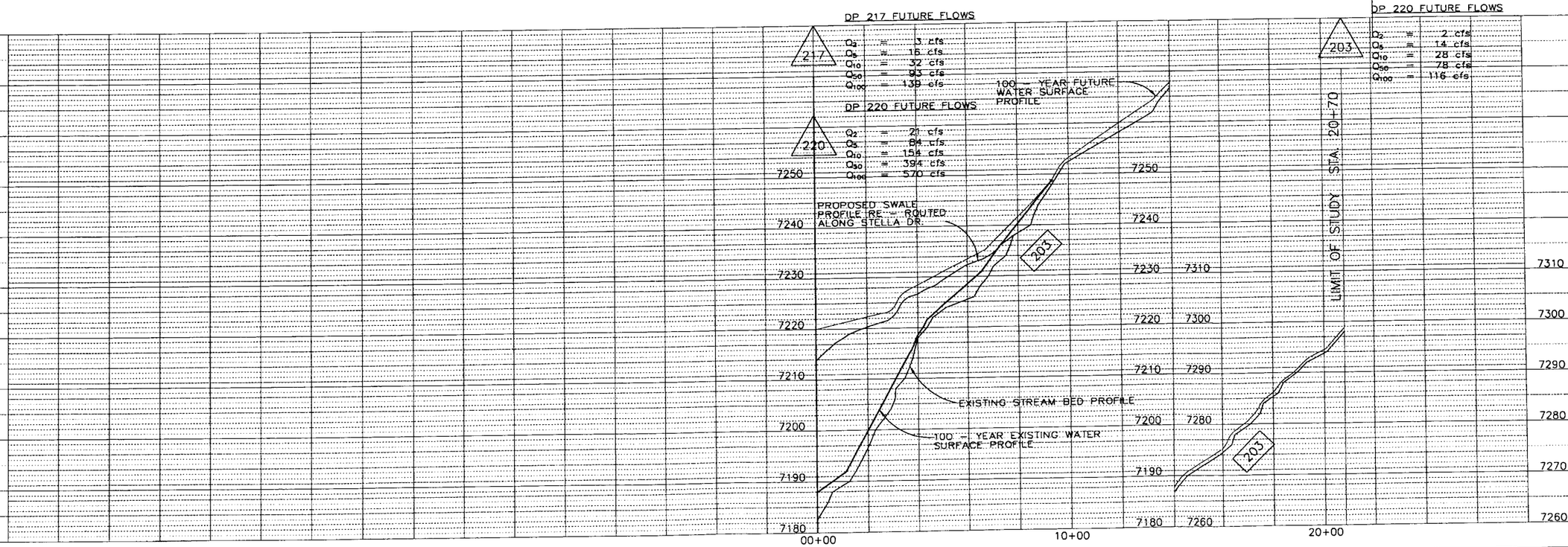
NOTE:
SOME OF THE CULVERTS WITHIN THE FOX RUN REGIONAL PARK APPEAR TO BE UNDERSIZED. IN ADDITION, REGRADING AT THE EXISTING STORAGE AREA APPEARS TO HAVE BLOCKED OR DIVERTED FLOW FROM ITS ORIGINAL COURSE. WITHOUT NEW TOPOGRAPHIC INFORMATION, IT IS NOT POSSIBLE TO REEVALUATE THIS AREA. PER SECTION 6.3.1 OF THE DRAINAGE CRITERIA MANUAL, "SOME TYPES OF FACILITES... SUCH AS PARKS DO NOT REQUIRE HIGH LEVELS OF PROTECTION AND PERIODIC FLOODING IS ACCEPTABLE SUBJECT TO APPROVAL BY THE CITY/COUNTY." AT THIS TIME, NO IMPROVEMENTS ARE PROPOSED WITHIN FOX RUN REGIONAL PARK.







NOTE:
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SMITH CREEK
DRAINAGE BASIN PLANNING STUDY

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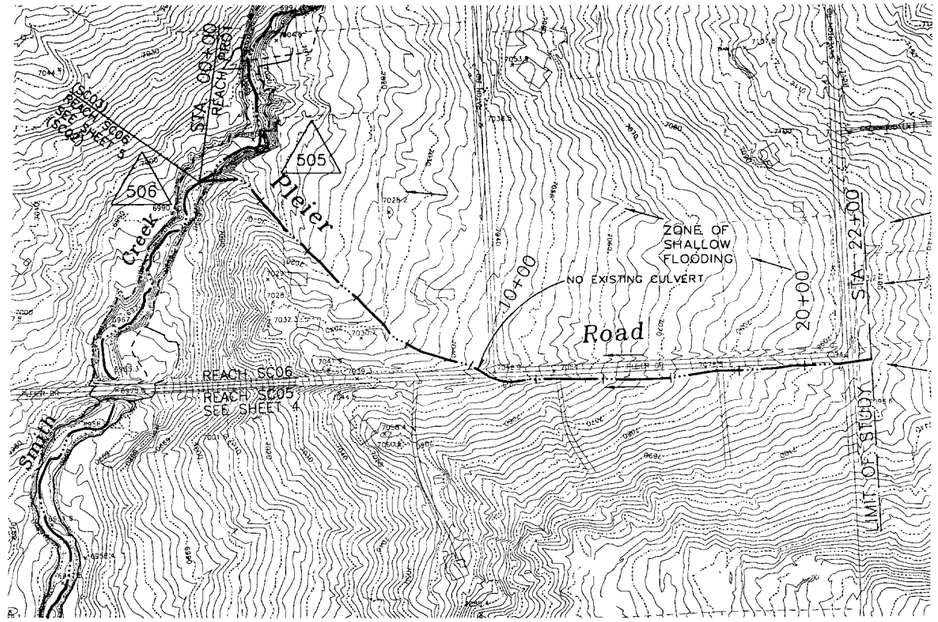
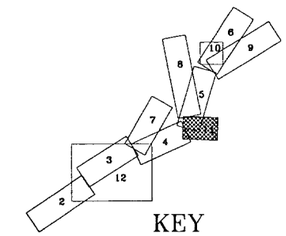
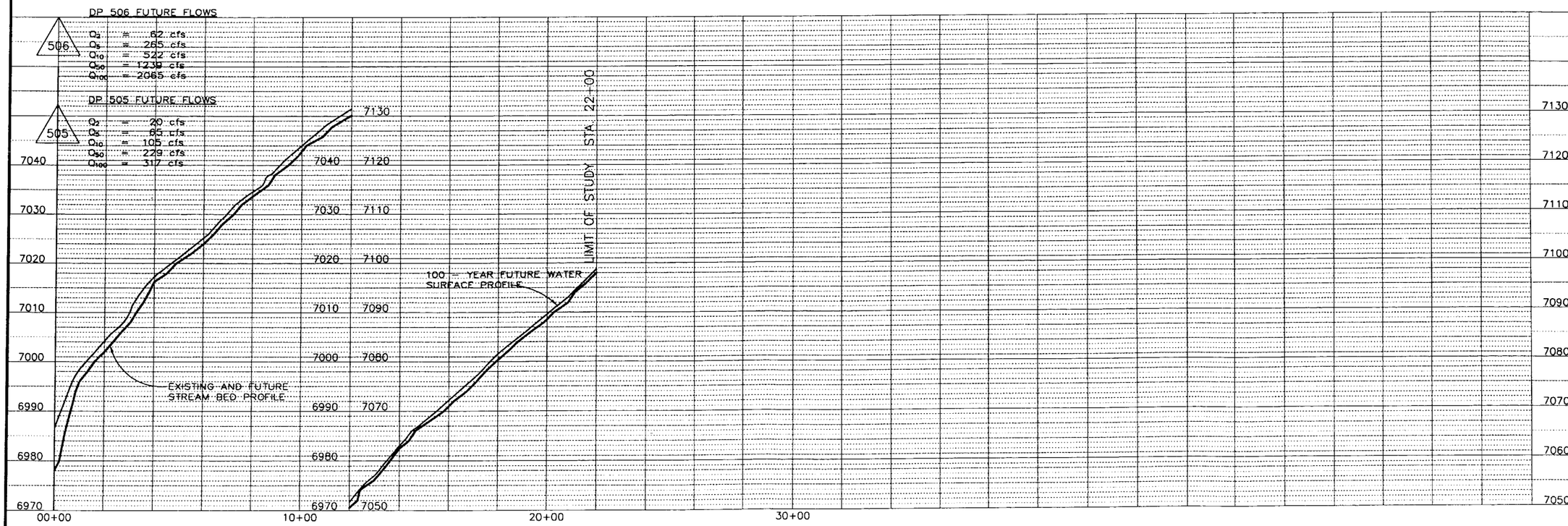


NOTE: DRAINAGE IS SHALLOW AND SCATTERED THROUGHOUT THE BASIN WITH MANY SMALL AND UNDEFINABLE DRAINAGE PATHS. BECAUSE OF THIS, THERE ARE NO MAJOR DRAINAGEWAY IMPROVEMENTS SUGGESTED ON THE PLAN FOR THIS TRIBUTARY.

NO FLOODPLAIN OR PRUDENT LINE DETERMINATION COULD BE MADE ON THE PLEIER ROAD TRIBUTARY DUE TO THE WIDESPREAD, SHALLOW NATURE OF THE FLOODING IN THIS AREA.





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SMITH CREEK
DRAINAGE BASIN PLANNING STUDY

PRELIMINARY PLAN AND PROFILE

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SHEET 11 OF 13

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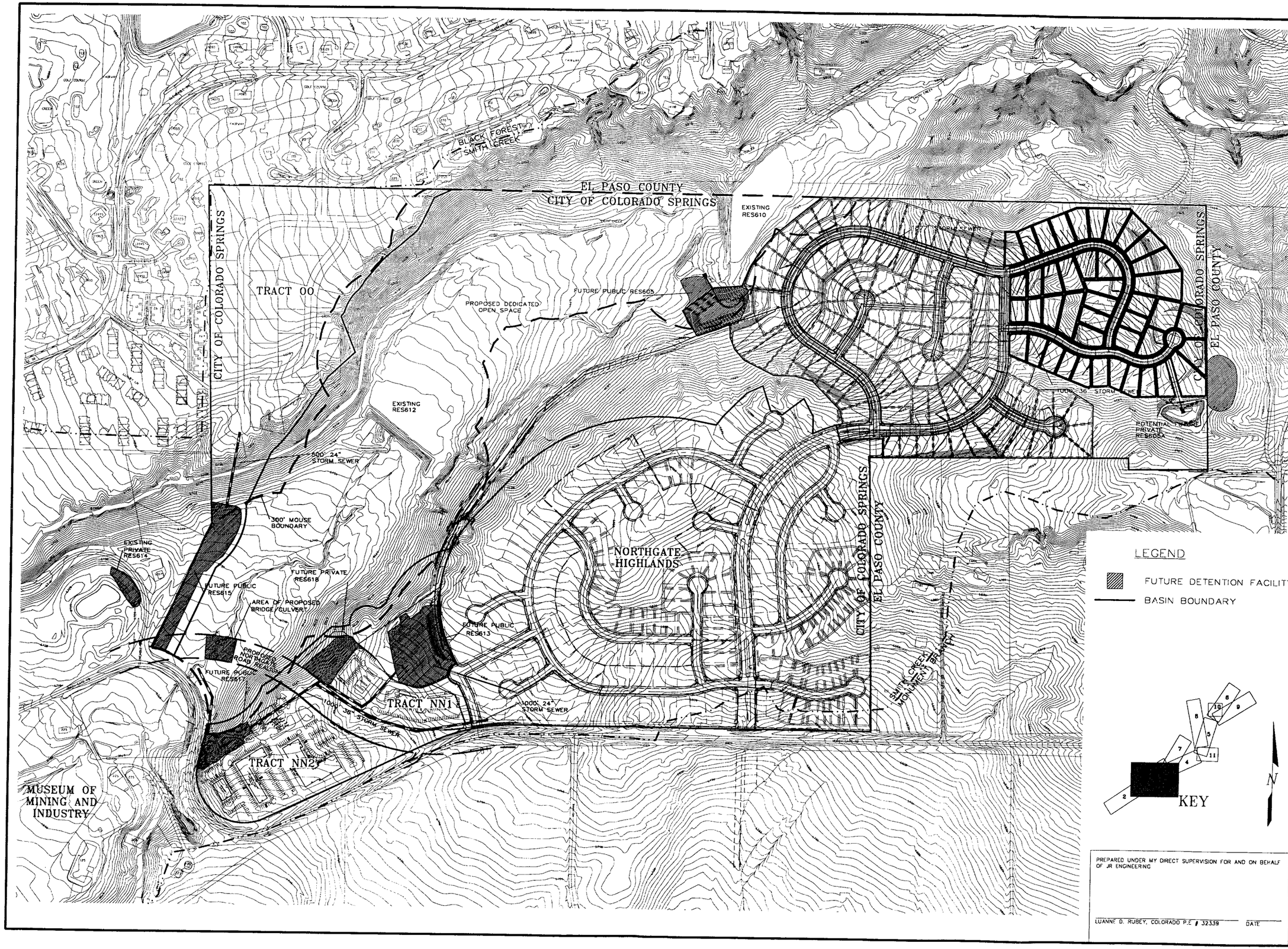

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SMITH CREEK
DRAINAGE BASIN PLANNING STUDY

PLAN VIEW- CITY IMPROVMENTS

SHEET 12 OF 13

JOB NO. 8896.90

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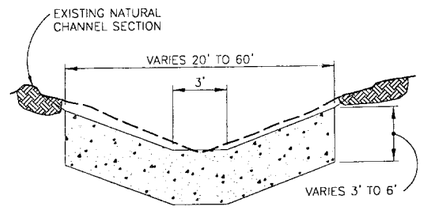
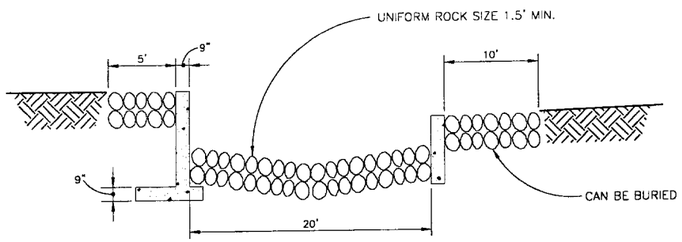
SUGGESTED CHECK STRUCTURE DESIGN



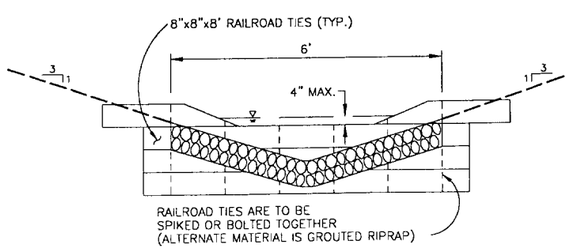
NOTE:
CHECK STRUCTURE IS TO CONFORM
TO SHAPE OF DEFINED LOW FLOW CHANNEL

SUGGESTED CHECK STRUCTURE
TYPICAL SECTION
N.T.S.

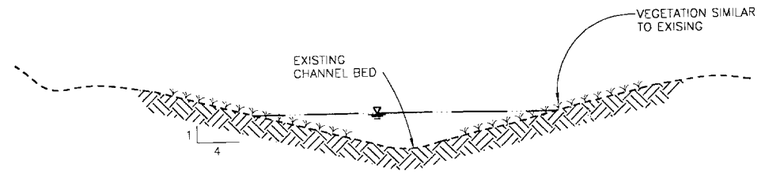


SUGGESTED VERTICAL DROP STRUCTURE DESIGN
PROFILE
N.T.S.

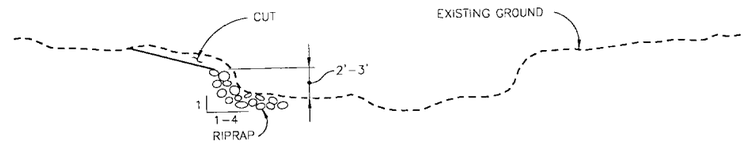
* STRUCTURE WIDTH WILL VARY
* SHALL HAVE LOW FLOW TRICKLE CHANNEL



SUGGESTED DITCH CHECK/DROP STRUCTURE
TYPICAL SECTION
N.T.S.



TYPICAL CHANNEL W/VEGETATED BANKS
N.T.S.



ROCK TOE PROTECTION
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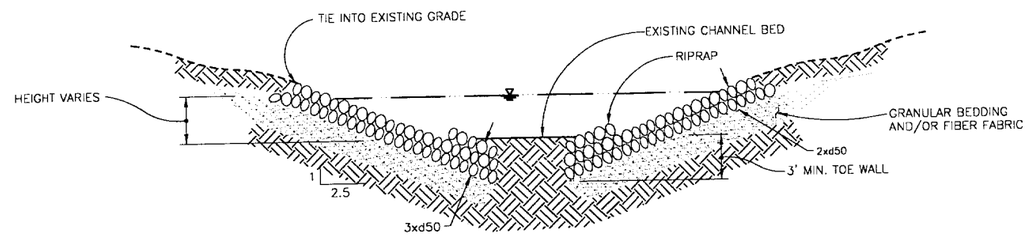

TYPICAL CHANNEL W/RIPRAP BANK PROTECTION
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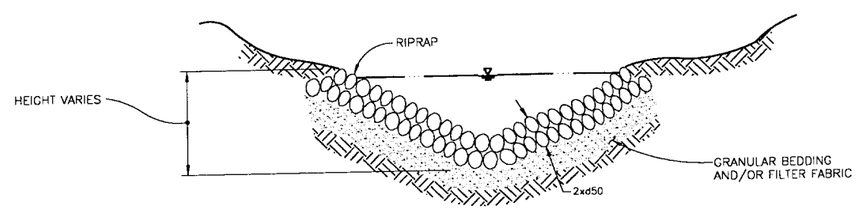

TYPICAL CHANNEL W/RIPRAP BED PROTECTION
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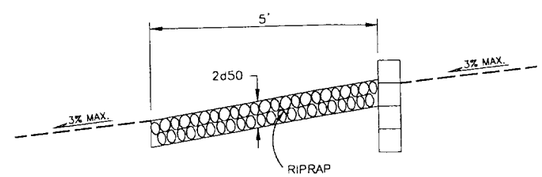

SUGGESTED DITCH CHECK/DROP STRUCTURE
PROFILE
N.T.S.

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SMITH CREEK
DRAINAGE BASIN PLANNING STUDY

DETAIL SHEET

SHEET 13 OF 13
JOB NO. 8896.90

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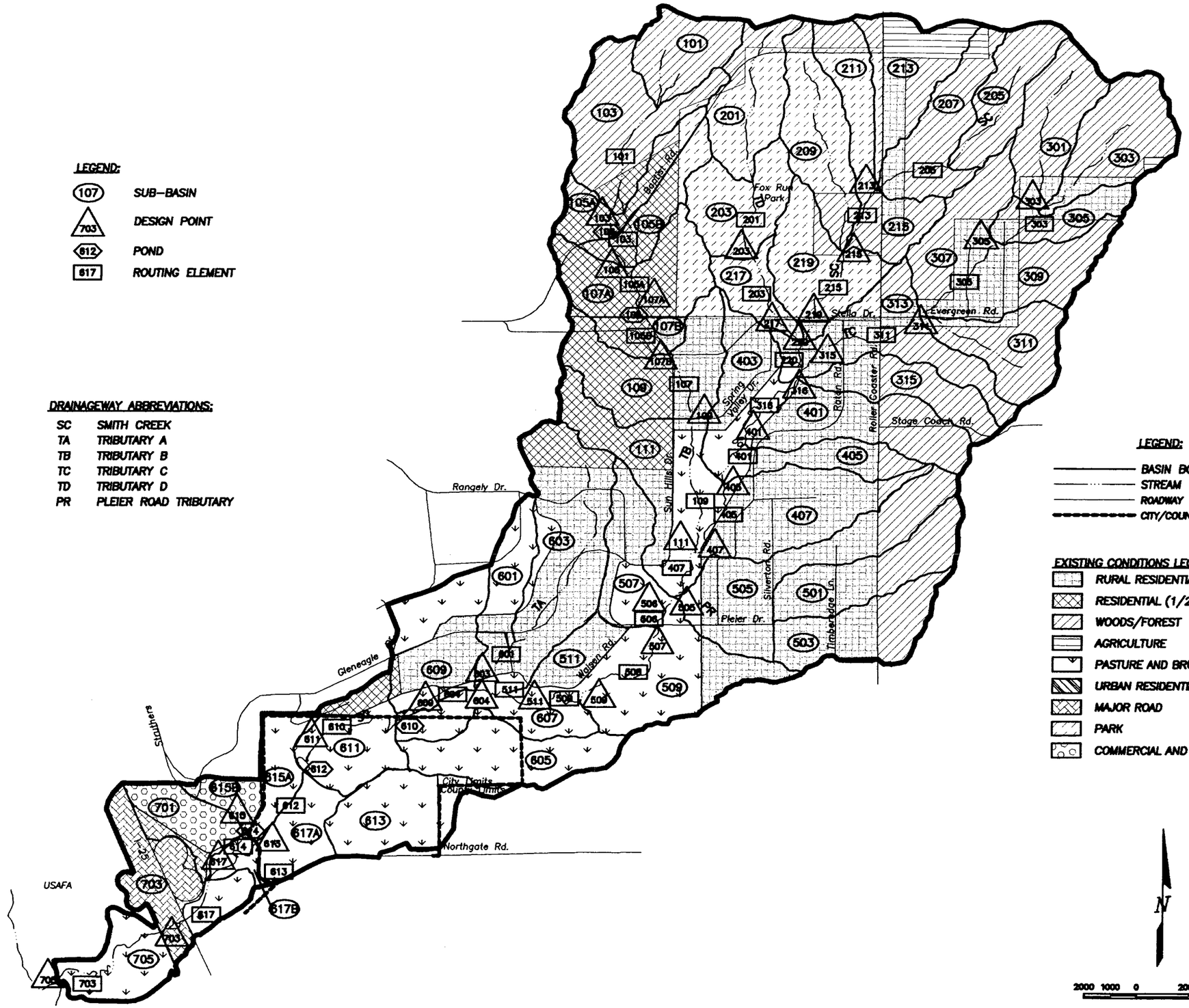

LEGEND:

- 107 — SUB-BASIN
- 703 — DESIGN POINT
- 612 — POND
- 617 — ROUTING ELEMENT

DRAINAGEWAY ABBREVIATIONS:

SC	SMITH CREEK
TA	TRIBUTARY A
TB	TRIBUTARY B
TC	TRIBUTARY C
TD	TRIBUTARY D
PR	PLEIER ROAD TRIBUTARY

LEGEND:

- BASIN BOUNDARY
- STREAM
- ROADWAY
- CITY/COUNTY BOUNDARY

EXISTING CONDITIONS LEGEND:

- RURAL RESIDENTIAL (5± AC.)
- RESIDENTIAL (1/2 AC.)
- WOODS/FOREST
- AGRICULTURE
- PASTURE AND BRUSH
- URBAN RESIDENTIAL (1/4 AC.)
- MAJOR ROAD
- PARK
- COMMERCIAL AND BUSINESS

N

2000 1000 0 2000 4000

SCALE: 1" = 2000'

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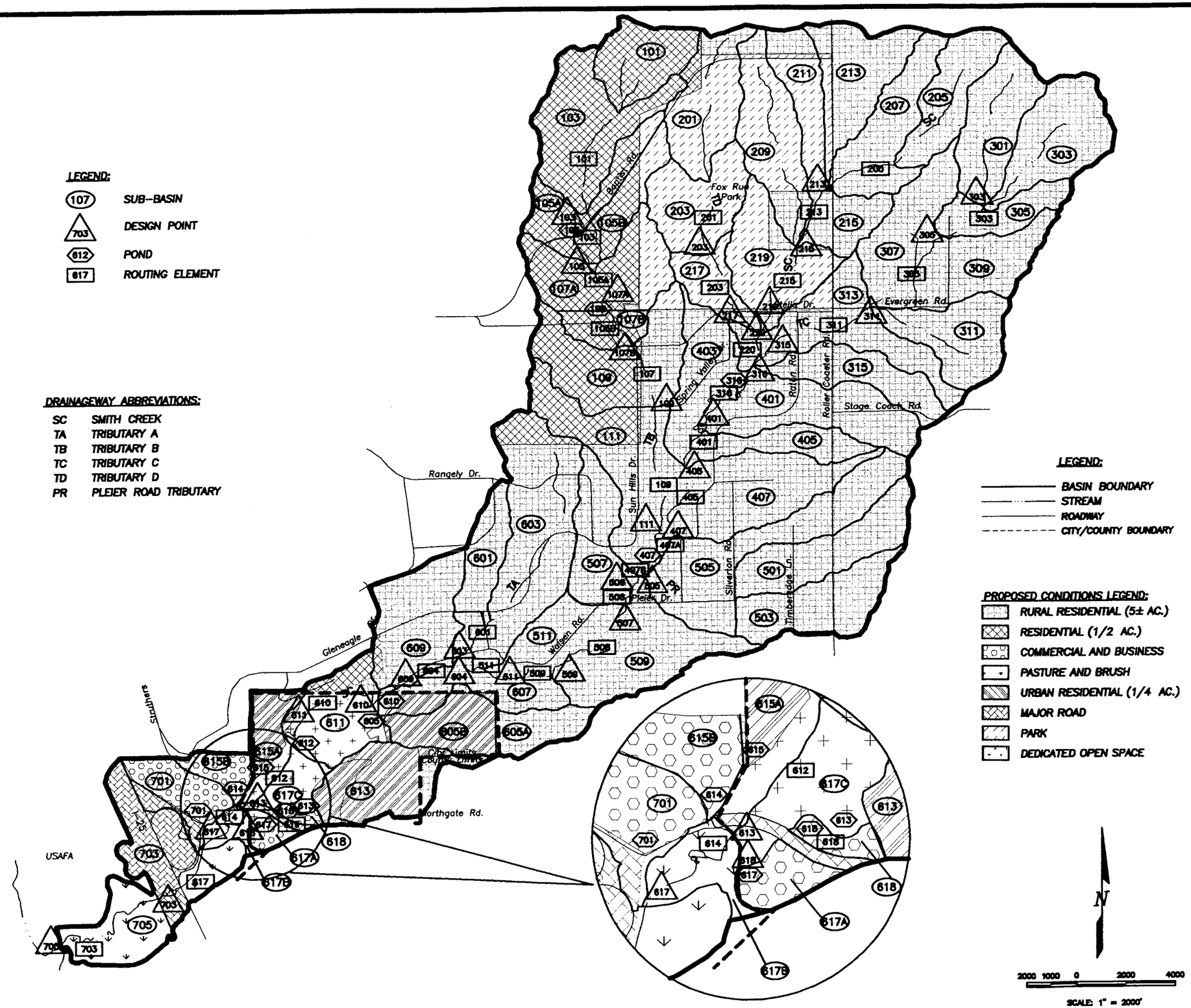
SMITH CREEK
DRAINAGE BASIN PLANNING STUDY

FIG III-1A
BASIN MAP

LAND USE EXISTING

SHEET 1 OF 1

JOB NO. 5596.90



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SMITH CREEK
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FIG III-1B
BASIN MAP

LAND USE PROPOSED

SHEET 1 OF 1

JOB NO. 5896.90

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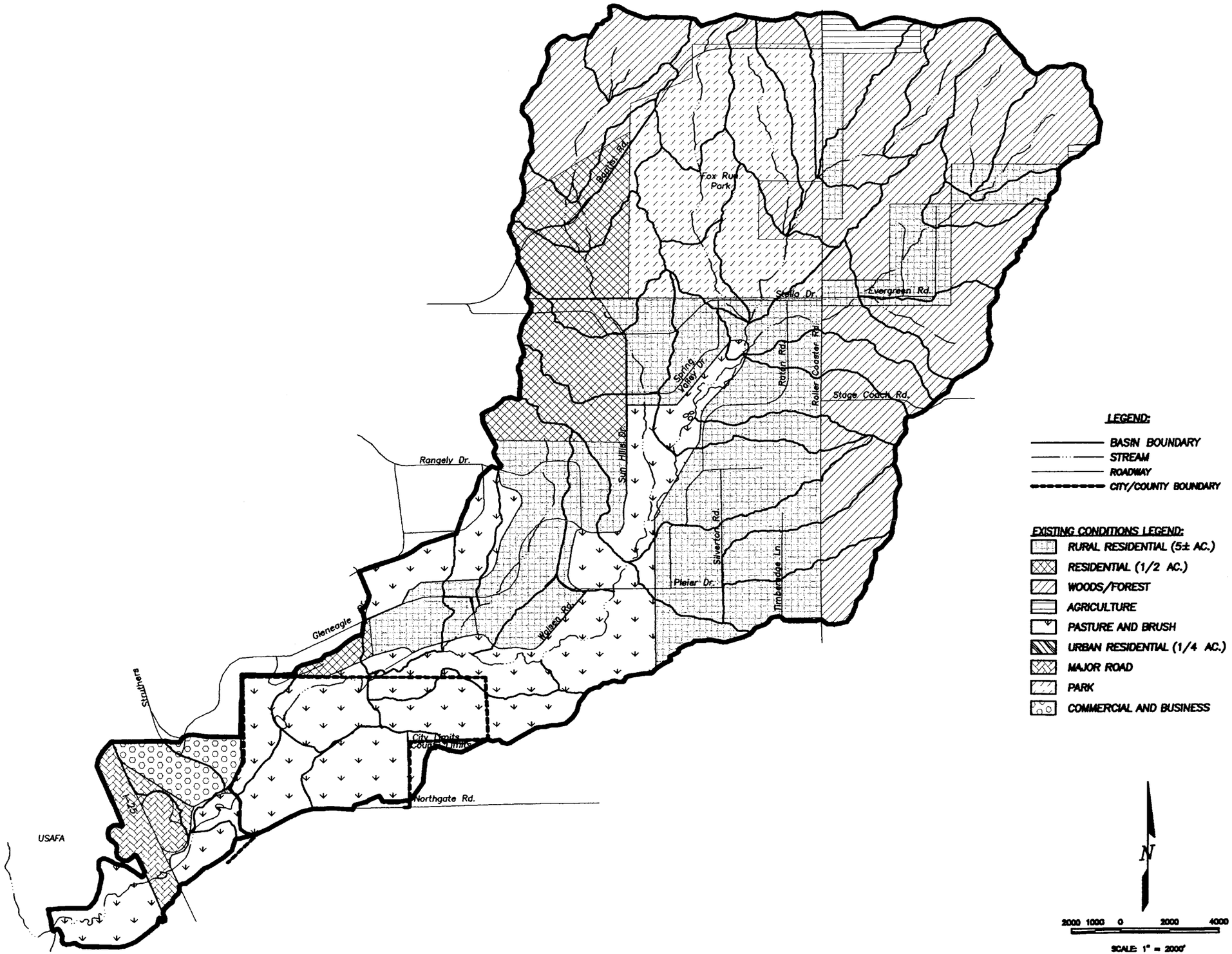

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SMITH CREEK
DRAINAGE BASIN PLANNING STUDY

FIG III-2

LAND USE EXISTING

SHEET 1 OF 1

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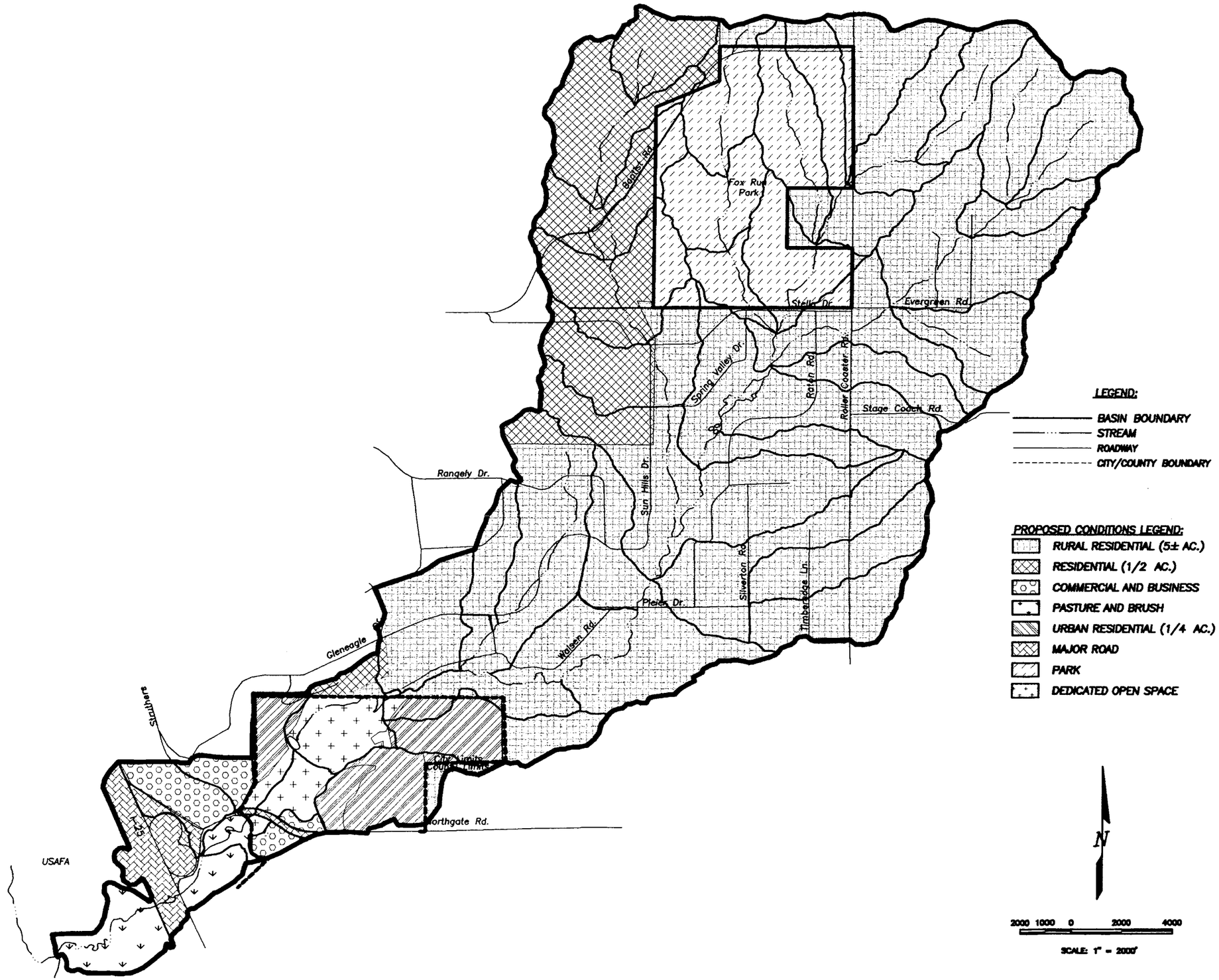

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SMITH CREEK
DRAINAGE BASIN PLANNING STUDY

FIG III-3

LAND USE PROPOSED

SHEET 1 OF 1

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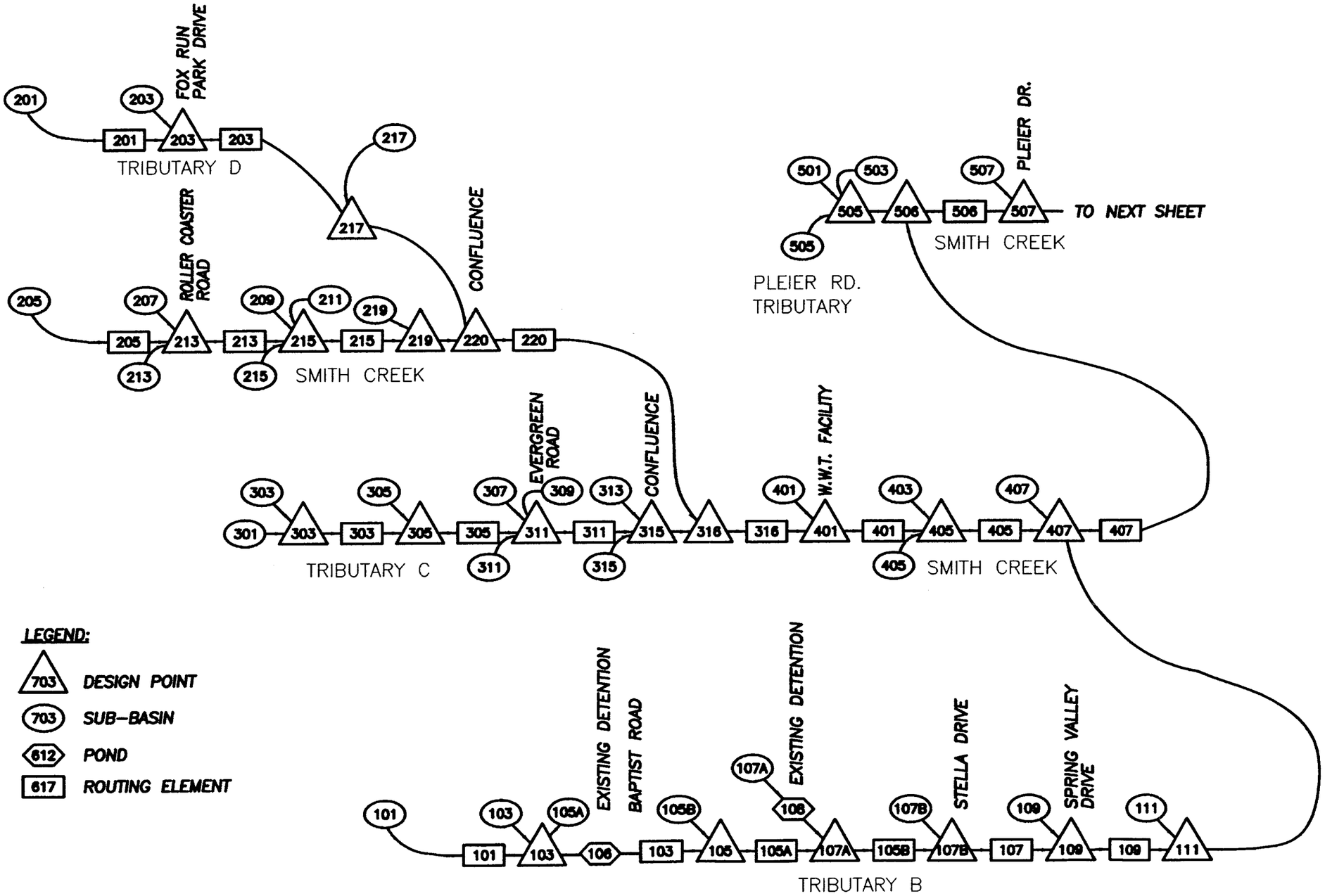

LEGEND:

- 703 DESIGN POINT
- 703 SUB-BASIN
- 612 POND
- 617 ROUTING ELEMENT

UNTIL SUCH TIME AS THESE DRAWINGS ARE APPROVED BY THE APPROPRIATE REVIEWING AGENCIES, JR ENGINEERING APPROVES THEIR USE ONLY FOR THE PURPOSES DESIGNATED BY WRITTEN AUTHORIZATION.

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BY	DATE	No.

H-SCALE	N/A
V-SCALE	N/A
DATE	6/18/01
DESIGNED BY	
DRAWN BY	MSD
CHECKED BY	

SMITH CREEK
DRAINAGE BASIN PLANNING STUDY

EXISTING CONDITIONS
FLOW CHART

FIG IIB-4A

SHEET 1 OF 2

JOB NO. 5596.90