FINAL DRAINAGE REPORT

for

SILVERADO RANCH FILING NO. 1

Prepared for:

Silverado Ranch, Inc.
18911 Cherry Springs Ranch Dr.
Monument, CO 80132

June 18, 2018

Prepared by:

JPS
ENGINEERING

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SF-18-011

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EXECUTIVE SUMMARY

A. Background

- Silverado Ranch is a proposed rural residential subdivision consisting of 64 lots (2.5-acre minimum lot sizes) on a 320-acre parcel at the southeast corner of Peyton Highway and Drennan Road. Filing No. 1 consists of 10 lots on 106.4 acres in the northwest area of the property.
- The site is located within the Drennan Drainage Basin, which comprises a total drainage area in excess of 16 square miles. The proposed Silverado Ranch development represents less than three percent of the total basin area.
- An "on-site" drainage planning approach is proposed based on the small size of this development relative to the remaining undeveloped basin area, which is primarily agricultural land.

B. General Drainage Concept

- Developed drainage within the site will be conveyed through roadside ditches and culverts along the proposed road system, as well as grass-lined swales through open space areas and drainage easements.
- Developed flow impacts from the Silverado Ranch Subdivision will be mitigated by preservation of two existing on-site retention ponds.

C. Drainage Impacts

- Based on the large size of the off-site basins impacting this site in comparison to the relatively small size and rural nature of the proposed development, developed flow impacts from the project will be minimal.
- Preservation of the existing retention ponds will mitigate developed flow impacts from the subdivision. Overflow swales will be graded to discharge to the existing natural drainage swales downstream of the site, consistent with historic conditions.
- Drainage facilities within public road rights-of-way will be designed and constructed to El Paso County standards, and dedicated to the County for maintenance.
- Drainage facilities such as swales running through private open space areas and retention ponds will be owned and maintained by the Homeowners Association.

DRAINAGE 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/County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report

COLORADO REGISTERED PROFESSIONAL ENGINEER
JOHN P. SCHWAB
29891

John P. Schwab, P.E. #29891

Developer's Statement:

I, the developer have read and will comply with all of the requirements specified in this drainage report and plan.

By: Stan Searle . president

Silverado Ranch, Inc. June 18, 2018

Printed Name: Date
Title:

El Paso County's Statement

Filed in accordance with the requirements of the El Paso County Land Development Code, Drainage Criteria Manual, Volumes 1 and 2, and Engineering Criteria Manual, as amended.

Approved
by Elizabeth Nijkamp
El Paso County Planning and Community Development
on behalf of Jennifer Irvine, County Engineer, ECM Administrator
08/08/2018 7:02:53 AM

County Engineer / ECM Administrator Date

Conditions:

FLOODPLAIN STATEMENT

To the best of my knowledge and belief, no portions of the Silverado Ranch parcel are located within a FEMA designated floodplain, as shown on FIRM panel No. 08041C1025F, dated March 17, 1997.

COLORADO REGISTERED
JOHN P. SCHWAB
29891
PROFESSIONAL ENGINEER

John P. Schwab, P.E. #29891

I. GENERAL LOCATION AND DESCRIPTION

A. Background

Silverado Ranch is a proposed residential subdivision located in the Ellicott Valley area of eastern El Paso County, Colorado. The development is located southeast of Drennan Road and Peyton Highway, as shown in Figure A1 (Appendix F). The Silverado Ranch project will consist of 64 rural residential units on a 320-acre parcel (2.5-acre minimum lots). The gross density of the project is 5 acres per residential lot. The El Paso County Board of County Commissioners approved the Preliminary Plan for Silverado Ranch on August 28, 2008.

An initial final plat consisting of 20 lots at the west end of the subdivision was approved by the El Paso County Board of County Commissioners on December 17, 2009. Based on market conditions, the developer did not record this approved final plat, although some initial rough grading was performed within the site. The areas that were previously disturbed during rough grading in the 2009-2010 timeframe have significantly re-vegetated.

The developer, Silverado Ranch, Inc., has decided to reduce the scope of Filing No. 1, resulting in a revised final plat application superseding the previously approved final plat. The current proposal for Silverado Ranch Filing No. 1 consists of 10 lots on 106.4 acres in the northwest area of the property.

B. Scope

This report is intended to fulfill the El Paso County requirements for a Final Drainage Report (FDR) in support of the final plat submittal for Filing No. 1. The report will provide a summary of site drainage issues impacting the proposed development, including analysis of impacts from upstream drainage areas, site-specific developed drainage patterns, and impacts on downstream facilities. This report was prepared based on the guidelines and criteria presented in the El Paso County Drainage Criteria Manual.

C. Site Location and Description

The Silverado Ranch parcel (El Paso County Assessor’s Parcel Number 35000-00-082) is described as the north half of Section 16, Township 15 South, Range 63 West of the 6th Principal Meridian. The 320-acre site is currently undeveloped agricultural land. Peyton Highway borders the property to the west, and Drennan Road borders the property to the north. Unplatted properties zoned RR3 (rural residential – 5-acre lots) border this parcel on all sides.

Ground elevations within the parcel range from a high point of approximately 5,880 feet above mean sea level at the west boundary of the site, to a low point of 5,780 at the southeasterly corner of the property.

The proposed Silverado Ranch development will include 64 low-density residential lots, maintaining a gross density of 5 units per acre. Associated site improvements will include gravel and asphalt paving and utility installation along the roads within the site. Interior roads will be classified as rural residential roads, and ultimately constructed in accordance with El Paso County public road standards. New public roads will provide access to each lot within the subdivision, with a new access connection to Peyton Highway at the westerly site boundary, and a new access connection to Drennan Road at the north property boundary.

Filing No. 1 will include construction of Drover Canyon Road and a portion of Silverado Hill Loop, providing access into the site from Drennan Road at the northern subdivision boundary. Construction of Drover Canyon Road along with the northwest segment of Silverado Hill Loop will provide access to the 10 residential lots within Filing No. 1.

The natural drainage channels throughout this area flow to tributaries of Upper Dry Squirrel Creek, which outfalls into Black Squirrel Creek southeast of this site. The site is located entirely within the Drennan Drainage Basin (CHDS0400).

The terrain is generally flat with gentle northwest to southeast slopes ranging from one to three percent. Historic drainage flows from the site are conveyed overland towards the southerly boundary of the site. Existing vegetation within the site consists of native prairie grasses.

D. General Soil Conditions

According to the Soil Survey of El Paso County prepared by the Soil Conservation Service, on-site soils are comprised of the following soil types (see Appendix A):

- Type 5 - “Bijou loamy sand”: rapid permeability, slow surface runoff, severe erosion hazard, Hydrologic Group B (approximately 65% of site, encompassing central and eastern areas of parcel)
- Type 6 – “Bijou sandy loam”: rapid permeability, slow surface runoff, moderate erosion hazard, Hydrologic Group B (small area near easterly site boundary)
- Type 106 – “Wigton loamy sand”: rapid permeability, slow surface runoff, moderate to high erosion hazard, Hydrologic Group A (approximately 35% of site, encompassing western area of parcel)

The soils within this parcel are classified as hydrologic soils group A/B.

E. References

City of Colorado Springs & El Paso County “Drainage Criteria Manual, Volumes 1 and 2,” revised May, 2014.

CDOT, “CDOT Drainage Design Manual,” July, 1995.

El Paso County "Engineering Criteria Manual," January 9, 2006.

FEMA, Flood Insurance Rate Map (FIRM) Number 08041C1025-F, March 17, 1997.

JPS Engineering, Inc., "Master Development Drainage Plan and Preliminary Drainage Report for Silverado Ranch," June 24, 2008 (approved by El Paso County 8/18/08).

USDA/NRCS, "Soil Survey of El Paso County Area, Colorado," June, 1981.

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Basin Description

The major drainage basins lying in and around the proposed development are depicted in Figure EX1. The proposed development lies completely within the Drennan Drainage Basin (CHDS0400) as classified by El Paso County. The Drennan Basin comprises a total drainage area in excess of 16 square miles. As such, the proposed 320-acre Silverado Ranch development represents less than three percent of the total basin area, which is primarily agricultural land.

No drainage planning study has been completed for this drainage basin, or any adjacent drainage basins. In the absence of plans for regional drainage facilities, El Paso County generally requires new developments to provide stormwater detention to maintain historic runoff flows leaving developed areas.

The Silverado Ranch parcel is impacted by several large off-site basins to the northwest of the site, which combine with on-site basins flowing southeasterly towards Dry Squirrel Creek.

B. Floodplain Impacts

This site is not impacted by any delineated 100-year floodplains, as studied by the Federal Emergency Management Agency (FEMA). The 100-year floodplain limits in the vicinity of the site are shown in Flood Insurance Rate Map (FIRM) Number 08041C1025F, dated March 17, 1997, and depicted in Figure A2 (Appendix F).

C. Sub-Basin Description

The developed drainage basins lying within the proposed development are depicted in Figure D1. The interior site layout has been divided into several sub-basins (A1-A6, B1-B7, C, D) based on the interior road layout and grading concept within the site. The natural drainage patterns will be impacted through development by site grading and concentration of runoff in subdivision roadside ditches and channels. The majority of sub-basins drain to the southeast, collecting in the interior roads and drainage channels. On-site flows will be diverted to natural swales draining towards the southerly site boundary, following historic drainage paths.

As shown in Figure D1 (Appendix F), Filing No. 1 lies within parts of Drainage Basins A and B. There will be no developed drainage impact to Basins C and D with Filing No. 1.

III. DRAINAGE DESIGN CRITERIA

A. Development Criteria Reference

The Drennan Drainage Basin has not had a Drainage Basin Planning Study performed for the basin. The majority of areas within the basin are comprised of agricultural lands and rural residential uses.

B. Hydrologic Criteria

SCS procedures were utilized for analysis of major basin flows impacting the site. In accordance with El Paso County drainage criteria, SCS hydrologic calculations were based on the following assumptions:

• Design storm (minor)	5-year
• Design storm (major)	100-year
• 100-year, 24-hour rainfall	4.4 inches per hour (NOAA isopluvial map)
• 5-year, 24-hour rainfall	2.6 inches per hour (NOAA isopluvial map)
• Hydrologic soil type	B
• SCS curve number - undeveloped conditions	61 (pasture / range)
• SCS curve number - undeveloped conditions	50 (pasture / range with upstream retention)
• SCS curve number - developed 5-acre lots	63.22

Rational method procedures were utilized for calculation of peak flows within the on-site drainage basins. Rational method hydrologic calculations were based on the following assumptions:

• Design storm (minor)	5-year	
• Design storm (major)	100-year	
• Time of Concentration – Overland Flow	"Airport" equation	
• Time of Concentration – Gutter/Ditch Flow	"SCS Upland" equation	
• Rainfall Intensities	El Paso County I-D-F Curve	
• Hydrologic soil type	B	
	C5	C100
• Runoff Coefficients - undeveloped:		
Existing pasture/range areas	0.25	0.35
• Runoff Coefficients - developed:		
Proposed lot areas (5-acre average lots)	0.289	0.386

Composite runoff coefficients (C-values) have been calculated based on the proposed rural residential lot sizes. Hydrologic calculations are enclosed in Appendix B, and peak design flows are identified on the drainage basin drawings.

IV. DRAINAGE FACILITY DESIGN

A. General Concept

Development of Silverado Ranch Filing No. 1 will require site grading and roadway construction, resulting in additional impervious areas across the site. The general drainage pattern will consist of grading away from home sites to swales and roadside ditches along the internal roads within the subdivision, conveying runoff flows through the site. Runoff from the site will flow by roadside ditches to cross culverts at low points in the road profiles, and grass-lined channels connecting to existing natural swales at the site boundaries.

The stormwater management concept for Silverado Ranch Filing No. 1 will be to provide roadside ditches and natural swales as required to convey developed drainage through the site to existing natural drainage channel outfalls. Individual lot grading will provide positive drainage away from building sites, and direct developed flows into the system of roadside ditches and drainage swales running through the subdivision.

Two existing retention ponds within the overall Silverado Ranch site will be maintained and upgraded to mitigate the impact of developed flows and ensure that historic flows are maintained downstream of the proposed subdivision. One pond is located at the northwest corner of the property (west of Filing No. 1), and overflows from this pond drain southeasterly to a larger pond located in the future subdivision filing area in the southeast part of the Silverado Ranch property.

The following development practices are generally recommended as good practice for future development within this drainage basin:
- Preserve natural drainageways and floodplains.
- Locate roadways on ridges to minimize crossings and impacts to natural drainage areas.
- Maximize use of grass-lined swales for stormwater quality management.
- Regionalize detention pond facilities where possible to minimize maintenance requirements.

B. Specific Details

1. Existing Drainage Conditions

Historic drainage conditions are depicted in Figures EX1 and EX2. There are no existing drainage facilities within or adjacent to the site, with the exception of an existing culvert crossing Drennan Road at the north boundary of the property, and the existing stock pond areas within the site. The overall Silverado Ranch property is characterized by two large drainage retention areas, as depicted on Sheet EX2. Based on the substantial upstream drainage area, major storm flows (5-year and 100-year) would be expected to overtop the existing retention ponds within the site and overflow towards the southern boundary of the site. Historic overflows from this site would drain to existing grass-lined drainage swales downstream.

Off-site flows from Basin OA1 drain across Drennan Road into the existing depression within Basin A1 at the northwest corner of the parcel. Off-site Basin OA1 discharges historic peak flows of Q_5 = 34.6 cfs and Q_{100} = 261.3 cfs (SCS Method). An existing 18-inch CMP culvert conveys flows from Basin OA1 across the low point in Drennan Road. This undersized culvert would be expected to overtop during major storm events.

Off-site Basin OA2 consists of a tributary area at the southwest corner of Drennan Road and Peyton Highway, which discharges historic peak flows of Q_5 = 19.6 cfs and Q_{100} = 48.4 cfs (Rational Method), entering the northwest corner of the Silverado Ranch property. There is currently no culvert crossing the south side of Drennan Road at Peyton Highway. Historic flows from Basin OA2 would be expected to overtop Peyton Highway at this location.

The existing retention area (Retention Pond A) has a storage volume of approximately 36.5 acre-feet between the 5845 and 5857 contours. Based on topographic survey data, overflows from Retention Pond A would drain southeasterly through Basin A1 towards Pond B in the southeastern part of the property. Off-site flows from Basins OA1 and OA2 combine with on-site flows from Basin A, and the combined flows are routed through Pond A to Design Point #A1, with calculated historic peak flows (SCS Method) of Q_5 = 4.1 cfs and Q_{100} = 216.6 cfs.

These historic flows have been calculated using an SCS Curve Number of 50 for the major off-site basins (OA1 and OB1) recognizing the existence of several upstream (off-site) retention pond areas.

Off-site drainage from the large northwesterly Basin OB1 crosses Drennan Road at an existing 18-inch CMP culvert crossing, which would be expected to overtop during large storm events. Off-site Basin OB1 discharges historic peak flows of Q_5 = 38.7 cfs and Q_{100} = 289.4 cfs (SCS Method), flowing southeasterly into Basin B.

There is currently no culvert crossing where drainage from off-site Basin OB2 crosses an existing low point in Drennan Road at the north boundary of the site. Based on the topography, overflows from Basin OB2 would overtop Drennan Road and flow south into Basin B. Off-site Basin OB2 contributes historic peak flows of Q_5 = 22.3 cfs and Q_{100} = 54.6 cfs (Rational Method), entering the north boundary of the Silverado Ranch property.

Calculations for potential widths of roadway overtopping at the existing off-site drainage basin crossings of Drennan Road along the north boundary of the subdivision (Design Points OA1, OB1 and OB2) are enclosed in Appendix C. As calculated in the appendix, the 100-year depths at these drainage crossings are anticipated to remain less than 12 inches, which is within allowable standards for roadway crossings. Based on field observations at the site, the theoretical 100-year flows calculated in this report would appear to be extremely conservative (high) as indicated by the lack of any significant defined drainage channels approaching these crossings and the existence of only 18-inch diameter culverts with no apparent signs of historic overtopping.

The easterly retention area (Retention Pond B) within the Silverado Ranch site has a storage volume of approximately 74.3 acre-feet between the 5790 and 5796 contours. In the event the existing retention pond was completely full, overflows from this retention area would drain towards the southeast corner of the site. Flows from Basins OA1, OA2, A1, OB1, OB2, and B combine at Design Point #2, with calculated historic peak flows (SCS Method) of Q_5 = 0.0 cfs (completely retained during the 5-year event) and Q_{100} = 355.6 cfs.

Basin A2 comprises the drainage area in the southwest corner of the property, which flows towards Design Point #1 at the southern boundary of the site, with calculated historic peak flows (Rational Method) of Q_5 = 23.9 cfs and Q_{100} = 60.1 cfs.

Basin C comprises the area in the southeasterly part of the overall Silverado site (not part of Filing No. 1), which flows towards Design Point #3 at the southeast corner of the site, with calculated historic peak flows (Rational Method) of Q_5 = 6.8 cfs and Q_{100} = 17.1 cfs.

Basin D comprises the area in the northeast corner of the overall Silverado site (not part of Filing No. 1), which flows towards Design Point #4 near the northeast corner of the site, with calculated historic peak flows (Rational Method) of Q_5 = 8.5 cfs and Q_{100} = 20.2 cfs.

2. Developed Drainage Conditions

The developed drainage basins and projected flows are shown in the Developed Drainage Plan (Figure D1, Appendix F). In the developed condition, Basin A has been divided into sub-basins A1-A5 by the proposed public road layout within the site. Off-site flows from Basins OA1 and OA2 will continue to flow into the existing Retention Pond A within Basin A1 at the northwest corner of the site.

As detailed in Appendix D, in order to meet retention pond design criteria, the calculated 100-year, 24-hour retention storage volume required for Pond A would be 162.3 acre-feet. The available retention storage volume up to the 5857 contour level within Basin A is approximately 36.5 acre-feet (without freeboard), so major storm events would be expected to overtop Pond A and overflow southeasterly following the existing improved drainage channels and existing drainage swales downstream.

Off-site flows from Basins OA1 and OA2 will combine with flows from Basin A1 at Design Point #A1, with developed peak flows of Q_5 = 7.2 cfs and Q_{100} = 222.0 cfs (SCS Method).

Silverado Ranch Filing No. 1 will include construction of Culverts A6 and B1 to convey site drainage across the new public roads (see hydraulic calculations in Appendix C). Culvert A6 is an 18” RCP culvert crossing Drover Canyon Lane on the north side of the intersection with Silverado Hill Loop. Culvert B1 is a 24” RCP culvert crossing Silverado Hill Loop on the south side of Lot 5.

Overflows from the existing Retention Pond A will ultimately cross Silverado Hill Loop west of Filing No. 1, and these flows will continue southeasterly through Basin A5, ultimately flowing to Pond B. Recognizing that some rough grading of Silverado Hill Loop was previously performed at this site, an interim graded spillway will be provided at Design Point A1 to allow for potential overflows from Pond A to overtop the rough-graded roadway and flow southeasterly through Channel A1 towards Pond B. Calculations for the interim spillway are enclosed in Appendix C. Future final design of the roadway and culvert crossing at Design Point A1 will include adequate provisions to safely convey overflows to the downstream drainage channel flowing to Pond B.

Off-site flows from Basin OB1 will overtop Drennan Road and flow easterly through Basin B1 to the existing natural drainage swale flowing south into Retention Pond B (within Basin B6). Filing No. 1 will include construction of Channel OB1 to divert the off-site drainage from Basin OB1 easterly along the south side of Drennan Road beyond the limits of Filing No. 1, allowing the off-site drainage to follow the general historic drainage pattern within the property, flowing southeasterly to Retention Pond B.

During future phases of the subdivision, culverts will be installed at Design Point B6 where flows from this major basin cross the new public roadway. Off-site flows from Basin OB2 will also overtop Drennan Road and flow southeasterly to Retention Pond B.

Flows from Basins OA1-OA2, A1, A5, A6, OB1, and OB2 will continue to combine with on-site flows from Basins B1-B7 at Design Point #2, with developed peak flows of Q_5 = 12.1 cfs and Q_{100} = 342.2 cfs (SCS Method). Based on the significant existing retention storage volume within Pond B, the developed flow impact at Design Point #2 is negligible.

Retention Pond B has a calculated storage volume of 77.1 acre-feet (without freeboard) between the existing bottom elevation of 5790.0 and the overflow elevation of 5796.0 (matching existing). With ultimate development of the subdivision, a limited amount of pond grading will be performed to ensure adequate buildable areas within Lots 30-32 while maintaining the historic storage volume in Pond B. As detailed in Appendix E, in order to meet retention pond design criteria, the calculated 100-year, 24-hour retention volume required at Design Point #2 would be 352.5 acre-feet, which is much greater than the available pond volume. Based on the limited storage volume in comparison to the large off-site drainage basin sizes, major storm events would be expected to overtop Pond B and overflow southeasterly following the existing drainage swales downstream.

Developed Basins A2-A4 will continue to follow historic drainage patterns in the southwesterly part of the site, flowing towards Design Point #1 at the southern site boundary, with calculated developed peak flows (Rational Method) of Q_5 = 27.4 cfs and Q_{100} = 64.1 cfs.

Silverado Ranch Filing No. 1 will not have any developed drainage impact within Basins C or D.

C. Comparison of Developed to Historic Discharges

Based on the hydrologic calculations in Appendix B, the proposed development will result in calculated developed flows marginally exceeding historic flows from the parcel, although the increases are relatively insignificant considering the large size of the off-site tributary drainage areas relative to the on-site development area. The comparison of developed to historic discharges at key design points is summarized as follows:

Design Point	Historic Flow			Developed Flow			Comparison of Developed to Historic Flow (Q_{100})
	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)	
1	56.3	23.9	60.1	47.4	27.4	64.1	107% (increase + 4.0 cfs)
2	5755	0	355.6	5754	12.1	342.2	96% (decrease – 13.4 cfs)

Based on the large size of the off-site basins impacting this site in comparison to the rural nature of the proposed development, developed flow impacts from the project will be minimal. The developed drainage impacts will be attenuated through preservation of the existing on-site stormwater retention ponds.

D. Retention Ponds

Developed runoff impacts from the project will be mitigated by preservation of two existing stormwater retention ponds within the site. The existing retention ponds provide sufficient volume to meet stormwater detention requirements, mitigating developed drainage impacts from the subdivision.

Stormwater retention storage capacity has been evaluated at each of the existing retention ponds based on Denver Urban Drainage and Flood Control District (UDFCD) design criteria. The UDFCD criteria require stormwater retention ponds to have a storage volume of 1.5 times the 24-hour, 100-year volume. Detention volume sizing parameters are summarized as follows (see details in Appendix D):

Pond	**Required 100-Year Retention Volume (ac-ft)**	**Existing Storage Volume w/ 1’ freeboard (ac-ft)**
A (DP-A1)	162.3	28.9
B (DP2)	352.5	57.8

As indicated in the table above, based on the large off-site drainage areas flowing into the site, Ponds A and B do not have sufficient capacity to meet the recommended stormwater retention volume, and as such both ponds would be anticipated to overtop during major storm events. Based on the relatively small impact of developed flows from this site in comparison to the large off-site drainage areas flowing through the site, together with the routing of flows through the existing retention ponds, the impact of developed flows from the Silverado Ranch Subdivision is negligible. As indicated in the HEC-HMS modeling in Appendix C1, The SCS flow calculations indicate no increase in developed flows at Design Point #2 based on maintaining the existing retention storage volume.

Retention pond drain times have been evaluated based on percolation testing performed by Front Range Geotechnical, Inc. As detailed in Appendix D, Pond A is projected to have a drain time of 23.9 hours and Pond B is projected to have a drain time of 14 hours.

Overflow swales will be provided downstream of each pond to convey major storm discharges or back-to-back storm events following historic drainage patterns. 15-foot wide gravel maintenance access roads will be provided for all stormwater retention facilities. The proposed retention ponds will be privately maintained by the subdivision homeowners' association, and a detention pond maintenance agreement will be filed with El Paso County during the final platting stage of the project. Provisions for maintenance of the retention ponds are included in the BMP operation and maintenance (O&M) manual provided in Appendix D.

E. On-Site Drainage Facility Design

Developed sub-basins and proposed drainage improvements are depicted in the enclosed Drainage Plan (Sheet D1). In accordance with El Paso County standards, the interior roads on this relatively flat parcel will be graded with a minimum longitudinal slope of 1.0 percent.

On-site drainage facilities will consist of roadside ditches, grass-lined channels, and culverts. Hydraulic calculations for preliminary sizing of major on-site drainage facilities are enclosed in Appendix D, and design criteria are summarized as follows:

1. Culverts

The internal road system will be graded to drain roadside ditches to low points along the road profile, where cross-culverts will convey developed flows into grass-lined channels following historic drainage paths. Culvert pipes have been specified as reinforced concrete pipe (RCP) with a minimum diameter of 18-inches. Culvert sizes have been identified based on a maximum headwater-to-depth ratio (HW/D) of 1.0 for the minor (5-year) design storm. Final culvert design has been performed utilizing the FHWA HY-8 software package to perform a detailed analysis of inlet and outlet control conditions, meeting El Paso County criteria for allowable overtopping. Riprap outlet protection will be provided at all culverts. Culvert sizes are detailed in the "Culvert Sizing Table" in Appendix C.

2. Open Channels

Drainage easements will be dedicated along major drainage channels following historic drainage paths through the subdivision. These channels will generally be grass-lined channels designed to convey 100-year flows, with a trapezoidal cross-section, variable bottom width and depth, 4:1 maximum side slopes, 1-foot freeboard, and a minimum slope of 0.5 percent. The proposed drainage channels have been sized utilizing Manning's equation for open channel flow, assuming a friction factor ("n") of 0.030 for dry-land grass channels. Maximum allowable velocities have been evaluated based on El Paso County drainage criteria, typically allowing for a maximum 100-year velocity of 5 feet per second. Ditch checks will be installed as required to maintain minimum slopes and velocities. Riprap and/or erosion control blanket channel lining will be provided where required based on erosive velocities.

Channel hydraulic calculations are enclosed in Appendix C, including tables summarizing design parameters for channels and roadside ditches. The proposed channels will be seeded with native grasses for erosion control. Primary drainage swales crossing proposed lots have been placed in drainage easements, with variable widths based on the required channel sections.

F. Analysis of Existing and Proposed Downstream Facilities

The proposed drainage concept is to preserve the existing on-site retention ponds to ensure that flows leaving the developed site remain consistent with historic levels. Based on the maintenance of existing on-site stormwater retention ponds, no downstream or off-site drainage improvements are proposed.

G. Anticipated Drainage Problems and Solutions

The primary drainage problems anticipated within this rural residential subdivision development will consist of maintenance of the proposed drainage channels, culverts, and retention ponds. Care will need to be taken to implement proper erosion control measures in the proposed roadside ditches and swales. Ditches will be designed to meet allowable velocity criteria. Erosion control blankets will be installed where necessary to minimize erosion concerns in ditches and channels. Maintenance of the existing retention ponds will minimize downstream drainage impacts.

H. Proposed Phasing Plan

The proposed phasing of the development will begin with 10 lots at the northwest area of the site in Filing No. 1. The new internal loop road will terminate at temporary cul-de-sacs at the interim phase boundaries, and riprap energy dissipaters will be installed where ditch flows are discharged to the existing natural drainage swales. Applicable roadside ditches, culverts, and channels will be constructed as required with each development phase.

V. EROSION / SEDIMENT CONTROL

Best management practices (BMP's) will be implemented for erosion control during construction. Sediment control measures will include installation of silt fence at the toe of disturbed slopes and hay bales protecting drainage ditches. Cut slopes will be stabilized during excavation as necessary and vegetation will be established for stabilization of disturbed areas as soon as possible. All ditches will be designed to meet El Paso County criteria for slope and velocity. Vehicle tracking control pads will be installed at construction access points, and the existing on-site retention ponds will serve as sediment ponds during the construction period.

VI. COST ESTIMATE AND DRAINAGE FEES

A cost estimate for proposed drainage improvements is enclosed in Appendix E, with a total estimated cost of approximately $23,730 for Filing No. 1 drainage improvements. The developer will finance all costs for proposed roadway and drainage improvements, and public facilities (those within the public right-of-way) will be owned and maintained by El Paso County upon final acceptance. Drainage swales crossing individual lots will be owned and maintained by the individual property owners. Shared private drainage facilities, including the existing retention ponds, will be owned and maintained by the subdivision HOA.

This parcel is located entirely within the Drennan Drainage Basin (CHDS0400), which does not have a drainage or bridge fee requirement. No drainage and bridge fees will be due at time of recordation of the final plat as the subject site is not located in a fee basin.

VII. SUMMARY

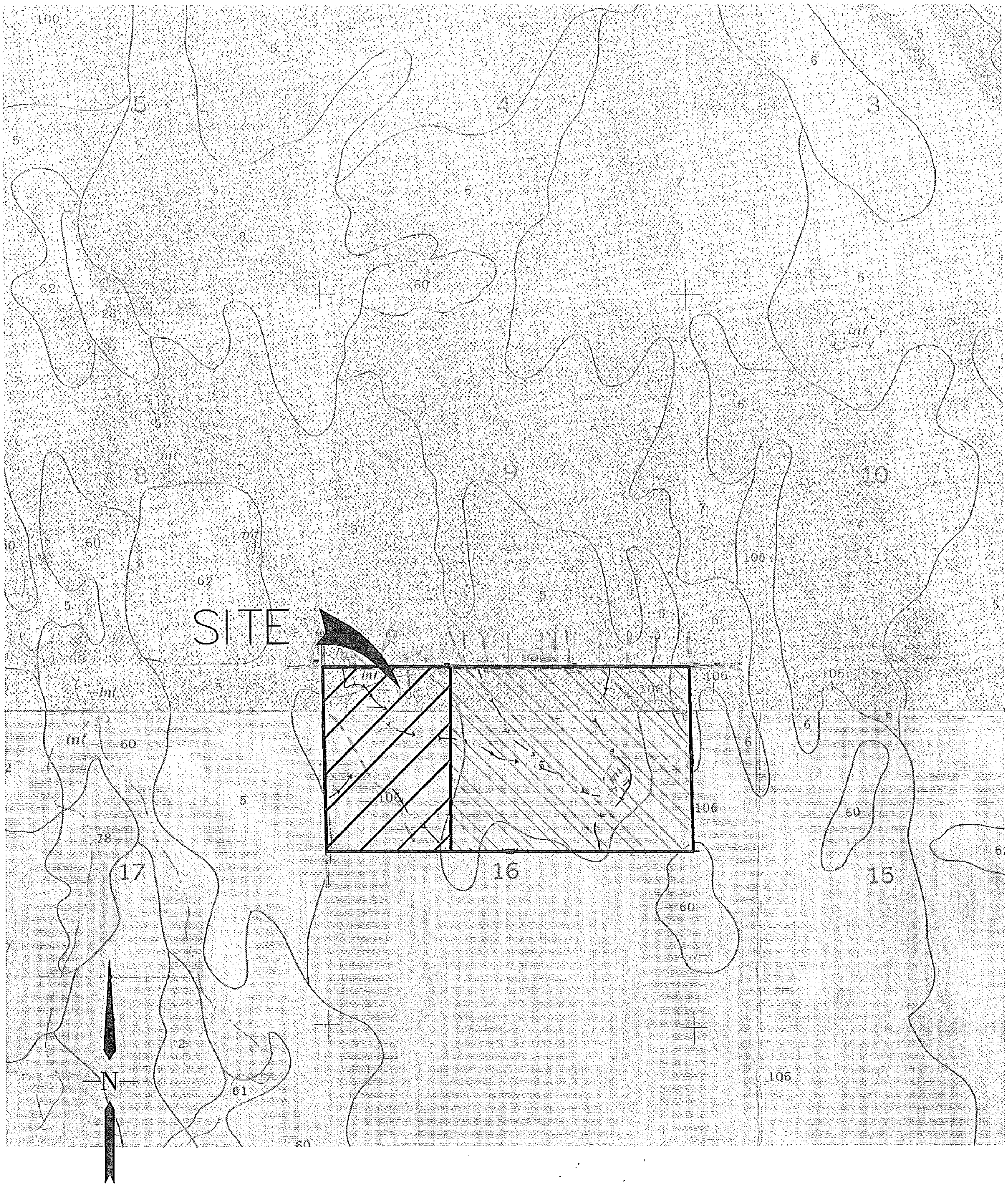
Silverado Ranch is a proposed residential subdivision located southeast of Drennan Road and Peyton Highway. The Silverado Ranch project will ultimately consist of 64 rural residential units on a 320-acre parcel (2.5-acre minimum lots; 5-acre gross density). Filing No. 1 consists of 10 lots on 106.4 acres in the northwest part of the property.

Development of the proposed Silverado Ranch subdivision will generate a marginal increase in developed runoff from the site, which will be mitigated through preservation and maintenance of the two existing on-site stormwater retention ponds. Based on the large size of the off-site basins impacting this site in comparison to the rural nature of the proposed development, developed flow impacts from the project will be minimal.

The proposed drainage patterns will remain consistent with historic conditions, and new drainage facilities constructed to El Paso County standards will safely convey runoff to the existing retention ponds. Preservation of the existing retention ponds and construction of the proposed on-site drainage and erosion control facilities will ensure that this subdivision has no significant adverse drainage impact on downstream or surrounding areas.

APPENDIX A

SCS SOILS INFORMATION



SCALE: 1"=2000' (EL PASO COUNTY SCS SHEETS NO. 19 & 26)

J:\jpsprojects\080603.silverado\dwg\Civil\B-F1.dwg Aug 13, 2009 - 11:01am

SCS SOILS MAP

JPS ENGINEERING

SILVERADO RANCH SUBDIVISION – FIL. #1

FIGURE B

JPS PROJ NO. 080603

of Calhan; the Corral Bluffs, east of Colorado Springs; the southwestern part of the survey area on Fort Carson; and the old Golden Cycle gold ore processing mill in the western part of Colorado Springs.

Runoff is very rapid, and the hazard of erosion is high. The reaction of the tailings material is slightly acid to extremely acid. Little or no soil development has taken place. Gullying is severe in most areas of Badland.

Vegetation grows only in small patches of soil material in drainageways and in some of the less eroded areas. The sloping part of Badland is extremely gullied and lacks vegetation.

Most areas of Badland are used for wildlife habitat. In the mill tailings area in the western part of Colorado Springs, some urban development has taken place in level areas that have had a layer of topsoil applied to the surface. Capability subclass VIIIs.

5—Bijou loamy sand, 1 to 8 percent slopes. This deep, somewhat excessively drained soil is on flood plains, terraces, and uplands. It formed in sandy alluvium and eolian material derived from arkose deposits. Elevation ranges from 5,400 to 6,200 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is brown loamy sand 8 inches thick. The subsoil is grayish brown sandy loam about 20 inches thick. The substratum is pale brown loamy coarse sand.

Included with this soil in mapping are small areas of Olney sandy loam, 3 to 5 percent slopes; Valent sand, 1 to 9 percent slopes; Vona sandy loam, 3 to 9 percent slopes, and Wigton loamy sand, 1 to 8 percent slopes.

Permeability of this Bijou soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Organic matter content of the surface layer is low. Surface runoff is slow, and the hazards of erosion and soil blowing are severe.

Most areas of this soil are used for range. A small acreage is used for crops grown under sprinkler irrigation.

This soil is not suited to dryfarming, because of the soil blowing hazard. Corn, pasture, and alfalfa are the principal crops grown under irrigation. Corn and pasture require moderate to heavy applications of nitrogen. Alfalfa generally responds to phosphate fertilizer. Some zinc deficiency has been noted on corn. Crop residue management must be used at all times to control soil blowing. Crops that produce little or no residue are not suited to this soil.

Native vegetation is mainly sandreed, sand bluestem, blue grama, and needleandthread. Sand sagebrush makes up only a small part of the total ground cover.

In overgrazed areas mechanical and chemical sagebrush control may be needed. This soil is highly susceptible to soil blowing, and water erosion occurs when the plant cover is inadequate. Interseeding should be used in overgrazed areas. Proper location of livestock watering facilities helps to control grazing.

Windbreaks and environmental plantings are fairly well suited to this soil. Blowing sand and low available water capacity are the principal limitations to the establishment of trees and shrubs. The soil is so loose that trees need to be planted in shallow furrows and plant cover needs to be maintained betweeen the rows. Supplemental irrigation may be needed to insure survival. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Siberian elm. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil has good potential for homesites. Shallow excavation is severely limited because cut banks cave in. This soil requires special management practices to reduce water erosion and soil blowing because it is sandy. Capability subclasses VIe, nonirrigated, and IVe, irrigated.

6—Bijou sandy loam, 1 to 3 percent slopes. This deep, well drained soil is on flood plains, terraces, and uplands. It formed in sandy alluvium and in eolian material derived from arkose deposits. Elevation ranges from 5,400 to 6,200 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is brown sandy loam about 4 inches thick. The subsoil is brown or grayish brown sandy loam about 24 inches thick. The substratum is pale brown loamy coarse sand.

Included with this soil in mapping are small areas of Olney sandy loam, 0 to 3 percent slopes; Vona sandy loam, 1 to 3 percent slopes; and Wigton loamy sand, 1 to 8 percent slopes.

Permeability of this Bijou soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Organic matter content of the surface layer is low. Surface runoff is slow, and the hazards of erosion and soil blowing are moderate.

Most areas of this soil are used for range, but some areas are used for dryland or irrigated farming.

Corn, sorghum, and wheat are the principal nonirrigated crops. Corn, alfalfa, and pasture are the main crops grown under irrigation. Irrigated crops respond to phosphate and nitrogen fertilizer. Dryfarmed corn and sorghum generally respond to nitrogen fertilizer. Management of crop residue is necessary to control soil blowing. Stripcropping helps to control soil blowing. Sprinkler irrigation is the most suitable and widely practiced method of applying water.

Native vegetation is dominantly blue grama, sand dropseed, needleandthread, side-oats grama, and buckwheat.

Seeding is advisable if the range has deteriorated. Seeding the native grasses is a good practice. If the range managing livestock grazing, and reseeding range where needed.

This soil has good potential for use as homesites. The main limitations of this soil for roads and streets are limited ability to support a load and frost action potential. Roads must be designed to overcome these limitations. This soil should be stabilized after site preparation, and as much of the existing vegetation as possible should be left on the soil. During site preparation, only small areas of this soil should be disturbed at a time. Capability subclass VIe.

106—Wigton loamy sand, 1 to 8 percent slopes. This deep, excessively drained soil formed in noncalcareous, sandy eolian material on dunelike uplands. Elevation ranges from 5,300 to 6,000 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 145 days.

Typically, the surface layer is brown loamy sand about 8 inches thick. The next layer is brown loamy sand about 11 inches thick. The underlying material is very pale brown sand to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Bijou loamy sand, 1 to 8 percent slopes; Bijou sandy loam, 1 to 3 percent slopes; Bijou sandy loam, 3 to 8 percent slopes; and Valent sand, 1 to 9 percent slopes.

Permeability of this Wigton soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low to moderate. Surface runoff is low, the hazard of erosion is moderate to high, and the hazard of soil blowing is high.

This soil is used mostly as rangeland.

If sprinkler irrigation is used, this soil is suited to limited use as cropland and pasture if crop residue is maintained on the surface. Only a very small acreage of this soil is cultivated, and it is used for alfalfa and grasses that are harvested for hay or are grazed by livestock. Nitrogen and phosphorus fertilizer is required for satisfactory yields. The soil is unsuited to nonirrigated crops.

Rangeland vegetation on this soil is mainly sand reedgrass, and bluestem, and needleandthread. Sand sagebrush is present in the stand, but it makes up only a small part of the total ground cover.

Mechanical and chemical methods of sagebrush control may be needed in overgrazed areas. This soil is highly susceptible to soil blowing, and it is subject to water erosion when the plant cover is inadequate. Interseeding is needed in overgrazed areas. Properly locating livestock watering facilities helps to control grazing.

Windbreaks and environmental plantings are fairly well suited to this soil. Blowing sand and low available water capacity are the main limitations for the establishment of trees and shrubs. The soil is so loose that trees need to be planted in shallow furrows and plant cover needs to be maintained between the rows. Supplemental irrigation may be needed to insure survival. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Siberian elm. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to wildlife habitat. It is best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

The main limitations of this soil for homesites are unstable cut banks during excavation and the hazard of soil blowing. Trenches for pipelines and shallow excavations must be made in such a way that cut banks remain stable, thus providing proper protection for workmen. Special practices must be used to control soil blowing. Only small areas of this soil should be disturbed at a time during construction in order to leave as much vegetation on the surface as possible. Capability subclasses VIe, nonirrigated, and IVe, irrigated.

~~**107—Wiley silt loam, 1 to 3 percent slopes.** This deep, well drained soil formed in calcareous, silty eolian material. Elevation ranges from 5,200 to 6,200 feet. The average annual precipitation is about 13 inches, the average annual air temperature is about 49 degrees F, and the average frost-free period is about 145 days.~~

~~Typically, the surface layer is pale brown silt loam about 5 inches thick. The subsoil is very pale brown heavy silt loam about 18 inches thick. The substratum is very pale brown silt loam to a depth of 60 inches or more. Visible soft masses of lime are in the lower part of the subsoil and in the substratum.~~

~~Included with this soil in mapping are small areas of Fort Collins loam, 0 to 3 percent slopes; Keith silt loam, 0 to 3 percent slopes; and Satanta loam, 0 to 3 percent slopes.~~

~~Permeability of this Wiley soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is slow, the hazard of erosion is slight to moderate, and the hazard of soil blowing is high.~~

~~Most areas of this soil are used as rangeland, but a few small areas are dryfarmed.~~

~~This soil is well suited to the production of native vegetation suitable for grazing. The native vegetation is mainly blue grama, western wheatgrass, sand dropseed, and galleta.~~

~~Fencing and properly locating livestock watering facilities help to control grazing. Deferment of grazing may be necessary to maintain a needed balance between livestock use and forage production. In areas where the plant cover has been depleted, pitting can be used to help the native vegetation recover. Chemical control practices may be needed in disturbed areas where dense stands of pricklypear occur. Ample amounts of litter and forage should be left on the soil because of the high hazard of soil blowing.~~

~~Windbreaks and environmental plantings generally are well suited to this soil. Summer fallow a year prior to~~

TABLE 16.--SOIL AND WATER FEATURES

[Absence of an entry indicates the feature is not a concern. See "flooding" in Glossary for definition of terms as "rare," "brief," and "very brief." The symbol > means greater than]

Soil name and map symbol	Hydrologic group	Flooding			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Hardness	
					In		
Alamosa:							
1	C	Frequent	Brief	May-Jun	>60	---	High.
Ascalon:							
2, 3	B	None	---	---	>60	---	Moderate.
Badland:							
4	D	---	---	---	---	---	---
Bijou:							
5, 6, 7	B	None	---	---	>60	---	Low.
Blakeland:							
8	A	None	---	---	>60	---	Low.
[1]9:							
Blakeland part	A	None	---	---	>60	---	Low.
Fluvaquentic Haplaquolls part	D	Common	Very brief	Mar-Aug	>60	---	High.
Blendon:							
10	B	None	---	---	>60	---	Moderate.
Bresser:							
11, 12, 13	B	None	---	---	>60	---	Low.
Brussett:							
14, 15	B	None	---	---	>60	---	Moderate.
Chaseville:							
16, 17	A	None	---	---	>60	---	Low.
[1]18:							
Chaseville part	A	None	---	---	>60	---	Low.
Midway part	D	None	---	---	10-20	Rippable	Moderate.
Columbine:							
19	A	None to rare	---	---	>60	---	Low.
Connerton:							
[1]20:							
Connerton part	B	None	---	---	>60	---	High.
Rock outcrop part	D	---	---	---	---	---	---
Cruckton:							
21	B	None	---	---	>60	---	Moderate.
Cushman:							
22, 23	C	None	---	---	20-40	Rippable	Moderate.
[1]24:							
Cushman part	C	None	---	---	20-40	Rippable	Moderate.
Kutch part	C	None	---	---	20-40	Rippable	Moderate.
Elbeth:							
25, 26	B	None	---	---	>60	---	Moderate.
[1]27:							
Elbeth part	B	None	---	---	>60	---	Moderate.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Hardness	
					In		
Tomah:							
[1]92, [1]93:							
Tomah part	B	None	---	---	>60	---	Moderate.
Crowfoot part	B	None	---	---	>60	---	Moderate.
Travessilla:							
[1]94:							
Travessilla part	D	None	---	---	6-20	Hard	Low.
Rock outcrop part	D	---	---	---	---	---	---
Truckton:							
95, 96, 97	B	None	---	---	>60	---	Moderate.
[1]98:							
Truckton part	B	None	---	---	>60	---	Moderate.
Blakeland part	A	None	---	---	>60	---	Low.
[1]99, [1]100:							
Truckton part	B	None	---	---	>60	---	Moderate.
Bresser part	B	None	---	---	>60	---	Low.
Ustic Torrifluvents:							
101	B	Occasional	Very brief	Mar-Aug	>60	---	Moderate.
Valent:							
102, 103	A	None	---	---	>60	---	Low.
Vona:							
104, 105	B	None	---	---	>60	---	Moderate.
Wigton:							
106	A	None	---	---	>60	---	Low.
Wiley:							
107, 108	B	None	---	---	>60	---	Low.
Yoder:							
109, 110	B	None	---	---	>60	---	Low.

---

[1] This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior characteristics of the map unit.

APPENDIX B1

HYDROLOGIC CALCULATIONS (SCS METHOD)

TABLE 5-4
RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL COVER COMPLEXES - RURAL CONDITIONS
(Antecedent Moisture Condition II, and Ia = 0.2 S)
(From: U.S. Dept. of Agriculture,
Soil Conservation Service, 1977)

Land Use	Cover Treatment or Practice	Hydrologic Condition	Runoff Curve Number by Hydrologic Soil Group			
			A	B	C	D
Fallow	Straight Row	----	77	86	91	94
Row Crops	Straight Row	Poor	72	81	88	91
	Straight Row	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	Contoured	Good	65	75	82	86
	Cont. & Terraced	Poor	66	74	80	82
	Cont. & Terraced	Good	62	71	78	81
Small Grain	Straight Row	Poor	65	76	84	88
	Straight Row	Good	63	75	83	87
	Contoured	Poor	63	74	82	85
	Contoured	Good	61	73	81	84
	Cont. & Terraced	Poor	61	72	79	82
	Cont. & Terraced	Good	59	70	78	81
Close-seeded legumes 1/ or rotation meadow	Straight Row	Poor	66	77	85	89
	Straight Row	Good	58	72	81	85
	Contoured	Poor	64	75	83	85
	Contoured	Good	55	69	78	83
	Cont. & Terraced	Poor	63	73	80	83
	Cont. & Terraced	Good	51	67	76	80
Pasture or range		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
	Contoured	Poor	47	67	81	88
	Contoured	Fair	25	59	75	83
	Contoured	Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		----	59	74	82	86
Roads (dirt) 2/		----	72	82	87	89
(hard surface) 2/		----	74	84	90	92

1/ Close-drilled or broadcast
2/ Including right-of-way

TABLE 5-5
RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL COVER COMPLEXES - URBAN AND SUBURBAN CONDITIONS 1/
(Antecedent Moisture Condition II)
(From: U.S. Dept. of Agriculture,
Soil Conservation Service, 1977)

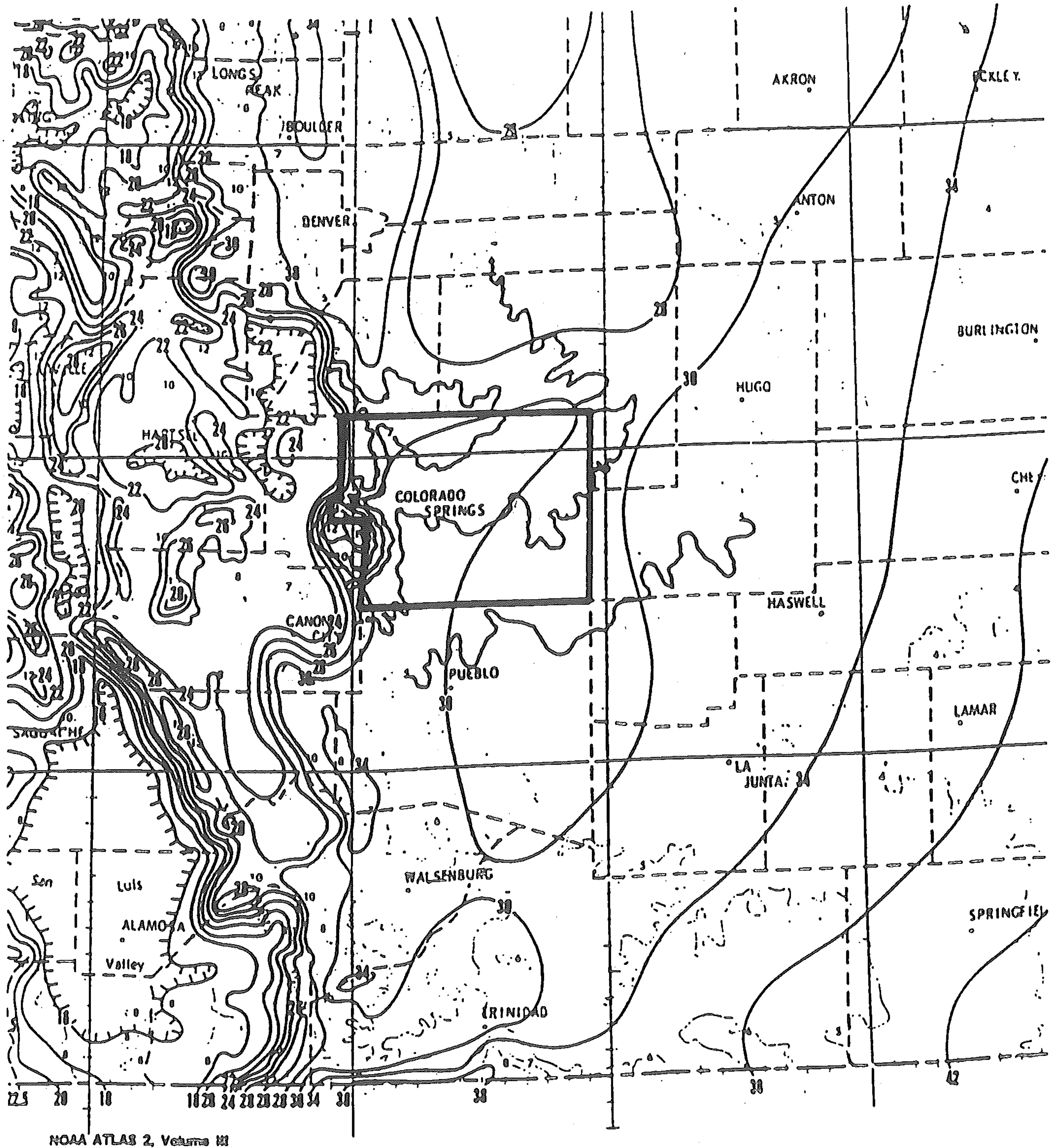
		Hydrologic Soil Group			
Land Use		A	B	C	D
Open spaces, lawns, parks, golf courses, cemeteries, etc.					
Good condition: grass cover on 75% or more of the area		39*	61	74	80
Fair condition: grass cover on 50% to 75% of the area		49*	69	79	84
Commercial and Business areas (85% Impervious)		89*	92	94	95
Industrial Districts 72% Impervious)		81*	88	91	93
Residential: 2/					
Acres per Dwelling Unit	Average % Impervious 3/				
1/8 acre or less	65	77*	85	90	92
1/4 acre	38	61*	75	83	87
1/3 acre	30	57*	72	81	86
1/2 acre	25	54*	70	80	85
1 acre	20	51*	68	79	84
Paved parking lots, roofs, driveways, etc.		98	98	98	98
Streets and Roads:					
paved with curbs and storm sewers		98	98	98	98
gravel		76*	85	89	91
dirt		72*	82	87	89

1/ For a more detailed description of agricultural land use curve numbers, refer to the National Engineering Handbook (U.S. Dept. of Agriculture, Soil Conservation Service, 1972).

2/ Curve numbers are computed assuming the runoff from the house and driveway is directed towards the street with a minimum of roof water directed to lawns where additional infiltration could occur.

3/ The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

* Not to be used wherever overlot grading or filling is to occur.



NOAA ATLAS 2, Volume III

Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology

Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

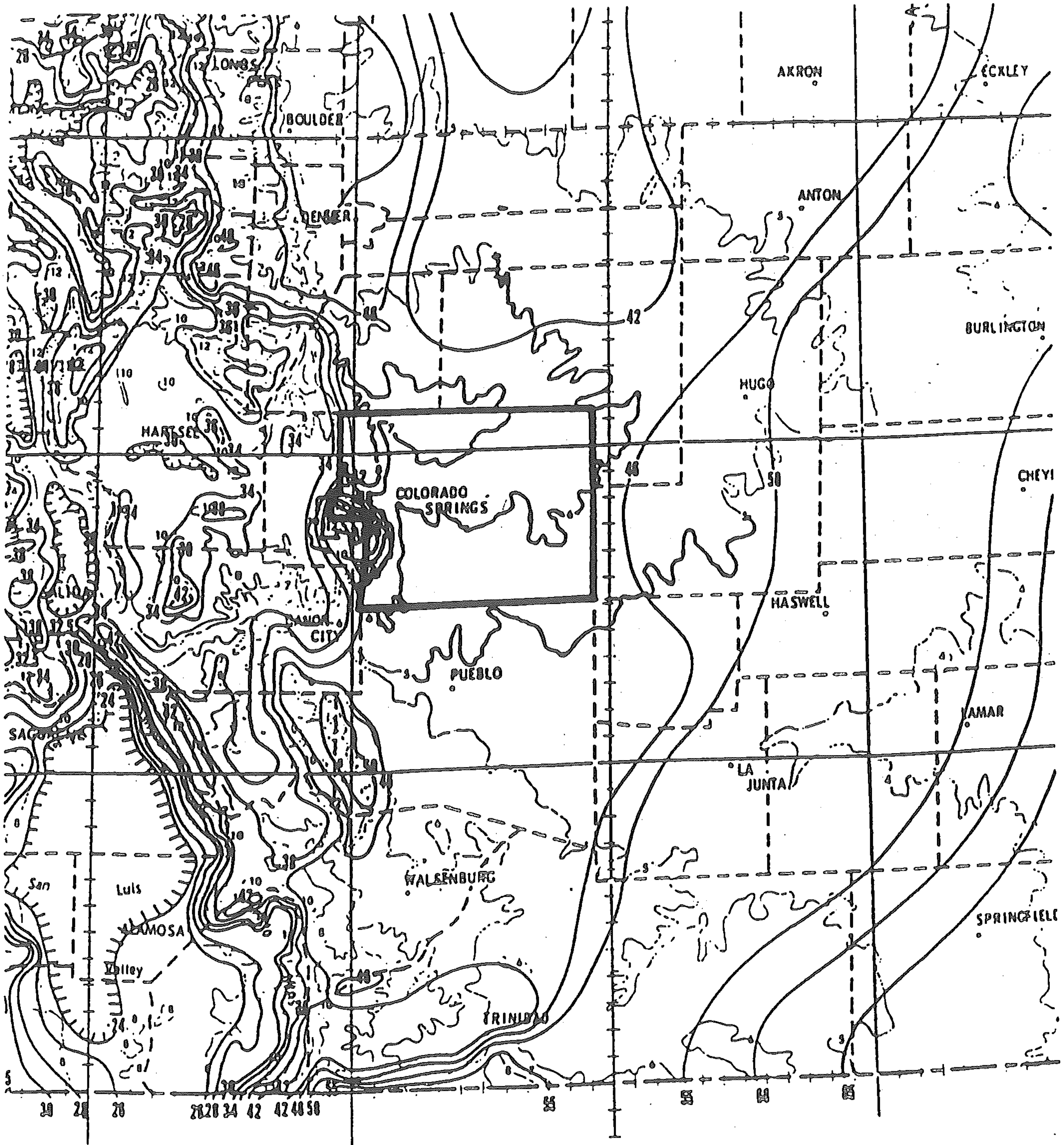
ISOPLUVIALS OF 10-YR 24-HR PRECIPITATIO
IN TENTHS OF AN INCH

The City of Colorado Springs / El Paso County
Drainage Criteria Manual

Date
OCT. 1987

Figure
A4

HDR Infrastructure, Inc.
A Centerra Company



NOAA ATLAS 2, Volume III
Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

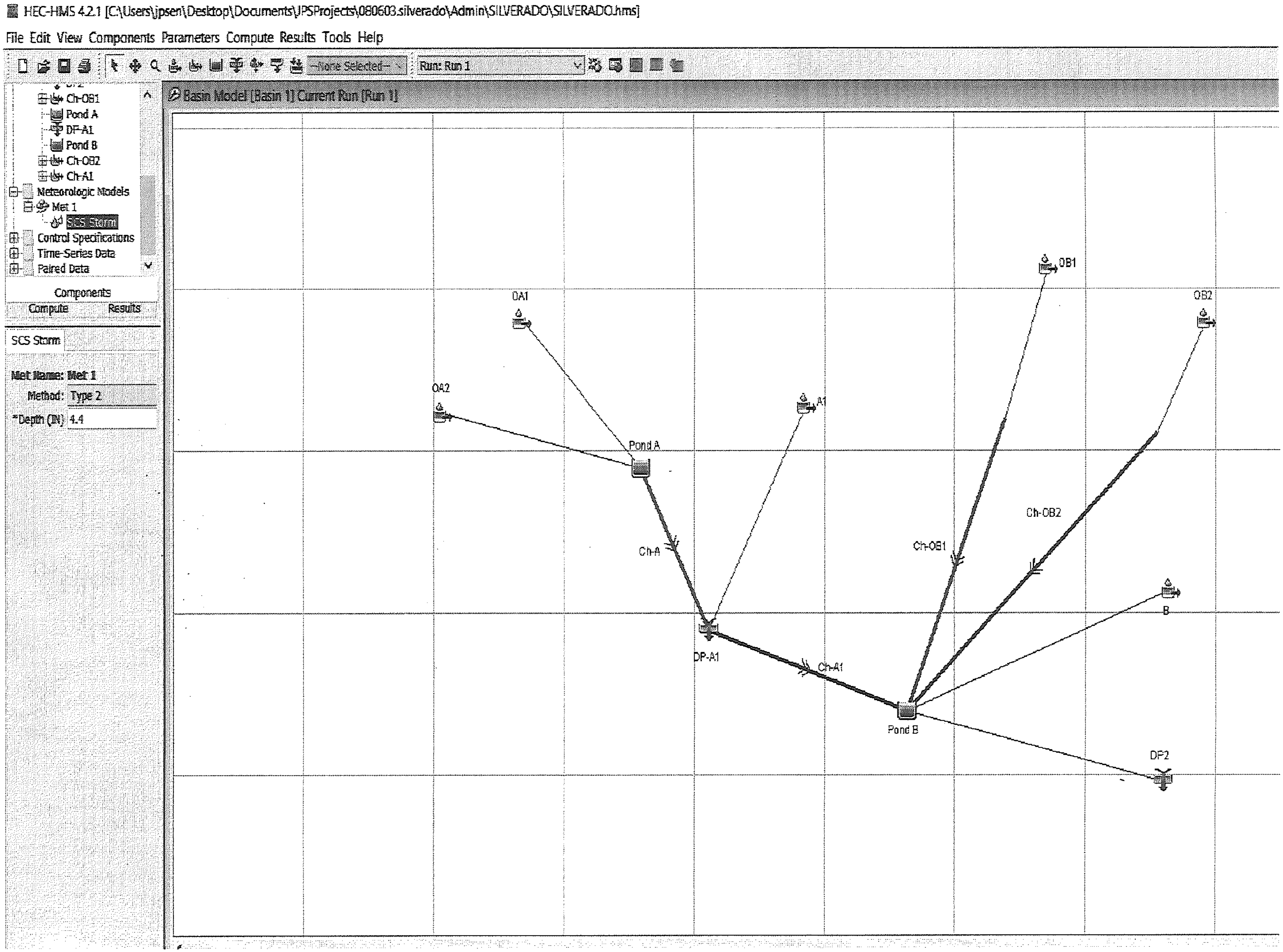
ISOPLUVIALS OF 100-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

The City of Colorado Springs / El Paso County
Drainage Criteria Manual

Date
OCT. 1987

Figure
A5

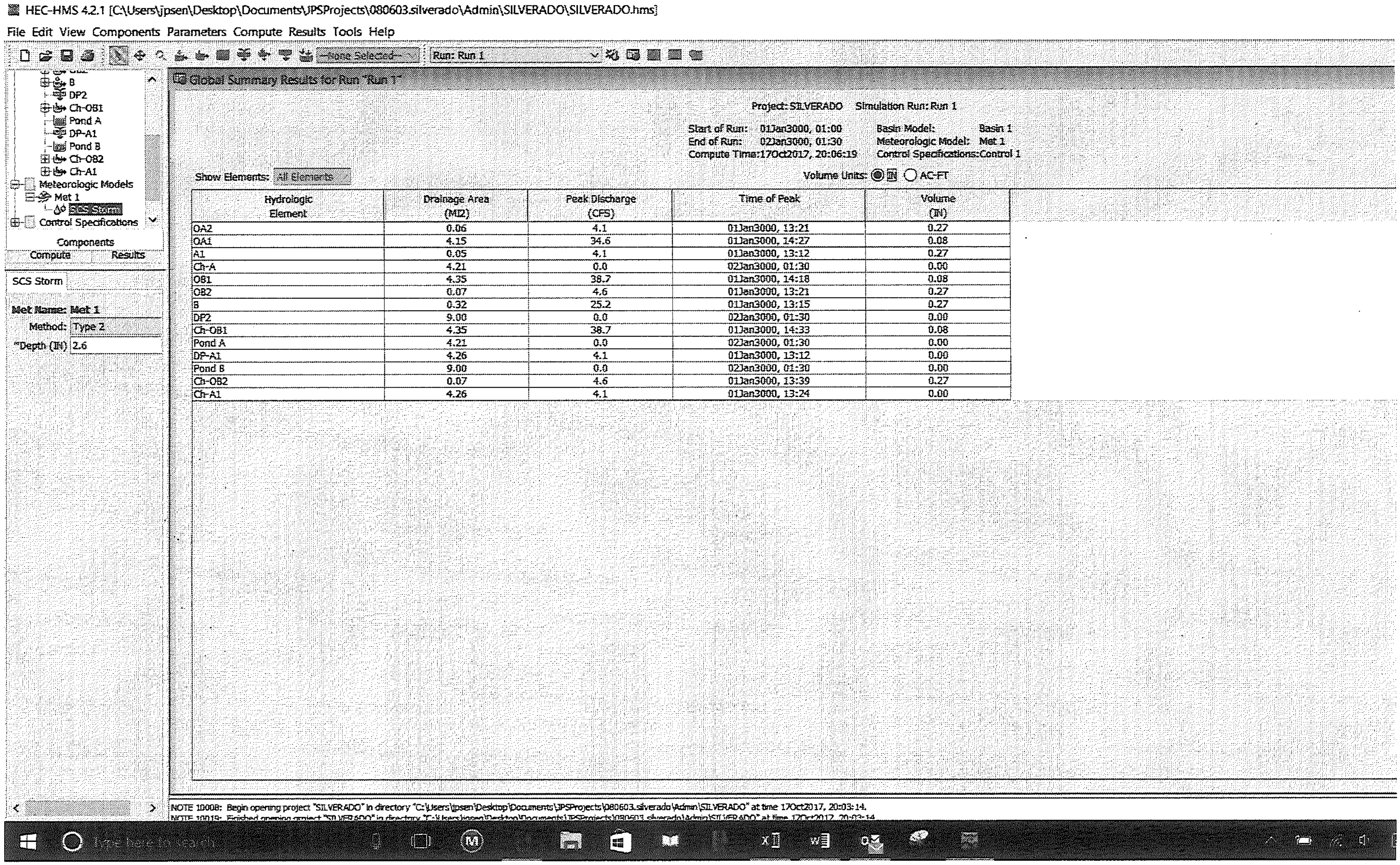
HDR Infrastructure, Inc.
A Centerra Company



Met Name: Met 1

Method: Type 2

*Depth (IN) 4.4



Met Name: Met 1

Method: Type 2

*Depth (IN) 2.6

Global Summary Results for Run "Run 1"

Project: SILVERADO Simulation Run: Run 1

Start of Run: 01Jan3000, 01:00
End of Run: 02Jan3000, 01:30
Compute Time: 17Oct2017, 20:06:19

Basin Model: Basin 1
Meteorologic Model: Met 1
Control Specifications: Control 1

Show Elements: All Elements

Volume Units: ● IN ○ AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
OA2	0.06	4.1	01Jan3000, 13:21	0.27
OA1	4.15	34.6	01Jan3000, 14:27	0.08
A1	0.05	4.1	01Jan3000, 13:12	0.27
Ch-A	4.21	0.0	02Jan3000, 01:30	0.00
OB1	4.35	38.7	01Jan3000, 14:18	0.08
OB2	0.07	4.6	01Jan3000, 13:21	0.27
B	0.32	25.2	01Jan3000, 13:15	0.27
DP2	9.00	0.0	02Jan3000, 01:30	0.00
Ch-OB1	4.35	38.7	01Jan3000, 14:33	0.08
Pond A	4.21	0.0	02Jan3000, 01:30	0.00
DP-A1	4.26	4.1	01Jan3000, 13:12	0.00
Pond B	9.00	0.0	02Jan3000, 01:30	0.00
Ch-OB2	0.07	4.6	01Jan3000, 13:39	0.27
Ch-A1	4.26	4.1	01Jan3000, 13:24	0.00

```
NOTE 10008: Begin opening project "SILVERADO" in directory "C:\Users\jpsen\Desktop\Documents\JPSProjects\080603.silverado\Admin\SILVERADO" at time 17Oct2017, 20:03:14.
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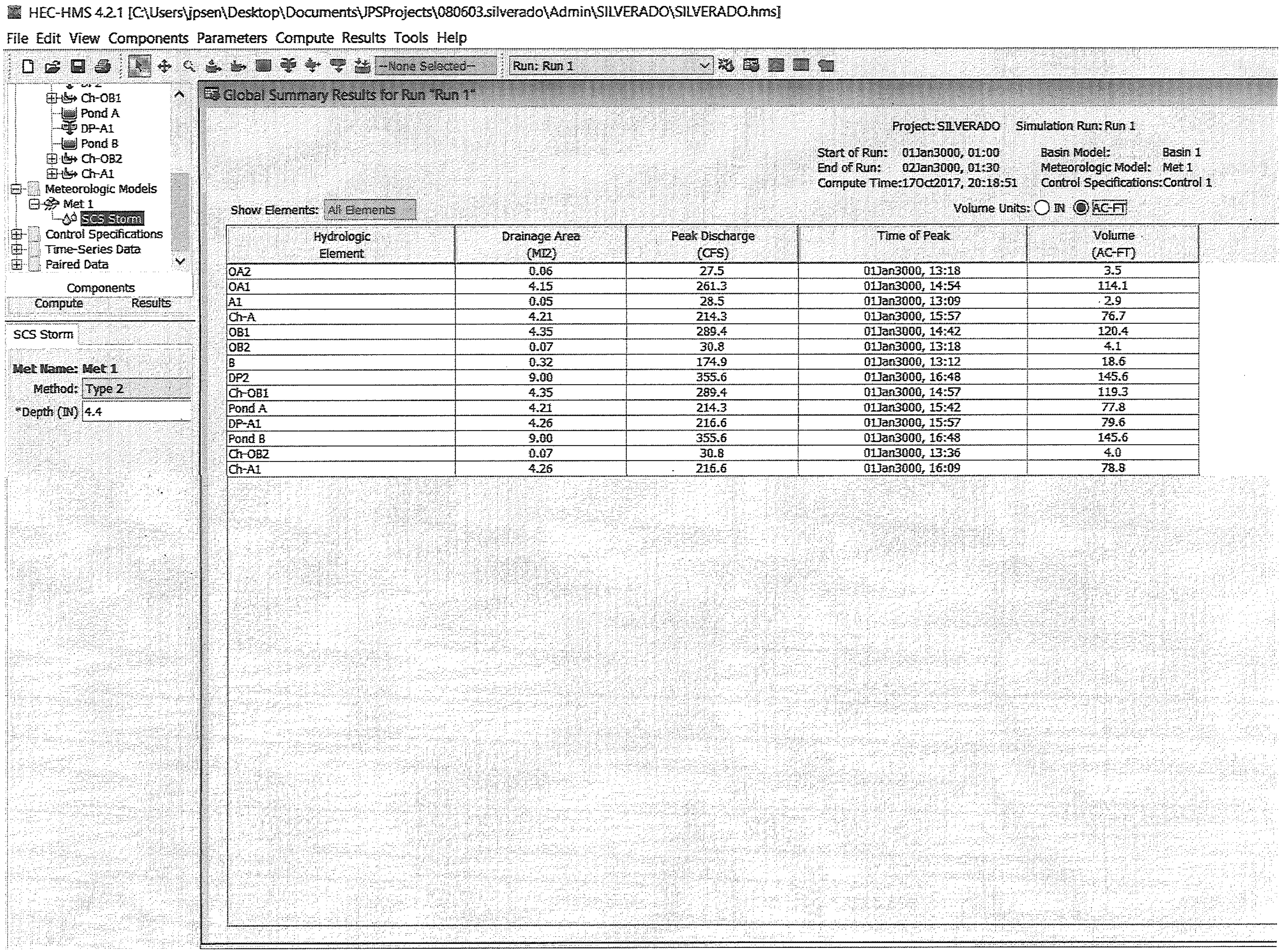


HEC-HMS 4.2.1 [C:\Users\jpsen\Desktop\Documents\JPSProjects\080603.silverado\Admin\SILVERADO\SILVERADO.hms]

Met Name: Met 1
Method: Type 2
*Depth (IN) 4.4

Global Summary Results for Run "Run 1"

Project: SILVERADO Simulation Run: Run 1

Start of Run: 01Jan3000, 01:00
End of Run: 02Jan3000, 01:30
Compute Time:17Oct2017, 20:18:51

Basin Model: Basin 1
Meteorologic Model: Met 1
Control Specifications:Control 1

Show Elements: All Elements

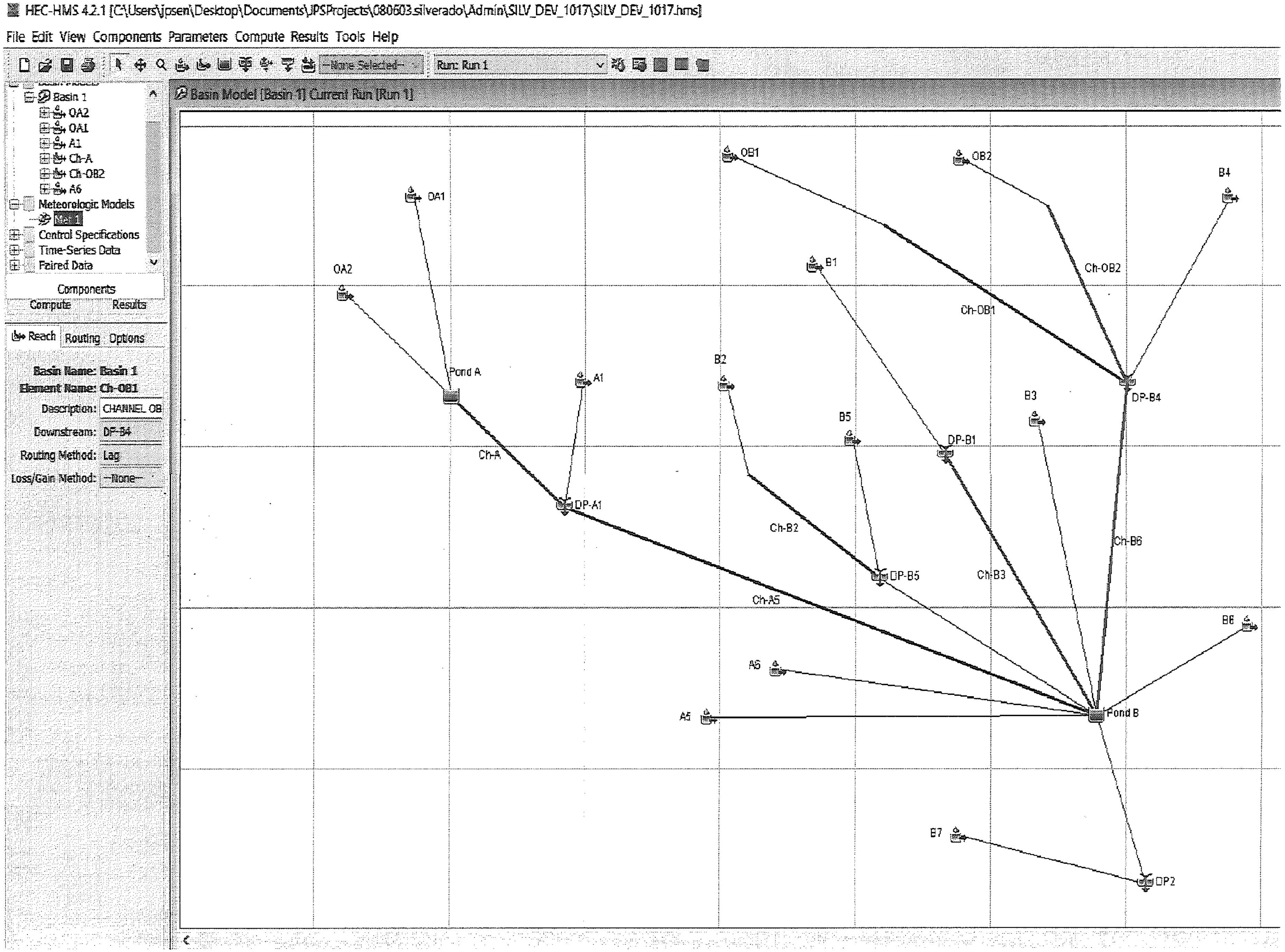
Volume Units: ○ IN ● AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
OA2	0.06	27.5	01Jan3000, 13:18	3.5
OA1	4.15	261.3	01Jan3000, 14:54	114.1
A1	0.05	28.5	01Jan3000, 13:09	2.9
Ch-A	4.21	214.3	01Jan3000, 15:57	76.7
OB1	4.35	289.4	01Jan3000, 14:42	120.4
OB2	0.07	30.8	01Jan3000, 13:18	4.1
B	0.32	174.9	01Jan3000, 13:12	18.6
DP2	9.00	355.6	01Jan3000, 16:48	145.6
Ch-OB1	4.35	289.4	01Jan3000, 14:57	119.3
Pond A	4.21	214.3	01Jan3000, 15:42	77.8
DP-A1	4.26	216.6	01Jan3000, 15:57	79.6
Pond B	9.00	355.6	01Jan3000, 16:48	145.6
Ch-OB2	0.07	30.8	01Jan3000, 13:36	4.0
Ch-A1	4.26	216.6	01Jan3000, 16:09	78.8

HISTORIC FLOWS

									Overland Flow			Channel flow							Time of Concentration	Total Lag Time	Total Lag Time	Peak Flow SCS	
BASIN	DESIGN POINT	AREA (AC)	AREA (SM)	RUNOFF COEFFICIENT (C5)	CURVE No. (CN)	S	Ia	PERCENT IMPERVIOUS (%)	LENGTH (FT)	SLOPE (%)	Tco $^{(1)}$ (MIN)	HIGH ELEV. (FT)	LOW ELEV. (FT)	H (FT)	CHANNEL LENGTH (FT)	CHANNEL LENGTH (MI)	SLOPE (%)	Tt $^{(1)}$ (MIN)	Tc $^{(2)}$ (MIN)	Tl $^{(2)}$ (HR)	Tl $^{(2)}$ (MIN)	Q5 $^{(3)}$ (CFS)	Q100 $^{(3)}$ (CFS)
OA1	OA1	2657.2	4.15	0.25	50	10.00	2.00	2	1000	4.0	30.5	6380	5854	526	35200	6.67	1.5%	124.82	155.31	1.55	93.19	34.6	261.3
OA2	OA2	37.4	0.06	0.25	61	6.39	1.28	2	1000	3.0	33.6	5860	5857	3	200	0.04	1.5%	2.33	35.88	0.36	21.53	4.1	27.5
CHANNEL A											0.0	5857	5855	2	1400	0.27	0.1%	25.73	25.73	0.26	15.44		
A1		30.49	0.05	0.25	61	6.39	1.28	2			0.0	5857	5855	2	1400	0.27	0.1%	25.73	25.73	0.26	15.44		
OA1,OA2,A1	A1	2725.05	4.26																181.04	1.81	108.63	4.1	216.6
CHANNEL A1											0.0	5855	5796	59	3620	0.69	1.6%	20.95	20.95	0.21	12.57		
OB1	OB1	2782.8	4.35	0.25	50	10.00	2.00	2	1000	1.0	48.4	6210	5830	380	24600	4.66	1.5%	93.52	141.90	1.42	85.14	38.7	289.4
CHANNEL OB1											0.0	5830	5780	50	4350	0.82	1.1%	27.60	27.60	0.28	16.56		
OB2		44.6	0.07	0.25	61	6.39	1.28	2	1000	3.0	33.6	5835	5808	27	800	0.15	3.4%	4.95	38.51	0.39	23.11	4.6	30.8
CHANNEL OB2											0.0	5808	5795	13	3050	0.58	0.4%	30.77	30.77	0.31	18.46		
B		202.54	0.32	0.25	61	6.39	1.28	2			0.0	5830	5780	50	4350	0.82	1.1%	27.60	27.60	0.28	16.56		
OA1,OA2,OB1,OB2,A2,E	2	5754.99	8.99																201.99	2.02	121.19	0.0	355.6

1) OVERLAND FLOW Tco = (1.8*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333)
2) TRAVEL TIME, Tt = ((11.9*L^3)/H)^(0.385
3) Tc = Tco + Tt
4) SCS LAG TIME, Tl = 0.6 * T
5) PEAK FLOWS CALCULATED BY HEC-HMS 4.2.1 (5-YR; 24-HR RAINFALL = 2.6 IN; 100-YR; 24-HR RAINFALL = 4.4 II



HEC-HMS 4.2.1 [C:\Users\jpsen\Desktop\Documents\JPSProjects\080603.silverado\Admin\SILV_DEV_1017\SILV_DEV_1017.hms]

Basin Model [Basin 1] Current Run [Run 1]

Run: Run 1

Basin Name: Basin 1

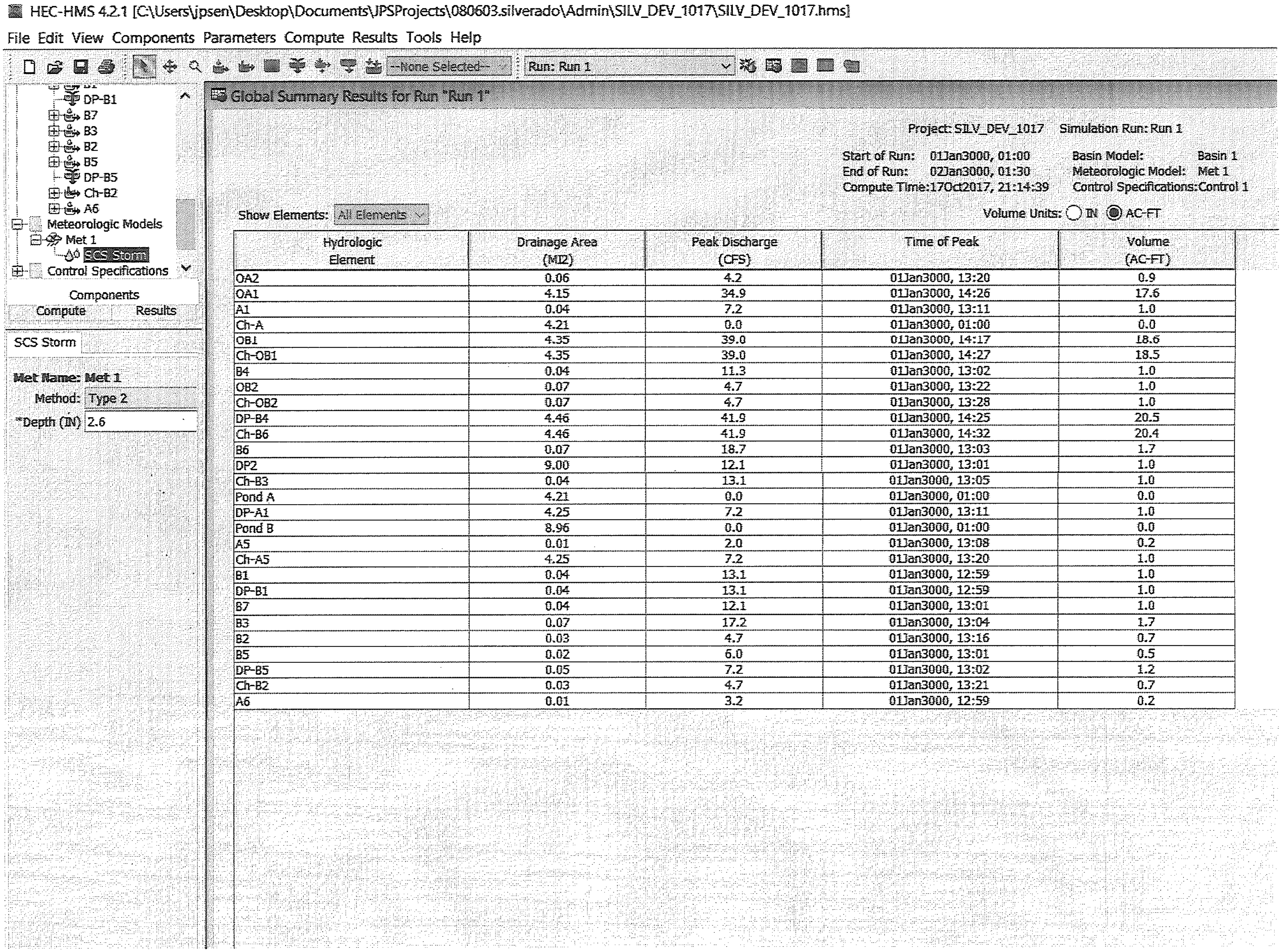
Element Name: Ch-OB1

Description: CHANNEL OB

Downstream: DP-B4

Routing Method: Lag

Loss/Gain Method: --None--



Met Name: Met 1
Method: Type 2
*Depth (IN) 2.6

Global Summary Results for Run "Run 1"

Project: SILV_DEV_1017 Simulation Run: Run 1

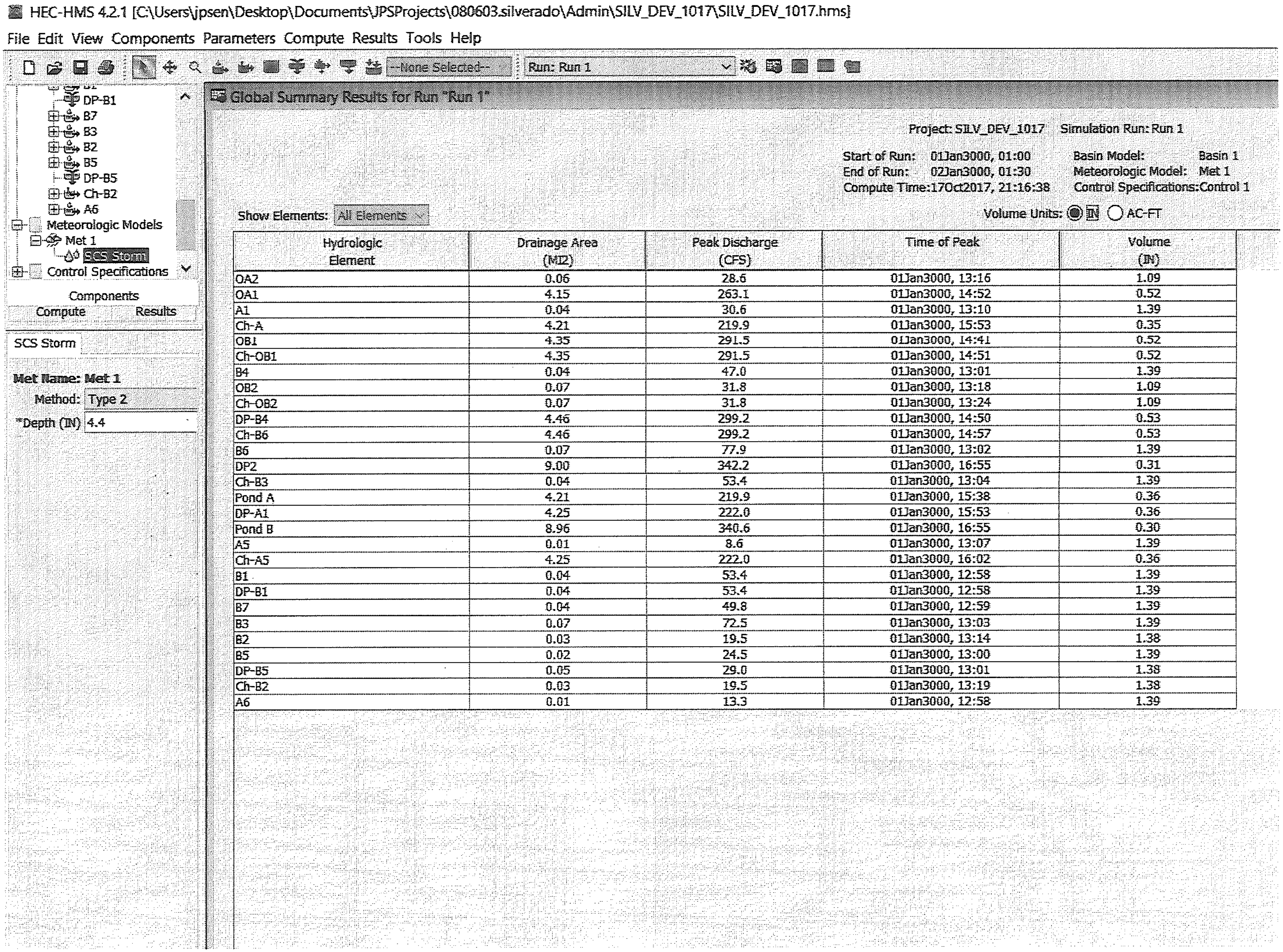
Start of Run: 01Jan3000, 01:00
End of Run: 02Jan3000, 01:30
Compute Time:17Oct2017, 21:14:39

Basin Model: Basin 1
Meteorologic Model: Met 1
Control Specifications:Control 1

Show Elements: All Elements

Volume Units: ○ IN ● AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
OA2	0.06	4.2	01Jan3000, 13:20	0.9
OA1	4.15	34.9	01Jan3000, 14:26	17.6
A1	0.04	7.2	01Jan3000, 13:11	1.0
Ch-A	4.21	0.0	01Jan3000, 01:00	0.0
OB1	4.35	39.0	01Jan3000, 14:17	18.6
Ch-OB1	4.35	39.0	01Jan3000, 14:27	18.5
B4	0.04	11.3	01Jan3000, 13:02	1.0
OB2	0.07	4.7	01Jan3000, 13:22	1.0
Ch-OB2	0.07	4.7	01Jan3000, 13:28	1.0
DP-B4	4.46	41.9	01Jan3000, 14:25	20.5
Ch-B6	4.46	41.9	01Jan3000, 14:32	20.4
B6	0.07	18.7	01Jan3000, 13:03	1.7
DP2	9.00	12.1	01Jan3000, 13:01	1.0
Ch-B3	0.04	13.1	01Jan3000, 13:05	1.0
Pond A	4.21	0.0	01Jan3000, 01:00	0.0
DP-A1	4.25	7.2	01Jan3000, 13:11	1.0
Pond B	8.96	0.0	01Jan3000, 01:00	0.0
A5	0.01	2.0	01Jan3000, 13:08	0.2
Ch-A5	4.25	7.2	01Jan3000, 13:20	1.0
B1	0.04	13.1	01Jan3000, 12:59	1.0
DP-B1	0.04	13.1	01Jan3000, 12:59	1.0
B7	0.04	12.1	01Jan3000, 13:01	1.0
B3	0.07	17.2	01Jan3000, 13:04	1.7
B2	0.03	4.7	01Jan3000, 13:16	0.7
B5	0.02	6.0	01Jan3000, 13:01	0.5
DP-B5	0.05	7.2	01Jan3000, 13:02	1.2
Ch-B2	0.03	4.7	01Jan3000, 13:21	0.7
A6	0.01	3.2	01Jan3000, 12:59	0.2



HEC-HMS 4.2.1 [C:\Users\jpsen\Desktop\Documents\JPSProjects\080603.silverado\Admin\SILV_DEV_1017\SILV_DEV_1017.hms]

Run: Run 1

Met Name: Met 1

Method: Type 2

*Depth (IN) 4.4

Global Summary Results for Run "Run 1"

Project: SILV_DEV_1017 Simulation Run: Run 1

Start of Run: 01Jan3000, 01:00
End of Run: 02Jan3000, 01:30
Compute Time:17Oct2017, 21:16:38

Basin Model: Basin 1
Meteorologic Model: Met 1
Control Specifications:Control 1

Show Elements: All Elements

Volume Units: ● IN ○ AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
OA2	0.06	28.6	01Jan3000, 13:16	1.09
OA1	4.15	263.1	01Jan3000, 14:52	0.52
A1	0.04	30.6	01Jan3000, 13:10	1.39
Ch-A	4.21	219.9	01Jan3000, 15:53	0.35
OB1	4.35	291.5	01Jan3000, 14:41	0.52
Ch-OB1	4.35	291.5	01Jan3000, 14:51	0.52
B4	0.04	47.0	01Jan3000, 13:01	1.39
OB2	0.07	31.8	01Jan3000, 13:18	1.09
Ch-OB2	0.07	31.8	01Jan3000, 13:24	1.09
DP-B4	4.46	299.2	01Jan3000, 14:50	0.53
Ch-B6	4.46	299.2	01Jan3000, 14:57	0.53
B6	0.07	77.9	01Jan3000, 13:02	1.39
DP2	9.00	342.2	01Jan3000, 16:55	0.31
Ch-B3	0.04	53.4	01Jan3000, 13:04	1.39
Pond A	4.21	219.9	01Jan3000, 15:38	0.36
DP-A1	4.25	222.0	01Jan3000, 15:53	0.36
Pond B	8.96	340.6	01Jan3000, 16:55	0.30
A5	0.01	8.6	01Jan3000, 13:07	1.39
Ch-A5	4.25	222.0	01Jan3000, 16:02	0.36
B1	0.04	53.4	01Jan3000, 12:58	1.39
DP-B1	0.04	53.4	01Jan3000, 12:58	1.39
B7	0.04	49.8	01Jan3000, 12:59	1.39
B3	0.07	72.5	01Jan3000, 13:03	1.39
B2	0.03	19.5	01Jan3000, 13:14	1.38
B5	0.02	24.5	01Jan3000, 13:00	1.39
DP-B5	0.05	29.0	01Jan3000, 13:01	1.38
Ch-B2	0.03	19.5	01Jan3000, 13:19	1.38
A6	0.01	13.3	01Jan3000, 12:58	1.39

SILVERADO RANCH
DEVELOPED FLOWS

									Overland Flow			Channel flow							Time of	Total	Total	Peak Flow	
BASIN	DESIGN POINT	AREA (AC)	AREA (SM)	RUNOFF COEFFICIENT (C5)	CURVE No. (CN)	S	Ia	PERCENT IMPERVIOUS (%)	LENGTH (FT)	SLOPE (%)	Tco (1) (MIN)	HIGH ELEV. (FT)	LOW ELEV. (FT)	H (FT)	CHANNEL LENGTH (FT)	CHANNEL LENGTH (MI)	SLOPE (%)	Tt (1) (MIN)	Concentration Tc (2) (MIN)	Lag Time Tl (2) (HR)	Lag Time Tl (2) (MIN)	SCS Q5 (3) (CFS)	Q100 (3) (CFS)
OA1	OA1	2657.2	4.15	0.25	50	10.00	2.00	2	1000	4.0	30.5	6380	5854	526	35200	6.67	1.5%	124.82	155.31	1.55	93.19	34.9	263.1
OA2	OA2	37.4	0.06	0.25	61	6.39	1.28	2	1000	3.0	33.6	5860	5857	3	200	0.04	1.5%	2.33	35.88	0.36	21.53	4.2	28.6
A1		24.51	0.04	0.25	63.22	5.82	1.16	7			0.0	5858	5857	1	1150	0.22	0.1%	26.77	26.77	0.27	16.06		
OA1,OA2,A1	A1	2719	4.25	0.25	50.287	9.89	1.98	2.051											182.08	1.82	109.25	7.2	222.0
A5		7.77	0.01	0.25	63.22	5.82	1.16	7			0.0	5857	5855	2	400	0.08	0.5%	6.05	6.05	0.06	3.63		
A6		3.42	0.01	0.25	63.22	5.82	1.16	7			0.0	5868	5856	12	730	0.14	1.6%	6.08	6.08	0.06	3.65		
OA1,OA2,A1,A5,A6		2730.2	4.27	0.25	50.323	9.87	1.97	2.065											188.14	1.88	112.88		
CHANNEL A5											0.0	5855	5802	53	2750	0.52	1.9%	15.89	15.89	0.16	9.54		
B1		22.9	0.04	0.25	63.22	5.82	1.16	7			0.0	5830	5824.5	5.5	530	0.10	1.0%	5.68	5.68	0.06	3.41		
B3		45.86	0.07	0.25	63.22	5.82	1.16	7			0.0	5825	5802	23	2000	0.38	1.2%	15.17	15.17	0.15	9.10		
OA1,OA2,A1,A5,B1,B3		2799	4.37	0.25	50.321	9.87	1.97	2.094											204.03	2.04	122.42		
CHANNEL B3											0.0	5802	5796	6	900	0.17	0.7%	10.12	10.12	0.10	6.07		
OB1	OB1	2782.8	4.35	0.25	50	10.00	2.00	2	1000	1.0	48.4	6210	5830	380	24600	4.66	1.5%	93.52	141.90	1.42	85.14	39.0	291.5
CHANNEL OB1											0.0	5828	5802	26	2360	0.45	1.1%	17.52	17.52	0.18	10.51		
OB2	OB2	44.6	0.07	0.25	61	6.39	1.28	2	1000	3.0	33.6	5835	5808	27	800	0.15	3.4%	4.95	38.51	0.39	23.11		
B4		28.75	0.04	0.25	63.22	5.82	1.16	7			0.0	5808	5802	6	940	0.18	0.6%	10.64	10.64	0.11	6.38		
OB1,OB2,B4	B4	2856.2	4.46	0.25	61.87	6.16	1.23	3.96											152.54	1.53	91.53	41.9	299.2
B2	B2	19.87	0.03	0.25	63.22	5.82	1.16	7	300	1.0	26.5	5852	5809	43	1380	0.26	3.1%	7.77	34.27	0.34	20.56		
B5		10.42	0.02	0.25	63.22	5.82	1.16	7			0.0	5809	5798	11	1000	0.19	1.1%	9.05	9.05	0.09	5.43		
B2,B5	B5	30.29	0.05	0.25	63.22	5.82	1.16	7											43.32	0.43	25.99		
B6		43.73	0.07	0.25	63.22	5.82	1.16	7			0.0	5802	5794	8	1200	0.23	0.7%	12.63	12.63	0.13	7.58		
DP.B3+DP.B4+DP.B5+B6	B6	5729.2	8.95	0.25	50.636	9.75	1.95	2.181											214.15	2.14	128.49	18.7	77.9
B7		24.76	0.04	0.25	63.22	5.82	1.16	7			0.0	5794	5780	14	1020	0.19	1.4%	8.44	8.44	0.08	5.06		
OA1,OA2,OB1,OB2,A1,A5,A6,B	2	5754	8.99	0.25	50.69	9.73	1.95	2.202											222.59	2.23	133.55	12.1	342.2

1) OVERLAND FLOW Tco = (1.8*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
2) TRAVEL TIME, Tt = ((11.9*L^3)/H)^(0.385)
3) Tc = Tco + Tt
4) SCS LAG TIME, Tl = 0.6 * Tt
5) PEAK FLOWS CALCULATED BY HEC-HMS 4.2.1 (5-YR; 24-HR RAINFALL = 2.6 IN; 100-YR; 24-HR RAINFALL = 4.4 IN)

APPENDIX B2

HYDROLOGIC CALCULATIONS (RATIONAL METHOD)

TABLE 5-1

RECOMMENDED AVERAGE RUNOFF COEFFICIENTS AND PERCENT IMPERVIOUS

		"C" FREQUENCY			
		10		100	
LAND USE OR SURFACE CHARACTERISTICS	PERCENT IMPERVIOUS	A&B*	C&D*	A&B*	C&D*
Business					
Commercial Areas	95	0.90	0.90	0.90	0.90
Neighborhood Areas	70	0.75	0.75	0.80	0.80
Residential					
1/8 Acre or less	65	0.60	0.70	0.70	0.80
1/4 Acre	40	0.50	0.60	0.60	0.70
1/3 Acre	30	0.40	0.50	0.55	0.60
1/2 Acre	25	0.35	0.45	0.45	0.55
1 Acre	20	0.30	0.40	0.40	0.50
Industrial					
Light Areas	80	0.70	0.70	0.80	0.80
Heavy Areas	90	0.80	0.80	0.90	0.90
Parks and Cemeteries	7	0.30	0.35	0.55	0.60
Playgrounds	13	0.30	0.35	0.60	0.65
Railroad Yard Areas	40	0.50	0.55	0.60	0.65
Undeveloped Areas					
Historic Flow Analysis- Greenbelts, Agricultural	2	0.15	0.25	0.20	0.30
Pasture/Meadow	0	0.25	0.30	0.35	0.45
Forest	0	0.10	0.15	0.15	0.20
Exposed Rock	100	0.90	0.90	0.95	0.95
Offsite Flow Analysis (when land use not defined)	45	0.55	0.60	0.65	0.70
Streets					
Paved	100	0.90	0.90	0.95	0.95
Gravel	80	0.80	0.80	0.85	0.85
Drive and Walks	100	0.90	0.90	0.95	0.95
Roofs	90	0.90	0.90	0.95	0.95
Lawns	0	0.25	0.30	0.35	0.45

* Hydrologic Soil Group

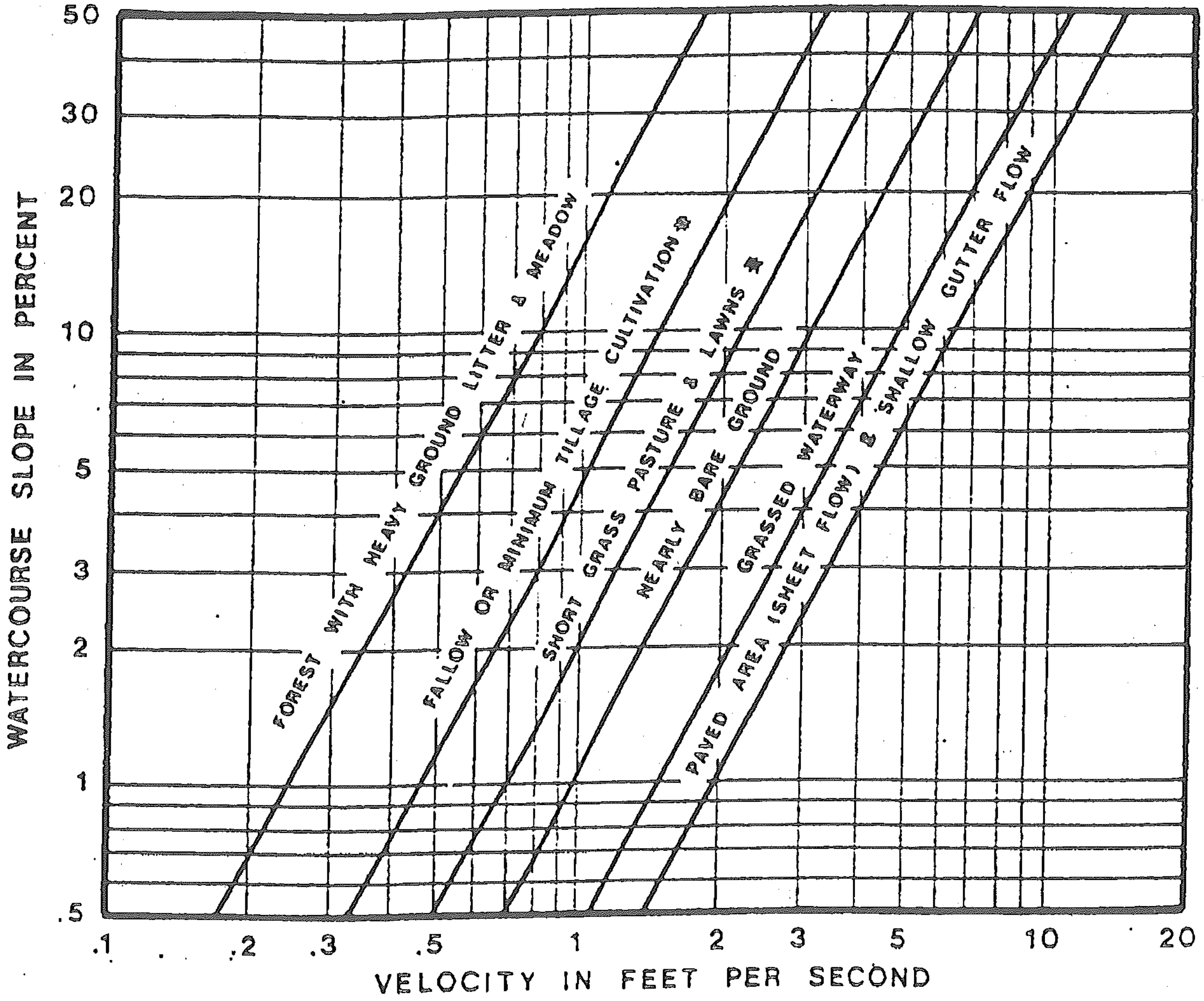
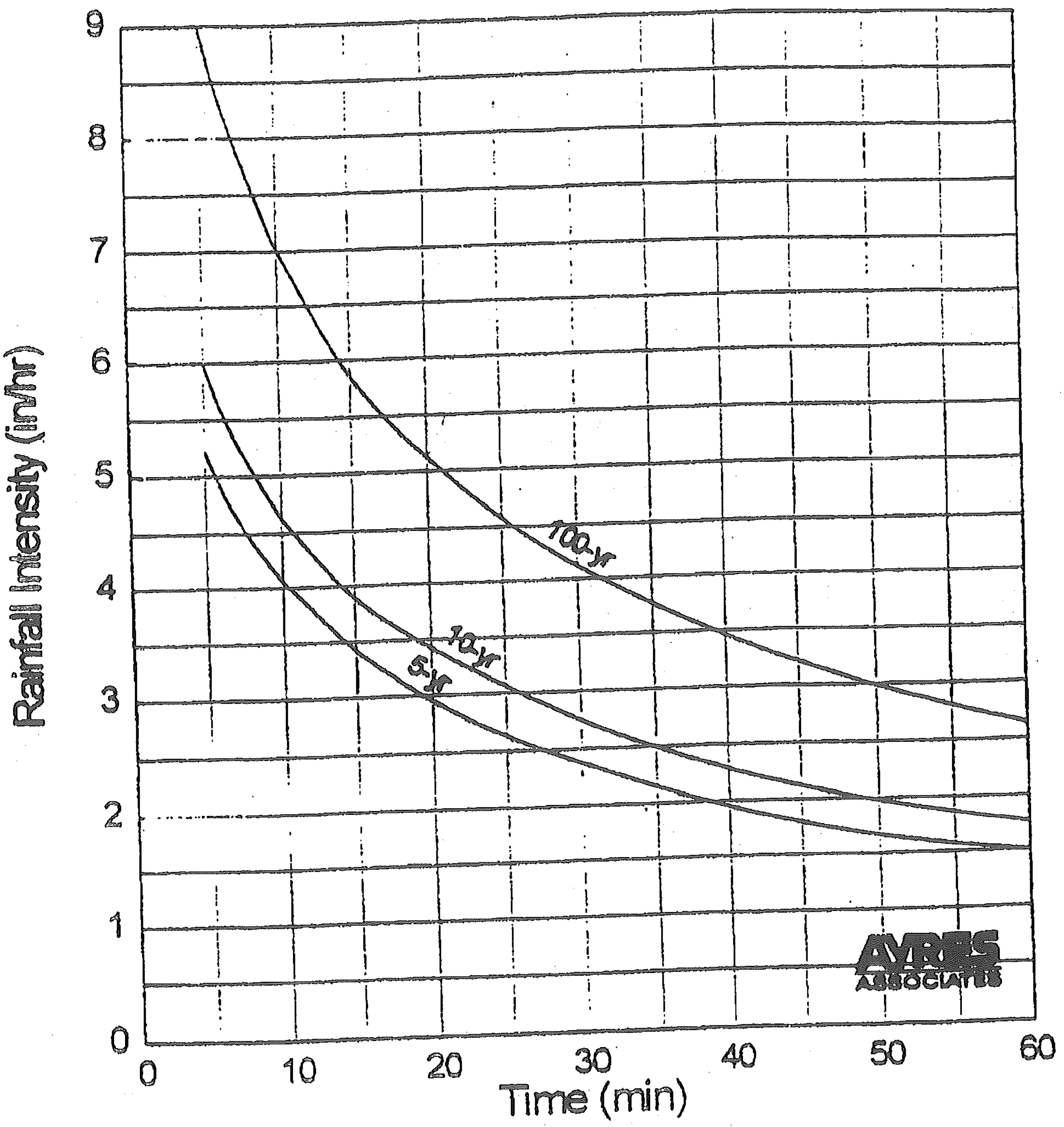


FIGURE 3-2. ESTIMATE OF AVERAGE FLOW VELOCITY FOR USE WITH THE RATIONAL FORMULA.

* MOST FREQUENTLY OCCURRING "UNDEVELOPED" LAND SURFACES IN THE DENVER REGION.

REFERENCE: "Urban Hydrology For Small Watersheds" Technical Release No 55, USDA, SCS Jan 1975.



Interim Release October 12, 1994, Rainfall Intensity Curves
City Of Colorado Springs Drainage Criteria Manual

SILVERADO RANCH
RATIONAL METHOD
HISTORIC FLOWS

BASIN	DESIGN POINT	AREA (AC)	C		OVERLAND LENGTH (FT)	SLOPE (%)	Tco $^{(1)}$ (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT K	SLOPE (%)	SCS $^{(2)}$ VELOCITY (FT/S)	Tcg $^{(3)}$ (MIN)	TOTAL Tc $^{(4)}$ (MIN)	INTENSITY $^{(5)}$		PEAK FLOW	
			5-YEAR $^{(7)}$	100-YEAR $^{(7)}$										5-YR (IN/HR)	100-YR (IN/HR)	Q5 $^{(6)}$ (CFS)	Q100 $^{(6)}$ (CFS)
A2	1	56.31	0.25	0.35	1000	2.8	34.3	1900	1.50	2.21	2.23	14.2	48.5	1.70	3.05	23.93	60.11
OA1		2657.2	0.25	0.35	1000	4.0	30.5	35200	1.50	1.49	1.83	320.4	350.9	1.50	2.65	996.44	2464.53
OA2		37.36	0.25	0.35	1000	3.0	33.6	200	1.50	1.5	1.84	1.8	35.4	2.10	3.70	19.61	48.38
A1		30.49	0.25	0.35			0.0	1400	1.50	0.5	1.06	22.0	22.0				
OA1,OA2,A1	A1	2725	0.25	0.35									372.9	1.50	2.65	1021.88	2527.46
OB1		2782.8	0.25	0.35	1000	1.0	48.4	24600	1.50	1.54	1.86	220.3	268.6	1.50	2.65	1043.55	2581.05
OB2		44.6	0.25	0.35	1000	3.0	33.6	800	1.50	3.4	2.77	4.8	38.4	2.00	3.50	22.30	54.64
B		202.54	0.25	0.35			0.0	4350	1.50	0.78	1.32	54.7	54.7				
CHANNEL A2 TO DP-B			0.25	0.35			0.0	3620	1.50	1.64	1.92	31.4	31.4				
OA1,OA2,OB1,OB2,A2,B	2	5755.0	0.25	0.35									404.3	1.50	2.65	2158.11	5337.73
C	3	18.1	0.250	0.350	500	3.2	23.2	2450	1.50	0.6	1.16	35.1	58.4	1.50	2.70	6.80	17.12
D	4	11.3	0.250	0.350	300	4.2	16.4	300	1.50	1.3	1.71	2.9	19.4	3.00	5.10	8.48	20.17

1) OVERLAND FLOW Tco = (1.8*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))

2) SCS VELOCITY = K * ((SLOPE(%))^0.5)

K = 0.25 FOR MEADOW
K = 1.0 FOR BARE SOIL
K = 1.5 FOR GRASS CHANNEL
K = 2.0 FOR PAVEMENT

3) GUTTER/SWALE FLOW, Tcg = (GUTTER LENGTH/ SCS VELOCITY) / 60 SEC

4) Tc = Tco + Tcg

*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED

5) INTENSITY BASED ON I-D-F CURVE IN EL PASO COUNTY DRAINAGE CRITERIA MANUAL

6) Q = CiA

7) WEIGHTED AVERAGE C VALUES FOR COMBINED BASINS

SILVERADO RANCH

COMPOSITE RUNOFF COEFFICIENTS - TYPICAL 5-ACRE DEVELOPED RESIDENTIAL AREA

DEVELOPED CONDITIONS

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
5-ACRE LOTS	5.00	6.00	BLDG/DRIVEWAY	0.9	94.00	LAWN/MEADOW	0.25				0.289

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
5-ACRE LOTS	5.00	6.00	BLDG/DRIVEWAY	0.95	94.00	LAWN/MEADOW	0.35				0.386

SILVERADO RANCH
COMPOSITE RUNOFF COEFFICIENTS

DEVELOPED CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
A2	4.02	4.02	5-ACRE LOTS	0.289							0.289
A3	16.38	16.38	5-ACRE LOTS	0.289							0.289
A2,A3	20.4										0.289
A4	27.01	27.01	5-ACRE LOTS	0.289							0.289
A2-A4	47.41										0.289
OB2	44.6	44.60	MEADOW	0.25							0.250
B4	28.75	28.75	5-ACRE LOTS	0.289							0.289
OB2,B4	73.35										0.265
B2	19.87	19.87	5-ACRE LOTS	0.289							0.289
B5	9.9	9.90	5-ACRE LOTS	0.289							0.289
B2,B5	29.77										0.289

SILVERADO RANCH
COMPOSITE RUNOFF COEFFICIENTS

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
A2	4.02	4.02	5-ACRE LOTS	0.386							0.386
A3	16.38	16.38	5-ACRE LOTS	0.386							0.386
A2,A3	20.4										0.386
A4	27.01	27.01	5-ACRE LOTS	0.386							0.386
A2-A4	47.41										0.386
OB2	44.6	44.60	MEADOW	0.35							0.350
B4	28.75	28.75	5-ACRE LOTS	0.386							0.386
OB2,B4	73.35										0.364
B2	19.87	19.87	5-ACRE LOTS	0.386							0.386
B5	9.9	9.90	5-ACRE LOTS	0.386							0.386
B2,B5	29.77										0.386

SILVERADO RANCH
RATIONAL METHOD - DRAINAGE CALCULATIONS

DEVELOPED FLOWS

BASIN	DESIGN POINT	AREA (AC)	C		OVERLAND LENGTH (FT)	SLOPE (%)	Tco(1) (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT K	SLOPE (%)	SCS(2) VELOCITY (FT/S)	Tcg(3) (MIN)	TOTAL Tc(4) (MIN)	INTENSITY(5)		PEAK FLOW	
			5-YEAR(7)	100-YEAR(7)										5-YR (IN/HR)	100-YR (IN/HR)	Q5(6) (CFS)	Q100(6) (CFS)
A2	A2	4.02	0.289	0.386	300	3.3	17.0	270	1.50	2.2	2.22	2.0	19.0	3.00	5.15	3.49	7.99
A3		16.38	0.289	0.386			0.0	1400	1.50	1.57	1.88	12.4	12.4	3.70	6.20	17.52	39.20
A2,A3	A3	20.40	0.289	0.386									31.4	2.30	4.00	13.56	31.50
A4		27.01	0.289	0.386			0.0	1000	1.50	3.1	2.64	6.3	6.3	4.90	8.40	38.25	87.58
A2-A4	**1**	**47.41**	**0.289**	**0.386**									**37.7**	**2.00**	**3.50**	**27.40**	**64.05**
A1		24.51	0.289	0.386			0.0	950	1.50	0.5	1.06	14.9	14.9	3.50	5.95	24.79	56.29
A5		7.77	0.289	0.386			0.0	400	1.50	0.5	1.06	6.3	6.3	4.90	8.25	11.00	24.74
A6	A6	3.42	0.289	0.386	150	2.7	12.8	580	1.50	1.4	1.77	5.4	18.3	3.05	5.25	3.01	6.93
B1	B1	22.90	0.289	0.386	100	2.0	11.6	1350	1.50	2.96	2.58	8.7	20.3	2.90	5.10	19.19	45.08
B3		56.28	0.289	0.386			0.0	1800	1.50	1.22	1.66	18.1	18.1	3.05	5.20	49.61	112.97
OB2		44.60	0.250	0.350	1000	3.0	33.6	800	1.50	3.4	2.77	4.8	38.4	2.00	3.50	22.30	54.64
B4		28.75	0.289	0.386			0.0	650	1.50	0.9	1.42	7.6	7.6				
OB2,B4	B4	73.35	0.265	0.364									46.0	1.75	3.20	34.05	85.46
B2	B2	19.87	0.289	0.386	300	1.0	25.3	1380	1.50	3.1	2.64	8.7	34.0	2.15	3.80	12.35	29.15
B5		9.90	0.289	0.386			0.0	1000	1.50	1.2	1.64	10.1	10.1				
B2,B5	B5	29.77	0.289	0.386									44.1	1.80	3.20	15.49	36.77
B6		43.73	0.289	0.386			0.0	900	1.50	0.67	1.23	12.2	12.2	3.75	6.30	47.39	106.34
B7		24.76	0.289	0.386			0.0	400	1.50	0.25	0.75	8.9	8.9	4.15	7.10	29.70	67.86
C	**3**	**28.26**	**0.289**	**0.386**	**500**	**3.2**	**22.2**	**2450**	**1.50**	**0.6**	**1.16**	**35.1**	**57.3**	**1.50**	**2.65**	**12.25**	**28.91**
D	**4**	**11.30**	**0.289**	**0.386**	**300**	**4.2**	**15.7**	**300**	**1.50**	**1.3**	**1.71**	**2.9**	**18.6**	**3.00**	**5.20**	**9.80**	**22.68**

1) OVERLAND FLOW Tco = (1.87*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))

2) SCS VELOCITY = K * ((SLOPE(%))^0.5)

K = 0.70 FOR MEADOW / FOREST
K = 1.0 FOR BARE SOIL
K = 1.5 FOR GRASS CHANNEL
K = 2.0 FOR PAVEMENT

3) GUTTER/SWALE FLOW, Tcg = (CHANNEL LENGTH/ SCS VELOCITY) / 60 SEC

4) Tc = Tco + Tcg

*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED

5) INTENSITY BASED ON I-D-F CURVE IN EL PASO COUNTY DRAINAGE CRITERIA MANUAL

6) Q = CiA

7) WEIGHTED AVERAGE C VALUES FOR COMBINED BASINS

APPENDIX C

HYDRAULIC CALCULATIONS

SILVERAD RANCH FILING NO. 1 - SPILLWAY MODELING (OVERTOPPING OF ROADWAYS)

DESIGN POINT	DESIGN FEATURE	Q100 FLOW (CFS)	Q100 DEPTH (FT)	Q100 LENGTH (FT)
OA1	OVERTOPPING DRENNAN ROAD	260.8	**1.0**	**86.9**
A1	OVERTOPPING SILVERADO HILL LOOP	221.2	**2.0**	**26.1**
OB1	OVERTOPPING DRENNAN ROAD	126.5	**0.7**	**72.0**
OB2	OVERTOPPING DRENNAN ROAD	54.6	**0.5**	**51.5**

1) Overtopping calculations based on Broad-Crested Weir Flow
2) Q = (3.0 * L * H^1.5)
3) L = Q / (3 * H^1.5)

TABLE 10-2 (Continued)

TYPICAL ROUGHNESS COEFFICIENTS FOR OPEN CHANNELS

Type of Channel and Description	Minimum	Normal	Maximum
c. Concrete bottom float finished with sides of			
1. Dressed stone in mortar	0.015	0.017	0.020
2. Random stone in mortar	0.017	0.020	0.024
3. Cement rubble masonry, plastered	0.016	0.020	0.024
4. Cement rubble masonry	0.020	0.025	0.030
5. Dry rubble or riprap	0.020	0.030	0.035
d. Gravel bottom with sides of			
1. Formed concrete	0.017	0.020	0.025
2. Random stone in mortar	0.020	0.023	0.026
3. Dry rubble or riprap	0.023	0.033	0.036
e. Asphalt			
1. Smooth		0.013	
2. Rough		0.016	
f. Grassed	0.030	0.040	0.050

TABLE 10-3

MAXIMUM PERMISSIBLE DESIGN OPEN CHANNEL FLOW VELOCITIES IN EARTH*

Soil Types	Permissible Mean Channel Velocity (ft/sec)
Fine Sand (noncolloidal)	2.0
Coarse Sand (noncolloidal)	4.0
Sandy Loam (noncolloidal)	2.5
Silt Loam (noncolloidal)	3.0
Ordinary Firm Loam	3.5
Silty Clay	3.5
Fine Gravel	5.0
Stiff Clay (very colloidal)	5.0
Graded, Loam to Cobbles (noncolloidal)	5.0
Graded, Silt to Cobbles (colloidal)	5.5
Alluvial Silts (noncolloidal)	3.5
Alluvial Silts (colloidal)	5.0
Coarse Gravel (noncolloidal)	6.0
Cobbles and Shingles	5.5
Hard Shales and Hard Pans	6.0
Soft Shales	3.5
Soft Sandstone	8.0
Sound rock (usu. igneous or hard metamorphic)	20.0

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* These velocities shall be used in conjunction with scour calculations and as approved by City/County.

TABLE 10-2

TYPICAL ROUGHNESS COEFFICIENTS FOR OPEN CHANNELS
(Reference: Chow, Ven Te, 1959; Open-Channel Hydraulics)

Type of Channel and Description	Minimum	Normal	Maximum
EXCAVATED OR DREDGED			
a. Earth, straight and uniform			
1. Clean, recently completed	0.016	0.018	0.020
2. Clean, after weathering	0.018	0.022	0.025
3. Gravel, uniform section, clean	0.022	0.025	0.030
4. With short grass, few weeds	0.022	0.027	0.033
b. Earth, winding and sluggish			
1. No vegetation	0.023	0.025	0.030
2. Grass, some weeds	0.025	0.030	0.033
3. Dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
4. Earth bottom and rubble sides	0.028	0.030	0.035
5. Stony bottom and weedy banks	0.025	0.035	0.040
6. Cobble bottom and clean sides	0.030	0.040	0.050
c. Dragline-excavated or dredged			
1. No vegetation	0.025	0.028	0.033
2. Light brush on banks	0.035	0.050	0.060
d. Rock cuts			
1. Smooth and uniform	0.025	0.035	0.040
2. Jagged and irregular	0.035	0.040	0.050
e. Channels not maintained, weeds and brush uncut			
1. Dense weeds, high as flow depth	0.050	0.080	0.120
2. Clean bottom, brush on sides	0.040	0.050	0.080
3. Same, highest stage of flow	0.045	0.070	0.110
4. Dense brush, high stage	0.080	0.100	0.140

TABLE 10-4

MAXIMUM PERMISSIBLE VELOCITIES FOR EARTH CHANNELS WITH VARIED GRASS LININGS AND SLOPES

Channel Slope	Lining	Permissible Mean Channel Velocity * (ft/sec)
0 - 5%	Sodded grass	7
	Bermudagrass	6
	Reed canarygrass	5
	Tall fescue	5
	Kentucky bluegrass	5
	Grass-legume mixture	4
	Red fescue	2.5
	Redtop	2.5
	Sericea lespedeza	2.5
	Annual lespedeza	2.5
	Small grains (temporary)	2.5
5 - 10%	Sodded grass	6
	Bermudagrass	5
	Reed canarygrass	4
	Tall fescue	4
	Kentucky bluegrass	4
	Grass-legume mixture	3
Greater than 10%	Sodded grass	5
	Bermudagrass	4
	Reed canarygrass	3
	Tall fescue	3
	Kentucky bluegrass	3

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* For highly erodible soils, decrease permissible velocities by 25%.

* Grass lined channels are dependent upon assurances of continuous growth and maintenance of grass.

SILVERADO RANCH FILING NO. 1
DITCH CALCULATION SUMMARY

PROPOSED ROADSIDE DITCHES

ROADWAY	SHEET	FROM STA	TO STA	SIDE	PROPOSED SLOPE (%)	SIDE SLOPE (Z)	CHANNEL DEPTH (FT)	FRICTION FACTOR (n)	ROW WIDTH (ft)	BASIN	Q100 FLOW (CFS)	DITCH FLOW % OF BASIN	DITCH FLOW (CFS)	Q100 DEPTH (FT)	Q100 VELOCITY (FT/S)	DITCH LINING
DROVER CANYON LANE	PP1	10+20	12+00	W	2.12	4:1/3:1	2.5	0.030	60	A6	6.9	50	3.5	0.57	3.05	GRASS
DROVER CANYON LANE	PP1	10+20	12+00	E	2.12	4:1/3:1	2.5	0.030	60	B1	79.6	5	4.0	0.60	3.15	GRASS
DROVER CANYON LANE	PP1	12+00	17+63	W	1.66	4:1/3:1	2.5	0.030	60	A6	6.9	100	6.9	0.77	3.30	GRASS
DROVER CANYON LANE	PP1	12+00	17+63	E	1.66	4:1/3:1	2.5	0.030	60	B1	79.6	5	4.0	0.63	2.88	GRASS
SILVERADO HILL LOOP - N	PP2	21+94	24+00	N	1.50	4:1/3:1	2.5	0.030	60	B1	45.1	10	4.5	0.67	2.85	GRASS
SILVERADO HILL LOOP - N	PP2	21+94	24+00	S	1.50	4:1/3:1	2.5	0.030	60	B3	113.0	5	5.7	0.73	3.03	GRASS
SILVERADO HILL LOOP - N	PP2	24+00	29+00	N	4.50	4:1/3:1	2.5	0.030	60	B1	45.1	10	4.5	0.55	4.31	GRASS
SILVERADO HILL LOOP - N	PP2	24+00	29+00	S	4.50	4:1/3:1	2.5	0.030	60	B3	113.0	5	5.7	0.60	3.32	GRASS
SILVERADO HILL LOOP - N	PP3	29+00	36+00	N	1.00	4:1/3:1	2.5	0.030	60	B1	45.1	10	4.5	0.72	2.45	GRASS
SILVERADO HILL LOOP - N	PP3	29+00	36+00	S	1.00	4:1/3:1	2.5	0.030	60	B3	113.0	5	5.7	0.79	2.60	GRASS

1) Channel flow calculations based on Manning's Equation
2) n = 0.03 for grass-lined non-irrigated channels (minimum)
3) n = 0.035 for riprap-lined channels
4) Vmax = 5.0 fps for 100-year flows w/ grass-lined channels
5) Vmax = 8.0 fps for 100-year flows w/ Erosion Control Blankets (NAG C350 or equal)

Hydraulic Analysis Report

Project Data

Project Title: Silverado Ranch
Designer: JPS
Project Date: Tuesday, March 07, 2017
Project Units: U.S. Customary Units
Notes:

Channel Analysis: Ditch-SHL-2194-2400-N

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0150 ft/ft
Manning's n: 0.0300
Flow: 4.5000 cfs $= Q_{100}$

Result Parameters

Depth: 0.6713 ft
Area of Flow: 1.5773 ft^2
Wetted Perimeter: 4.8907 ft
Hydraulic Radius: 0.3225 ft
Average Velocity: 2.8530 ft/s < 5 fps ✓
Top Width: 4.6992 ft
Froude Number: 0.8678
Critical Depth: 0.6369 ft
Critical Velocity: 3.1694 ft/s
Critical Slope: 0.0199 ft/ft
Critical Top Width: 4.55 ft
Calculated Max Shear Stress: 0.6283 lb/ft^2
Calculated Avg Shear Stress: 0.3019 lb/ft^2

Channel Analysis: Ditch-SHL-2194-2400-S

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0150 ft/ft
Manning's n: 0.0300
Flow: 5.7000 cfs

Result Parameters

Depth: 0.7335 ft
Area of Flow: 1.8832 ft^2
Wetted Perimeter: 5.3441 ft
Hydraulic Radius: 0.3524 ft
Average Velocity: 3.0267 ft/s
Top Width: 5.1347 ft
Froude Number: 0.8807
Critical Depth: 0.7001 ft
Critical Velocity: 3.3228 ft/s
Critical Slope: 0.0192 ft/ft
Critical Top Width: 5.00 ft
Calculated Max Shear Stress: 0.6866 lb/ft^2
Calculated Avg Shear Stress: 0.3298 lb/ft^2

Channel Analysis: Ditch-SHL-2400-2900-N

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0450 ft/ft

Manning's n: 0.0300

Flow: 4.5000 cfs

Result Parameters

Depth: 0.5463 ft

Area of Flow: 1.0447 ft^2

Wetted Perimeter: 3.9803 ft

Hydraulic Radius: 0.2625 ft

Average Velocity: 4.3075 ft/s

Top Width: 3.8244 ft

Froude Number: 1.4524

Critical Depth: 0.6369 ft

Critical Velocity: 3.1694 ft/s

Critical Slope: 0.0199 ft/ft

Critical Top Width: 4.55 ft

Calculated Max Shear Stress: 1.5341 lb/ft^2

Calculated Avg Shear Stress: 0.7370 lb/ft^2

Channel Analysis: Ditch-SHL-2400-2900-S

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0450 ft/ft
Manning's n: 0.0300
Flow: 5.7000 cfs

Result Parameters

Depth: 0.5970 ft
Area of Flow: 1.2473 ft^2
Wetted Perimeter: 4.3492 ft
Hydraulic Radius: 0.2868 ft
Average Velocity: 4.5697 ft/s
Top Width: 4.1789 ft
Froude Number: 1.4740
Critical Depth: 0.7001 ft
Critical Velocity: 3.3228 ft/s
Critical Slope: 0.0192 ft/ft
Critical Top Width: 5.00 ft
Calculated Max Shear Stress: 1.6763 lb/ft^2
Calculated Avg Shear Stress: 0.8053 lb/ft^2

Channel Analysis: Ditch-SHL-2900-3600-N

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0100 ft/ft
Manning's n: 0.0300
Flow: 4.5000 cfs

Result Parameters

Depth: 0.7243 ft
Area of Flow: 1.8363 ft^2
Wetted Perimeter: 5.2770 ft
Hydraulic Radius: 0.3480 ft
Average Velocity: 2.4506 ft/s
Top Width: 5.0703 ft
Froude Number: 0.7176
Critical Depth: 0.6369 ft
Critical Velocity: 3.1694 ft/s
Critical Slope: 0.0199 ft/ft
Critical Top Width: 4.55 ft
Calculated Max Shear Stress: 0.4520 lb/ft^2
Calculated Avg Shear Stress: 0.2171 lb/ft^2

Channel Analysis: Ditch-SHL-2900-3600-S

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0100 ft/ft

Manning's n: 0.0300

Flow: 5.7000 cfs

Result Parameters

Depth: 0.7915 ft

Area of Flow: 2.1925 ft^2

Wetted Perimeter: 5.7662 ft

Hydraulic Radius: 0.3802 ft

Average Velocity: 2.5998 ft/s

Top Width: 5.5403 ft

Froude Number: 0.7283

Critical Depth: 0.7001 ft

Critical Velocity: 3.3228 ft/s

Critical Slope: 0.0192 ft/ft

Critical Top Width: 5.00 ft

Calculated Max Shear Stress: 0.4939 lb/ft^2

Calculated Avg Shear Stress: 0.2373 lb/ft^2

Channel Analysis: Ditch-Drover-1020-1200-W

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0212 ft/ft

Manning's n: 0.0300

Flow: 3.5000 cfs

Result Parameters

Depth: 0.5726 ft

Area of Flow: 1.1474 ft^2

Wetted Perimeter: 4.1713 ft

Hydraulic Radius: 0.2751 ft

Average Velocity: 3.0504 ft/s

Top Width: 4.0079 ft

Froude Number: 1.0047

Critical Depth: 0.5760 ft

Critical Velocity: 3.0140 ft/s

Critical Slope: 0.0205 ft/ft

Critical Top Width: 4.12 ft

Calculated Max Shear Stress: 0.7574 lb/ft^2

Calculated Avg Shear Stress: 0.3639 lb/ft^2

Channel Analysis: Ditch-Drover-1020-1200-E

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0212 ft/ft

Manning's n: 0.0300

Flow: 4.0000 cfs

Result Parameters

Depth: 0.6020 ft

Area of Flow: 1.2683 ft^2

Wetted Perimeter: 4.3855 ft

Hydraulic Radius: 0.2892 ft

Average Velocity: 3.1540 ft/s

Top Width: 4.2137 ft

Froude Number: 1.0131

Critical Depth: 0.6076 ft

Critical Velocity: 3.0956 ft/s

Critical Slope: 0.0202 ft/ft

Critical Top Width: 4.34 ft

Calculated Max Shear Stress: 0.7963 lb/ft^2

Calculated Avg Shear Stress: 0.3826 lb/ft^2

Channel Analysis: Ditch-Drover-1200-1763-W

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0166 ft/ft

Manning's n: 0.0300

Flow: 6.9000 cfs

Result Parameters

Depth: 0.7732 ft

Area of Flow: 2.0923 ft^2

Wetted Perimeter: 5.6329 ft

Hydraulic Radius: 0.3714 ft

Average Velocity: 3.2977 ft/s

Top Width: 5.4123 ft

Froude Number: 0.9347

Critical Depth: 0.7557 ft

Critical Velocity: 3.4523 ft/s

Critical Slope: 0.0188 ft/ft

Critical Top Width: 5.40 ft

Calculated Max Shear Stress: 0.8009 lb/ft^2

Calculated Avg Shear Stress: 0.3848 lb/ft^2

Channel Analysis: Ditch-Drover-1200-1763-E

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0166 ft/ft

Manning's n: 0.0300

Flow: 4.0000 cfs

Result Parameters

Depth: 0.6302 ft

Area of Flow: 1.3901 ft^2

Wetted Perimeter: 4.5913 ft

Hydraulic Radius: 0.3028 ft

Average Velocity: 2.8775 ft/s

Top Width: 4.4115 ft

Froude Number: 0.9034

Critical Depth: 0.6076 ft

Critical Velocity: 3.0956 ft/s

Critical Slope: 0.0202 ft/ft

Critical Top Width: 4.34 ft

Calculated Max Shear Stress: 0.6528 lb/ft^2

Calculated Avg Shear Stress: 0.3136 lb/ft^2

SILVERADO RANCH - FILING NO. 1
CHANNEL CALCULATIONS
DEVELOPED FLOWS

PROPOSED CHANNELS

CHANNEL	DESIGN POINT	PROPOSED SLOPE (%)	BOTTOM WIDTH (B, FT)	SIDE SLOPE (Z)	CHANNEL DEPTH (FT)	FRICTION FACTOR (n)		Q100 FLOW (CFS)	Q100 DEPTH (FT)	Q100 VELOCITY (FT/S)	CHANNEL LINING
OB1	OB1	0.50	12	4:1	3.0	0.030		126.5	1.7	4.0	GRASS
B3.1	B1	0.72	0	4:1	2.0	0.030		45.1	1.7	3.7	GRASS

1) Channel flow calculations based on Manning's Equation
2) Channel depth includes 1' minimum freeboard
3) n = 0.03 for grass-lined non-irrigated channels (minimum)
4) n = 0.035 for riprap-lined channels
5) Vmax = 5.0 fps per El Paso County criteria (p. 10-13) for fescue (dry land grass) for 100-year flows
6) Vmax = 8.0 fps with Erosion Control Blankets (NAG C350 or equal)

Hydraulic Analysis Report

Project Data

Project Title: SILVERADO RANCH

Designer: JPS

Project Date: Tuesday, October 17, 2017

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Channel Analysis-OB1

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 12.0000 ft

Longitudinal Slope: 0.0050 ft/ft

Manning's n: 0.0300

Flow: **291.5000 cfs = Q100**

Result Parameters

Depth: 2.5832 ft

Area of Flow: 57.6914 ft^2

Wetted Perimeter: 33.3019 ft

Hydraulic Radius: 1.7324 ft

Average Velocity: 5.0527 ft/s **OK**

Top Width: 32.6659 ft

Froude Number: 0.6700

Critical Depth: 2.0813 ft

Critical Velocity: 6.8908 ft/s

Critical Slope: 0.0118 ft/ft

Critical Top Width: 28.65 ft

Calculated Max Shear Stress: 0.8060 lb/ft^2

Calculated Avg Shear Stress: 0.5405 lb/ft^2

Channel Analysis: Channel Analysis-B3.1

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0072 ft/ft

Manning's n: 0.0300

Flow: 45.1000 cfs

Result Parameters

Depth: 1.7348 ft

Area of Flow: 12.0385 ft^2

Wetted Perimeter: 14.3057 ft

Hydraulic Radius: 0.8415 ft

Average Velocity: 3.7463 ft/s

Top Width: 13.8786 ft

Froude Number: 0.7089

Critical Depth: 1.5118 ft

Critical Velocity: 4.9335 ft/s

Critical Slope: 0.0150 ft/ft

Critical Top Width: 12.09 ft

Calculated Max Shear Stress: 0.7794 lb/ft^2

Calculated Avg Shear Stress: 0.3781 lb/ft^2

JPS ENGINEERING

SILVERADO RANCH - FILING NO. 1
CULVERT SIZING SUMMARY

Pipe	Selected Pipe	Road CL EL	Inv. In EL	Q_5 (cfs)	Allowable [a] 5-Yr. HW	Calc. 5-Year HW	Q_{100} (cfs)	Allowable [b] 100-Yr. HW	Calc. 100-Yr. HW	Riprap Size D_{50} (in)
Culvert A6	18" RCP	5854.15	5852.00	3.0	5853.5	5852.9	6.9	5854.33	5853.49	M (12")
Culvert B1	24" RCP	5822.67	5819.4	19.2	5821.4	58214	45.1	5822.85	5822.85	M (12")

[a] Maximum allowable 5-year HW/D = 1.0.

[b] Maximum allowable 100-year headwater depth is 6 inches above shoulder.

```
CURRENT DATE: 09-13-2010                                  FILE DATE: 09-13-2010
CURRENT TIME: 13:21:04                                    FILE NAME: SILV-A1

                          FHWA CULVERT ANALYSIS
                           HY-8, VERSION 6.1

  C          SITE DATA                     CULVERT SHAPE, MATERIAL, INLET
  U
  L    INLET    OUTLET   CULVERT   BARRELS
  V    ELEV.     ELEV.   LENGTH    SHAPE          SPAN    RISE   MANNING    INLET
 NO.   (ft)      (ft)     (ft)     MATERIAL       (ft)    (ft)      n        TYPE
  1  5852.00  5851.22    78.00     2 RCP          4.00    4.00    .013   CONVENTIONAL
  2
  3
  4
  5
  6

SUMMARY OF CULVERT FLOWS (cfs)          FILE: SILV-A1             DATE: 09-13-2010

 ELEV (ft)    TOTAL      1       2       3       4       5       6  ROADWAY ITR
  5852.00       0.0    0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
  5852.69       6.9    0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
  5853.87      44.2    0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
  5854.39      66.4    0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
  5854.83      88.5    0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
  5855.21     110.6    0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
  5855.57     132.7    0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
  5855.94     154.8    0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
  5856.32     177.0    0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
  5856.73     199.1    0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
  5857.19     221.2    0.0     0.0     0.0     0.0     0.0     0.0     0.00  0
     0.00       0.0    0.0     0.0     0.0     0.0     0.0     0.0 OVERTOPPING

  SUMMARY OF ITERATIVE SOLUTION ERRORS    FILE: SILV-A1           DATE: 09-13-2010

      HEAD          HEAD          TOTAL          FLOW          % FLOW
     ELEV (ft)    ERROR (ft)     FLOW (cfs)    ERROR (cfs)      ERROR
    5852.00        0.000           0.00          0.00           0.00
    5852.69        0.000           6.90          0.00           0.00
    5853.87        0.000          44.24          0.00           0.00
    5854.39        0.000          66.36          0.00           0.00
    5854.83        0.000          88.48          0.00           0.00
    5855.21        0.000         110.60          0.00           0.00
    5855.57        0.000         132.72          0.00           0.00
    5855.94        0.000         154.84          0.00           0.00
    5856.32        0.000         176.96          0.00           0.00
    5856.73        0.000         199.08          0.00           0.00
    5857.19        0.000         221.20          0.00           0.00

  <1> TOLERANCE (ft) = 0.010                         <2> TOLERANCE (%) = 1.000
```

```
CURRENT DATE: 09-13-2010                                   FILE DATE: 09-13-2010
CURRENT TIME: 13:21:04                                     FILE NAME: SILV-A1
--------------------------------------------------------------------------------
      PERFORMANCE CURVE FOR CULVERT 1 - 2(  4.00 (ft) BY   4.00 (ft)) RCP
--------------------------------------------------------------------------------
  DIS-    HEAD-  INLET  OUTLET
 CHARGE   WATER CONTROL CONTROL FLOW NORMAL  CRIT. OUTLET   TW   OUTLET   TW
  FLOW    ELEV.  DEPTH   DEPTH  TYPE  DEPTH  DEPTH  DEPTH  DEPTH  VEL.   VEL.
 (cfs)    (ft)   (ft)    (ft)   <F4>  (ft)   (ft)   (ft)   (ft)  (fps)  (fps)
--------------------------------------------------------------------------------
   0.00  5852.00  0.00   0.00 0-NF    0.00   0.00   0.00   0.00   0.00   0.00
   6.90  5852.69  0.69   0.69 1-S2n   0.42   0.51   0.31   0.14   5.58   0.95
  44.24  5853.87  1.87   1.87 1-S2n   1.04   1.37   0.97   0.43   9.26   1.96
  66.36  5854.39  2.39   2.39 1-S2n   1.30   1.70   1.35   0.55   8.84   2.29
  88.48  5854.83  2.83   2.83 1-S2n   1.52   1.99   1.59   0.66   9.52   2.56
 110.60  5855.21  3.21   3.21 1-S2n   1.72   2.23   1.81   0.75  10.03   2.78
 132.72  5855.57  3.57   3.57 1-S2n   1.90   2.46   2.01   0.84  10.53   2.98
 154.84  5855.94  3.94   3.94 1-S2n   2.09   2.66   2.21   0.92  10.90   3.15
 176.96  5856.32  4.32   4.32 5-S2n   2.27   2.85   2.39   0.99  11.32   3.31
 199.08  5856.74  4.74   4.74 5-S2n   2.45   3.01   2.57   1.06  11.68   3.46
 221.20  5857.19  5.19   5.19 5-S2n   2.63   3.18   2.76   1.13  11.99   3.59
--------------------------------------------------------------------------------
        El. inlet face invert    5852.00 ft   El. outlet invert  5851.22 ft
        El. inlet throat invert     0.00 ft   El. inlet crest       0.00 ft
--------------------------------------------------------------------------------

***** SITE DATA ***** CULVERT INVERT **************
      INLET STATION                              0.00 ft
      INLET ELEVATION                         5852.00 ft
      OUTLET STATION                            78.00 ft
      OUTLET ELEVATION                        5851.22 ft
      NUMBER OF BARRELS                           2
      SLOPE (V/H)                                0.0100
      CULVERT LENGTH ALONG SLOPE                78.00 ft

***** CULVERT DATA SUMMARY ************************
      BARREL SHAPE          CIRCULAR
      BARREL DIAMETER         4.00 ft
      BARREL MATERIAL       CONCRETE
      BARREL MANNING'S n    0.013
      INLET TYPE            CONVENTIONAL
      INLET EDGE AND WALL   GROOVED END PROJECTION
      INLET DEPRESSION      NONE
--------------------------------------------------------------------------------
```

```
CURRENT DATE: 09-13-2010                                FILE DATE: 09-13-2010
CURRENT TIME: 13:21:04                                  FILE NAME: SILV-A1

-------------------------------------------------------------------------------
---------------------------      TAILWATER       ------------------------------
-------------------------------------------------------------------------------

******* REGULAR CHANNEL CROSS SECTION ****************
        BOTTOM WIDTH                                 50.00 ft
        SIDE SLOPE  H/V (X:1)                         4.0
        CHANNEL SLOPE V/H (ft/ft)                     0.005
        MANNING'S n (.01-0.1)                         0.030
        CHANNEL INVERT ELEVATION                   5851.22 ft
        CULVERT NO.1 OUTLET INVERT ELEVATION       5851.22 ft

******* UNIFORM FLOW RATING CURVE FOR DOWNSTREAM CHANNEL

        FLOW      W.S.E.   FROUDE    DEPTH    VEL.    SHEAR
        (cfs)      (ft)    NUMBER     (ft)   (f/s)    (psf)
         0.00    5851.22   0.000     0.00    0.00     0.00
         6.90    5851.36   0.443     0.14    0.95     0.05
        44.24    5851.65   0.525     0.43    1.96     0.14
        66.36    5851.77   0.543     0.55    2.29     0.17
        88.48    5851.88   0.556     0.66    2.56     0.20
       110.60    5851.97   0.566     0.75    2.78     0.23
       132.72    5852.06   0.574     0.84    2.98     0.26
       154.84    5852.14   0.580     0.92    3.15     0.29
       176.96    5852.21   0.586     0.99    3.31     0.31
       199.08    5852.28   0.591     1.06    3.46     0.33
       221.20    5852.35   0.595     1.13    3.59     0.35

-------------------------------------------------------------------------------
--------------------------   ROADWAY OVERTOPPING DATA   -----------------------
-------------------------------------------------------------------------------

      ROADWAY SURFACE                              PAVED
      EMBANKMENT TOP WIDTH                         32.00 ft
      CREST LENGTH                                100.00 ft
      OVERTOPPING CREST ELEVATION                5857.77 ft

-------------------------------------------------------------------------------
```

Culvert A1

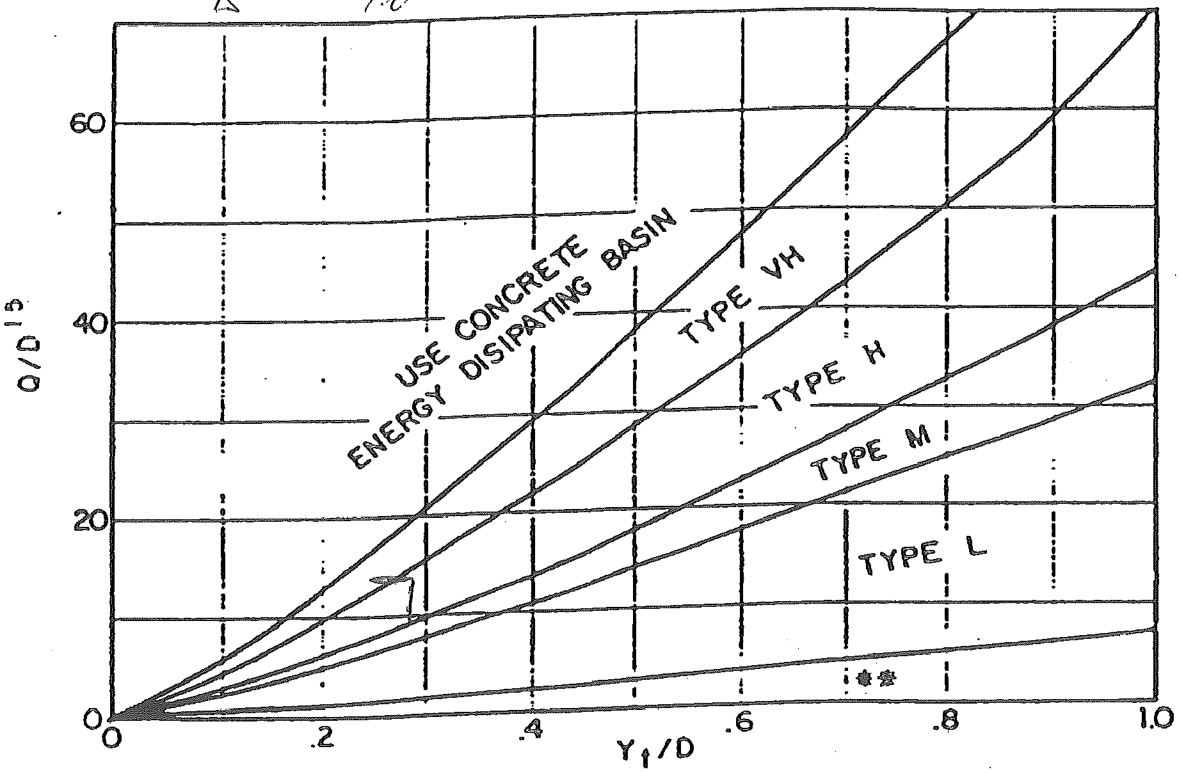
$Q_{100} = 221.2$ cfs / 2 pipes = 110.6 cfs/pipe

$\Delta = 48" = 4.0'$

$$\frac{Q}{\Delta^{1.5}} = \frac{110.6}{(4.0)^{1.5}} = 13.8$$

$Y_t = 1.1'$

$$\frac{Y_t}{\Delta} = \frac{1.1}{4.0} = 0.28$$



Use D_a instead of D whenever flow is supercritical in the barrel.
✱✱ Use Type L for a distance of 3D downstream.

→ Use Type H

FIGURE 5-7. RIPRAP EROSION PROTECTION AT CIRCULAR CONDUIT OUTLET.

HY-8 Analysis Results

Crossing Summary Table – Culvert B1 – 24"

Culvert Crossing: Crossing 1

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert B1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
5821.95	19.20	19.20	0.00	1
5822.36	22.28	22.28	0.00	1
5822.69	25.36	24.50	0.71	26
5822.73	28.44	24.74	3.61	6
5822.76	31.52	24.91	6.43	4
5822.78	34.60	25.07	9.43	4
5822.80	37.68	25.20	12.42	4
5822.82	40.76	25.32	15.29	3
5822.84	43.84	25.43	18.28	3
5822.85	45.10	25.48	19.57	3
5822.88	50.00	25.64	24.27	3
5822.67	24.37	24.37	0.00	Overtopping

APPENDIX D

RETENTION POND CALCULATIONS AND OPERATION & MAINTENANCE MANUAL

consequences of a facility failure. Generally, embankments should be fortified against and/or have spillways that, at a minimum, are capable of conveying the total not-routed peak 100-year storm discharge from a fully developed total tributary catchment, including all off-site areas, if any. Detailed analysis, however, of downstream hazards should be performed and may indicate that the embankment protection and/or spillway design needs to be for events much larger than the 100-year design storm.

3.3.4 Retention Facilities

A retention facility (a basin with a zero release rate or a very slow release rate) is used when there is no available formal downstream drainageway, or one that is grossly inadequate. When designing a retention facility, the hydrologic basis of design is difficult to describe because of the stochastic nature of rainfall events. Thus, sizing for a given set of assumptions does not ensure that another scenario produced by nature (e.g., a series of small storms that add up to large volumes over a week or two) will not overwhelm the intended design. For this reason, retention basins are not recommended as a permanent solution for drainage problems. They have been used in some instances as temporary measures until a formal system is developed downstream. When used, they can become a major nuisance to the community duo to problems that may include mosquito breeding, safety concerns, odors, etc.

When a retention basin is proposed as a temporary solution, the District recommends that it be sized to capture, as a minimum, the runoff equal to 1.5 times the 24-hour, 100-year storm plus 1-foot of freeboard. The facility also has to be situated and designed so that when it overtops, no human-occupied or critical structures (e.g., electrical vaults, homes, etc.) will be flooded, and no catastrophic failure at the facility (e.g., loss of dam embankment) will occur. It is also recommended that retention facilities be as shallow as possible to encourage infiltration and other losses of the captured urban runoff. When a trickle outflow can be accepted downstream or a small conduit can be built, provided and sized it in accordance with the locally approved release rates, preferably capable of emptying the full volume in 14 days or less.

3.4 Reservoir Routing of Storm Hydrographs for Sizing of Storage Volumes

The reservoir routing procedure for the sizing of detention storage volumes is more complex and time consuming than the use of empirical equations, FAA procedure or the simplified *Full Spectrum Detention* protocol. Its use requires the designer to develop an inflow hydrograph for the facility. This is generally accomplished using CUHP and UDSWM computer models as described in the RUNOFF chapter of this *Manual*. The hydrograph routing sizing method is an iterative procedure that follows the steps detailed below (Guo 1999b).

1. Select Location: The detention facility's location should be based upon criteria developed for the specific project. Regional storage facilities are normally placed where they provide the greatest overall benefit. Multi-use objectives such as the use of the detention facility as a park or for open space, preserving or providing wetlands and/or wildlife habitat, or others uses and community

SILVERADO RANCH - EXISTING CONDITIONS
POND A STAGE-STORAGE-DISCHARGE TABLE

POND DEPTH (FT)	SURFACE AREA (SF)	SURFACE AREA (AC)	INCREM. VOLUME (CF)	TOTAL VOLUME (CF)	TOTAL VOLUME (AF)	SPILLWAY WEIR L (FT)	SPILLWAY WEIR H (FT)	DISCHARGE (CFS)	
5845	5,629	0.13	0	0	0			0	
5846	27,321	0.63	16475	16475	0.38			0.00	
5848	53,233	1.22	80554	97029	2.23			0.00	
5850	88,319	2.03	141552	238581	5.48			0.00	
5852	130,854	3.00	219173	457754	10.51			0.00	
5853	160,460	3.68	145657	603411	13.85			0.00	
5854	190,065	4.36	175262.5	778673.5	17.88			0.00	
5855	239,746	5.50	214905.5	993579	22.81			0.00	
5856	289,427	6.64	264586.5	1258166	28.88			0.00	STORAGE VOLUME (1' FREEBOARD)
5857	377,975	8.68	333701	1591867	36.54			0.00	EXISTING OVERFLOW
5858	477,083	10.95	427529	2019396	46.36	500.00	0.90	1280.72	
5860	601,129	13.80	1078212	3097608	71.11	750.00	2.90	11111.67	

SILVERADO RANCH - PROPOSED / DEVELOPED CONDITIONS
POND A STAGE-STORAGE-DISCHARGE TABLE

POND DEPTH (FT)	SURFACE AREA (SF)	SURFACE AREA (AC)	INCREM. VOLUME (CF)	TOTAL VOLUME (CF)	TOTAL VOLUME (AF)	SPILLWAY WEIR L (FT)	SPILLWAY WEIR H (FT)	DISCHARGE (CFS)	
5845	5,629	0.13	0	0	0			0	
5846	27,321	0.63	16475	16475	0.38			0.00	
5848	53,233	1.22	80554	97029	2.23			0.00	
5850	88,319	2.03	141552	238581	5.48			0.00	
5852	130,854	3.00	219173	457754	10.51			0.00	
5853	160,460	3.68	145657	603411	13.85			0.00	
5854	190,065	4.36	175262.5	778673.5	17.88			0.00	PROPOSED OVERFLOW
5855	239,746	5.50	214905.5	993579	22.81	45.00	1.00	135.00	
5856	289,427	6.64	264586.5	1258166	28.88	53.00	2.00	449.72	STORAGE VOLUME (1' FREEBOARD)
5857	377,975	8.68	333701	1591867	36.54	61.00	3.00	950.90	EXISTING OVERFLOW
5858	477,083	10.95	427529	2019396	46.36	500.00	4.00	12000.00	
5860	601,129	13.80	1078212	3097608	71.11	750.00	5.00	25155.76	

DISCHARGE CALCULATION:
WEIR FLOW: Q = 3.0 * L * H^1.5 (BROAD-CRESTED WEIR)

RETENTION POND - BASIN A

REQUIRED 100-YEAR POND VOLUME, V:

V = Q * A * 1.5 (RETENTION POND VOLUME, ACRE-FEET)
= (100-YEAR; 24-HOUR RUNOFF) * (BASIN AREA) / (12 IN/FT) * 1.5
(UDFCD RETENTION STORAGE CRITERIA)

ASSUMPTIONS:

A = 2722.5 AC (DRAINAGE BASIN AREA, AC)

CN = 50.287 (WEIGHTED CURVE NUMBER FROM CN-SPREADSHEET)

P = 4.4 IN (100-YEAR; 24-HOUR STORM RAINFALL PER EL PASO COUNTY)

S = 9.89 S = (1000/CN)-10

Q = 0.48 IN Q = (P - 0.2S)^2 / (P + 0.8S)
(100-YEAR; 24-HOUR STORM RUNOFF PER SCS TR-55)

REQUIRED 100-YEAR RETENTION VOLUME, V:
V = 162.30 AC-FT

AVAILABLE RETENTION POND VOLUME:
V = 36.50 AC-FT (TOTAL)
V = 28.90 AC-FT (W/ 1' FREEBOARD)

RETENTION POND DRAIN TIME:
DEPTH = 9 FEET
PERC RATE = 13.3 MIN/IN (TEST HOLE P-1)
DRAIN TIME = **23.9 HOURS**

SILVERADO RANCH - EXISTING CONDITIONS
POND B STAGE-STORAGE-DISCHARGE TABLE

POND DEPTH (FT)	SURFACE AREA (SF)	SURFACE AREA (AC)	INCREM. VOLUME (CF)	TOTAL VOLUME (CF)	TOTAL VOLUME (AF)	SPILLWAY WEIR L (FT)	SPILLWAY WEIR H (FT)	DISCHARGE (CFS)	
5790	83,163	1.91	0	0	0			0.00	
5792	441,955	10.15	525118	525118	12.06			0.00	
5794	657,591	15.10	1099546	1624664	37.30			0.00	
5795	805484	18.49	731537.5	2356202	54.09			0.00	STORAGE VOLUME (1' FREEBOARD)
5796	953,377	21.89	879430.5	3235632	74.28			0.00	EXISTING OVERFLOW
5798	1,278,276	29.35	2231653	5467285	125.51	400.00	1.70	2659.83	

SILVERADO RANCH - PROPOSED CONDITIONS
POND B STAGE-STORAGE-DISCHARGE TABLE

POND DEPTH (FT)	SURFACE AREA (SF)	SURFACE AREA (AC)	INCREM. VOLUME (CF)	TOTAL VOLUME (CF)	TOTAL VOLUME (AF)	SPILLWAY WEIR L (FT)	SPILLWAY WEIR H (FT)	DISCHARGE (CFS)	
5790	83,163	1.91	0	0	0			0.00	
5792	441,955	10.15	525118	525118	12.06			0.00	
5794	762,220	17.50	1204175	1729293	39.70			0.00	
5795	814,212	18.69	788216	2517509	57.79			0.00	STORAGE VOLUME (1' FREEBOARD)
5796	871,277	20.00	842744.5	3360254	77.14			0.00	OVERFLOW
5798	1,278,276	29.35	2149553	5509807	126.49	400.00	1.70	2659.83	

DISCHARGE CALCULATION:
WEIR FLOW: Q = 3.0 * L * H^1.5 (BROAD-CRESTED WEIR)

RETENTION POND - BASIN B

REQUIRED 100-YEAR POND VOLUME, V:

V = Q * A * 1.5 (RETENTION POND VOLUME, ACRE-FEET)
= (100-YEAR; 24-HOUR RUNOFF) * (BASIN AREA) / (12 IN/FT) * 1.5
(UDFCD RETENTION STORAGE CRITERIA)

ASSUMPTIONS:

A = 5729.2 AC (DRAINAGE BASIN AREA, AC)

CN = 50.636 (WEIGHTED CURVE NUMBER FROM CN-SPREADSHEET)

P = 4.4 IN (100-YEAR; 24-HOUR STORM RAINFALL PER EL PASO COUNTY)

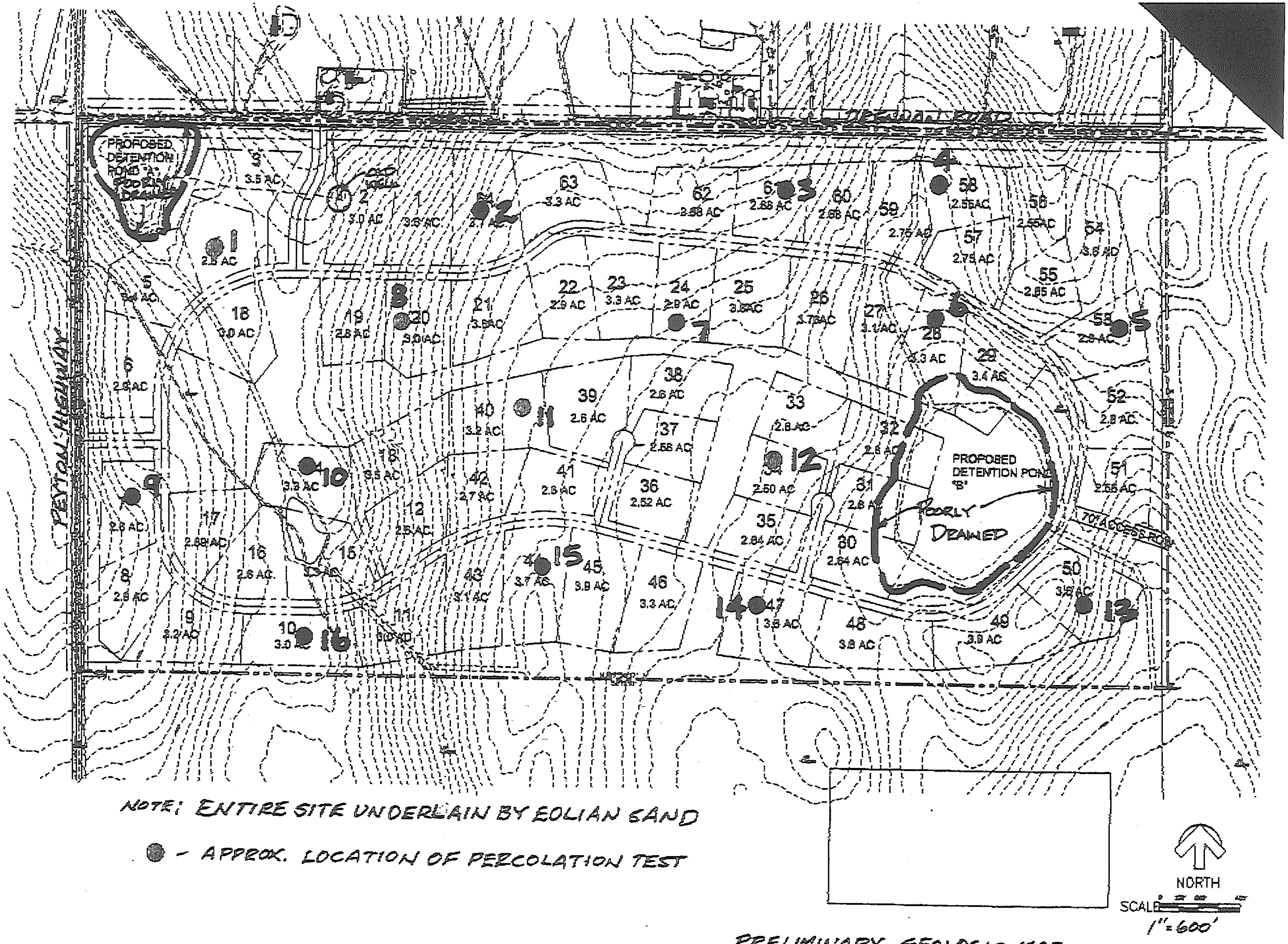
S = 9.75 S = (1000/CN)-10

Q = 0.49 IN Q = (P - 0.2S)^2 / (P + 0.8S)
(100-YEAR; 24-HOUR STORM RUNOFF PER SCS TR-55)

CALCULATED 100-YEAR POND VOLUME, V:
V = 352.45 AC-FT

AVAILABLE RETENTION POND VOLUME:
V = 77.10 AC-FT (TOTAL)
V = 57.80 AC-FT (W/ 1' FREEBOARD)

RETENTION POND DRAIN TIME:
DEPTH = 4 FEET
PERC RATE = 17.6 MIN/IN (AVG. OF P-5, P-6, P-12, P-13, P-14)
DRAIN TIME = **14 HOURS**



NOTE: ENTIRE SITE UNDERLAIN BY EOLIAN SAND

● - APPROX. LOCATION OF PERCOLATION TEST

PRELIMINARY GEOLOGIC MAP

FIGURE 2

FRONT RANGE GEOTECHNICAL INC.

DRILL LOGS

JOB#: 15365

TEST BORING NO.: P-1

DATE: 08-24-06

0"-4" <u>SANDY LOAM</u>

4"-10' <u>SAND</u>

fine-medium grained

low density

low moisture content

low clay content

non-plastic

buff color

DEPTH (in ft.)	SYMBOL	SAMPLES	BLOW COUNT	WATER %	SOIL TYPE
2					
		■	10/12"	4.7	SM
4					
6					
8					
10					
12					
14					
16					
18					
20					

[Perc rate: 1" in 13.3 minutes]

JOB#: 15365

TEST BORING NO.: P-2

DATE: 08-24-06

0"-6" <u>SANDY LOAM</u>

6"-10' <u>SAND</u>

fine grained

low density

low-mod moisture content

low clay content

low plasticity
<u>slight inc. w/depth</u>

light-brown color
<u>becomes buff @ 7'</u>

DEPTH (in ft.)	SYMBOL	SAMPLES	BLOW COUNT	WATER %	SOIL TYPE
2					
4					
6					
8					
10					
12					
14					
16					
18					
20					

[Perc rate: 1" in 12.3 minutes]

FRONT RANGE GEOTECHNICAL INC.

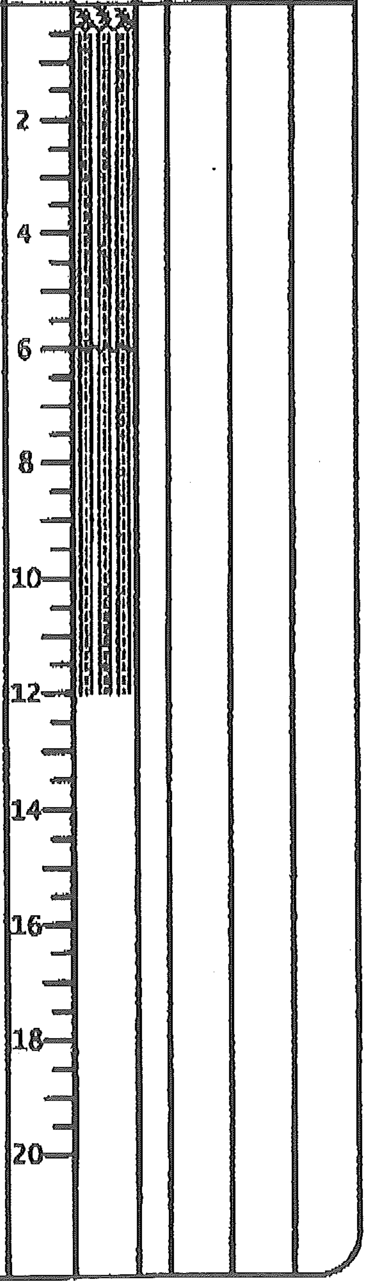
DRILL LOGS

JOB#: 15365

TEST BORING NO.: P-5

DATE: 08-24-06

DEPTH (in ft.) | SYMBOL | SAMPLES | BLOW COUNT | WATER % | SOIL TYPE



0"-4" SANDY LOAM

4"-6' SAND

fine grained

low density

low-mod moisture content

low clay content

low plasticity

light-brown color

6'-12' SAND

fine-medium grained

low-mod density

low-mod moisture content

low clay content

low plasticity

buff color

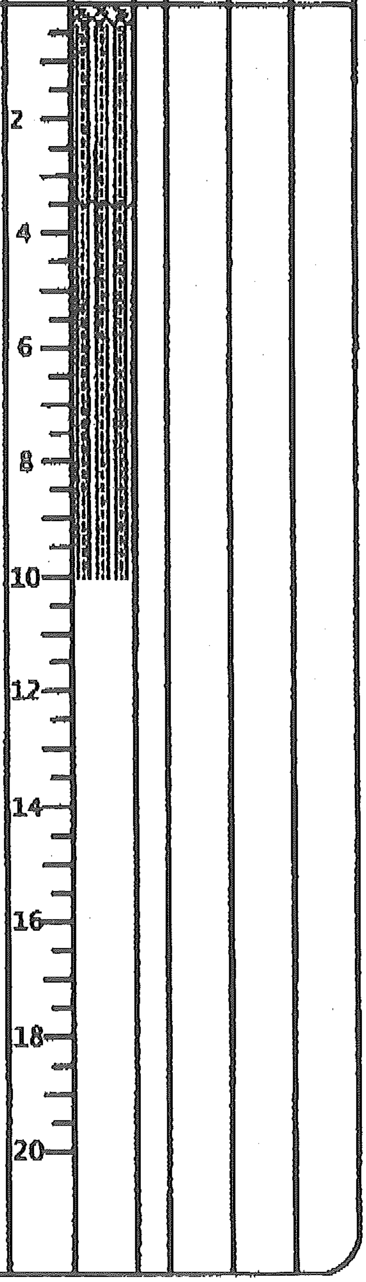
Perc rate:
1" in 13.3 minutes

JOB#: 15365

TEST BORING NO.: P-6

DATE: 08-24-06

DEPTH (in ft.) | SYMBOL | SAMPLES | BLOW COUNT | WATER % | SOIL TYPE



0"-3" SANDY LOAM

3"-3.5' SAND

fine grained

low density

low moisture content

low clay content

low plasticity

brown color

3.5'-10' SAND

fine-medium grained

low-mod density

low-mod moisture content

moderate clay content

moderate plasticity

buff color

Perc rate:
1" in 22.9 minutes

FRONT RANGE GEOTECHNICAL INC.

DRILL LOGS

JOB#: 15365

TEST BORING NO.: P-11

DATE: 08-24-06

DEPTH (in ft.) | SYMBOL | SAMPLES | BLOW COUNT | WATER % | SOIL TYPE

0"-6" SANDY LOAM

6"-8' SAND

fine-medium grained

low density

low moisture content

low clay content

low plasticity

brown color

8'-12' SAND

fine grained

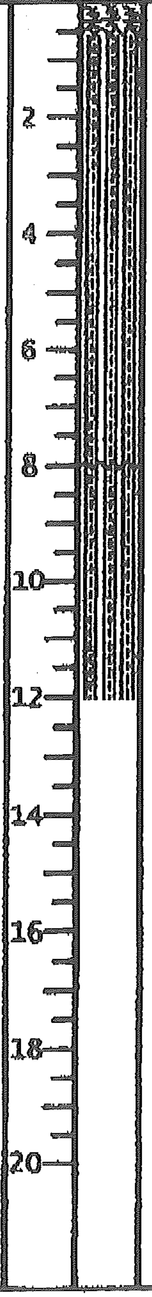
low density

low moisture content

low clay content

low plasticity

buff color



Perc rate:
1" in 20 minutes

JOB#: 15365

TEST BORING NO.: P-12

DATE: 08-24-06

DEPTH (in ft.) | SYMBOL | SAMPLES | BLOW COUNT | WATER % | SOIL TYPE

0"-6" SANDY LOAM

6"-11' SAND

fine grained

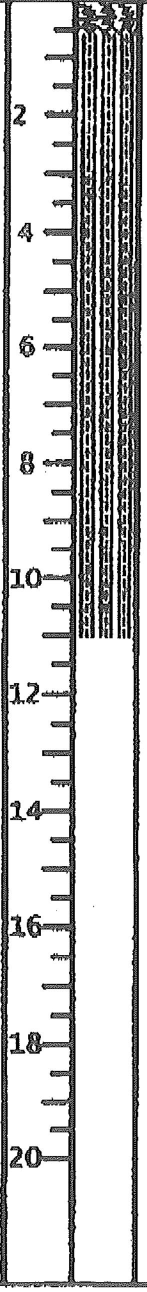
low density

low-mod moisture content
increases w/depth

low clay content

low plasticity

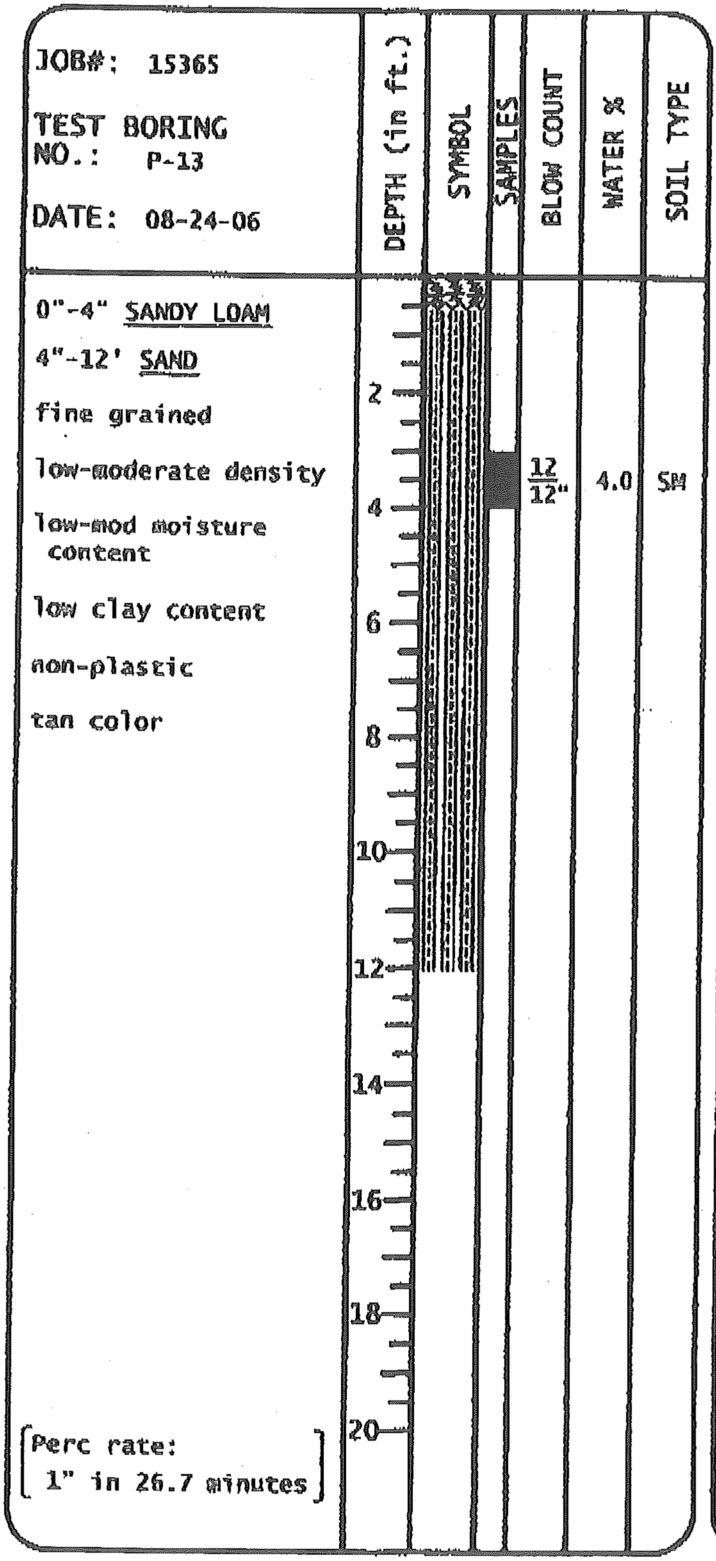
brown color
becomes buff @ 6'
becomes brown @ 8'
weakly oxidized @ 8'



Perc rate:
1" in 16 minutes

FRONT RANGE GEOTECHNICAL INC.

DRILL LOGS



JOB#: 15365

TEST BORING NO.: P-13

DATE: 08-24-06

0"-4" SANDY LOAM

4"-12' SAND

fine grained

low-moderate density

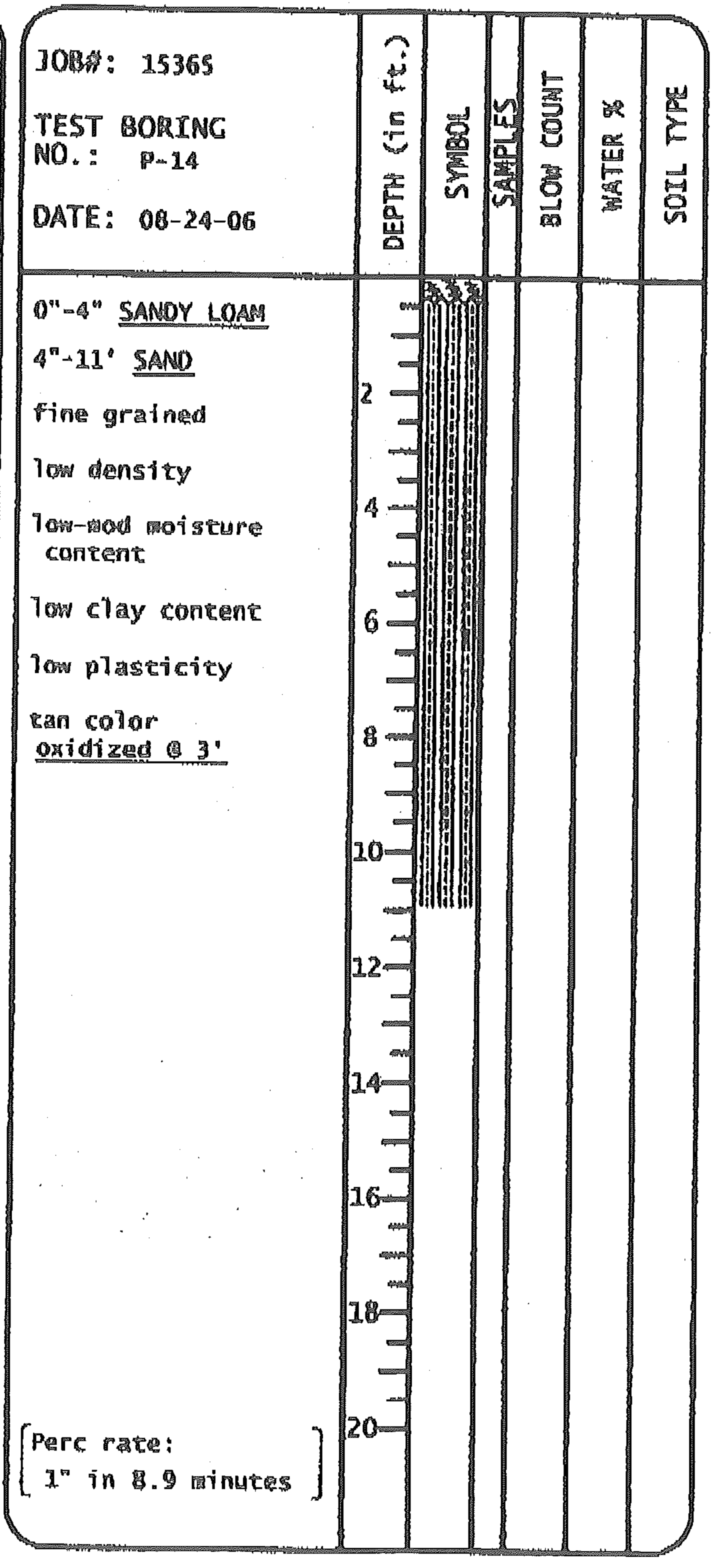
low-mod moisture content

low clay content

non-plastic

tan color

Perc rate: 1" in 26.7 minutes



JOB#: 15365

TEST BORING NO.: P-14

DATE: 08-24-06

0"-4" SANDY LOAM

4"-11' SAND

fine grained

low density

low-mod moisture content

low clay content

low plasticity

tan color

oxidized @ 3'

Perc rate: 1" in 8.9 minutes

Operation and Maintenance Manual

for

Stormwater Retention Ponds

April 2009

TABLE OF CONTENTS

RP-1 BACKGROUND

Stormwater Retention Ponds (RP's) are a type of Stormwater BMP utilized within the Front Range of Colorado. An RP is a stormwater pond designed to retain stormwater within a site, and encourage infiltration to minimize downstream drainage concerns. Depending on local soil characteristics, the basins may be normally "dry" because the majority of stormwater infiltrates into the soil following storm events. During major storms or extended storm events, the basins may have a significant permanent pool of water remaining between runoff events, and for a period of time following runoff events.

RP-2 INSPECTING RETENTION PONDS (RP's)

RP-2.1 Access and Easements

Inspection or maintenance personnel may utilize platted access and drainage easements as required for maintenance access to the ponds.

RP-2.2 Stormwater Best Management Practice (BMP) Locations

Inspection or maintenance personnel may refer to the approved Final Drainage Report for location(s) of the RP(s) within this development.

RP-2.3 Retention Pond (RP) Features

RP's have a number of features that are designed to serve a particular function. Therefore, it is critical that each feature of the RP is properly inspected and maintained to ensure that the overall facility functions as it was intended. Below is a list and description of the most common features within an RP and the corresponding maintenance inspection items that can be anticipated:

Table RP-1

Typical Inspection & Maintenance Requirements Matrix

RP Features	Sediment Removal	Mowing/ Weed control	Trash & Debris Removal	Erosion	Overgrown Vegetation Removal	Standing Water (mosquito/ algae control)	Structure Repair
Inflow Points (outfalls)	X		X				X
Bottom Stage	X	X	X	X	X	X	
Emergency Spillway			X	X	X		X
Embankment		X		X	X		

RP-2.3.1 Inflow Points

Inflow Points or Outfalls into RP's are the point source of the stormwater discharge into the facility. An inflow point is commonly a storm sewer pipe with a flared end section that discharges into the EDB. In some instances, an inflow point could be a drainage channel or ditch that flows into the facility.

An energy dissipater (riprap or hard armor protection) is typically immediately downstream of the discharge point into the RP to protect from erosion. In some cases, the storm sewer outfall can have a toe-wall or cut-off wall immediately below the structure to prevent undercutting of the outfall from erosion.

The typical maintenance items that are found with inflow points are as follows:

a. Riprap Displaced – Many times, because the repeated impact/force of water, the riprap can shift and settle. If any portion of the riprap apron appears to have settled, soil is present between the riprap, or the riprap has shifted, maintenance may be required to ensure future erosion is prevented.

b. Erosion Present/Outfall Undercut – In some situations, the energy dissipater may not have been sized, constructed, or maintained appropriately and erosion has occurred. Any erosion within the vicinity of the inflow point will require maintenance to prevent damage to the structure(s) and sediment transport within the facility.

c. Sediment Accumulation – Because of the turbulence in the water created by the energy dissipater, sediment often deposits immediately downstream of the inflow point. To prevent a loss in hydraulic performance of the upstream infrastructure, sediment that accumulates in this area must be removed in a timely manner.

d. Structural Damage – Structural damage can occur at anytime during the life of the facility. Typically, for an inflow, the structural damage occurs to the pipe flared end section (concrete or steel). Structural damage can lead to additional operating problems with the facility, including loss of hydraulic performance.

e. Woody Growth/Weeds Present – Undesirable vegetation can grow in and around the inflow area to an RP that can significantly affect the performance of the drainage facilities discharging into the facility. This type of vegetation includes trees (typically cottonwoods) and dense areas of shrubs (willows). If woody vegetation is not routinely mowed/removed, the growth can cause debris/sediment to accumulate, resulting in blockage of the discharge. Also, tree roots can cause damage to the structural components of the inflow. Routine maintenance is essential for trees (removing a small tree/sapling is much cheaper and "quieter" than a mature tree). In addition, noxious weeds growing in the facility can result in the loss of desirable native vegetation and impact adjacent open spaces/land.

RP-2.3.2 Bottom Stage

The typical maintenance items that are found with the bottom stage of the pond are as follows:

a. Sediment/Debris Accumulation – The micro-pool can frequently accumulate sediment and debris. This material must be removed to maintain pond volume and proper function of the outlet structure.

b. Woody Growth/Weeds Present - Because of the constant moisture in the soil surrounding the micro-pool, woody growth (cottonwoods/willows) can create operational problems for the RP. Routine management is essential for trees (removing a small tree/sapling is much cheaper and "quieter" than a mature tree).

c. Bank Erosion –Erosion can be caused by water dropping into the pond if adequate protection/armor is not present. Erosion in this area must be mitigated to prevent sediment transport and other RP feature damage.

d. Mosquitoes/Algae Treatment – Nuisance created by stagnant water can result from improper maintenance/treatment of the pond bottom. Mosquito larvae can be laid by adult mosquitoes within the permanent pool. Also, aquatic vegetation that grows in shallow pools of water can decompose causing foul odors. Chemical/mechanical treatment of the pond bottom may be necessary to reduce these impacts to adjacent homeowners.

e. Petroleum/Chemical Sheen – Many indicators of illicit discharges into the storm sewer systems will be present in the bottom of retention ponds. These indicators can include sheens, odors, discolored soil, and dead vegetation. If it is suspected that an illicit discharge has occurred, contact the supervisor immediately. Proper removal/mitigation of contaminated soils and water in the RP is necessary to minimize any environmental impacts downstream.

RP-2.3.3 Emergency Spillway

An emergency spillway is typical of all RP's and designed to serve as the overflow in the event the volume of the pond is exceeded. The emergency spillway is typically armored with riprap (or other hard armor) and is sometimes buried with soil. The emergency spillway is typically a weir (notch) in the pond embankment. Proper function of the emergency spillway is essential to ensure flooding does not affect adjacent properties.

The typical maintenance items that are found with emergency spillways are as follows:

a. Riprap Displaced – As mentioned before, the emergency spillway is typically armored with riprap to provide erosion protection. Over the life of an RP, the riprap may shift or dislodge due to flow.

b. Erosion Present – Although the spillway is typically armored, stormwater flowing through the spillway can cause erosion damage. Erosion must be repaired to ensure the integrity of the basin embankment, and proper function of the spillway.

c. Woody Growth/Weeds Present – Management of woody vegetation is essential in the proper long-term function of the spillway. Larger trees or dense shrubs can capture larger debris entering the RP and reduce the capacity of the spillway.

d. Obstruction Debris – The spillway must be cleared of any obstruction (man made or natural) to ensure the proper design capacity.

RP-2.3.4 Upper Stage (Dry Storage)

The upper stage of the RP typically stays dry, except during storm events. The upper stage is the largest feature/area of the basin. Sometimes, the upper stage can be utilized for park space and other uses in larger RP's.

The typical maintenance items that are found with upper stages are as follows:

a. Vegetation Sparse – The upper basin is the most visible part of the RP, and therefore aesthetics is important. Adequate and properly maintained vegetation can greatly increase the overall appearance and acceptance of the RP by the public. In addition, vegetation can reduce the potential for erosion and subsequent sediment transport to the other areas of the pond.

b. Woody Growth/Undesirable Vegetation – Although some trees and woody vegetation may be acceptable in the upper basin, some thinning of cottonwoods and willows may be necessary. Remember, the basin will have to be dredged to ensure volume, and large trees and shrubs will be difficult to protect during that operation.

c. Standing Water/Boggy Areas – Routine maintenance (mowing, trash removal, etc) can be extremely difficult for the upper stage if the ground is saturated. If this inspection item is checked, make sure you have identified the root cause of the problem.

d. Sediment Accumulation – Although other features within the RP are designed to capture sediment, the upper storage area will collect sediment over time. Excessive amounts of sedimentation will result in a loss of storage volume. It may be more difficult to determine if this area has accumulated sediment without conducting a field survey.

Below is a list of indicators:

1. Standing water or boggy areas in upper stage
2. Uneven grades or mounds

e. Erosion (banks and bottom) – The bottom grades of the dry storage are typically flat enough that erosion should not occur. However, inadequate vegetative cover may result in erosion of the upper stage. Erosion that occurs in the upper stage can result in increased dredging/maintenance of the micro-pool.

f. Trash/Debris – Trash and debris can accumulate in the upper area after large events, or from illegal dumping. Over time, this material can accumulate and clog the RP outlet works.

g. Maintenance Access – Most RP's typically have a gravel/concrete maintenance access path to either the upper stage or forebay. This access path should be inspected to ensure the surface is still drivable. Some of the smaller Rp's may not have maintenance access paths; however, the inspector should verify that access is available from adjacent properties.

RP-2.3.9 Miscellaneous

There are a variety of inspection/maintenance issues that may not be attributed to a single feature within the RP. This category on the inspection form is for maintenance items that are commonly found in the RP, but may not be attributed to an individual feature.

a. Access – Access needs to be maintained.

b. Graffiti/Vandalism – Damage to the RP infrastructure can be caused by vandals. If criminal mischief is evident, the inspector should forward this information to the local enforcement agency.

c. Public Hazards – Public hazards include items such as vertical drops of greater than 4-feet, containers of unknown/suspicious substances, exposed metal/jagged concrete on structures. **If any hazard is found within the facility area that poses an immediate threat to public safety, contact the local emergency services at 911 immediately!**

d. Burrowing Animals/Pests – Prairie dogs and other burrowing rodents may cause damage to the RP features and negatively affect the vegetation within the RP.

e. Other – Any miscellaneous inspection/maintenance items not contained on the form should be entered here.

RP-2.4 Inspection Forms

Inspection forms shall be completed by the person(s) conducting the inspection activities. These inspection forms shall be kept a minimum of 5 years and made available to the El Paso County Stormwater Team upon request.

RP-3 MAINTAINING RETENTION PONDS (RP'S)

RP-3.1 Maintenance Personnel

Maintenance personnel must be qualified to properly maintain RP's. Inadequately trained personnel can cause additional problems resulting in additional maintenance costs.

RP-3.2 Equipment

It is imperative that the appropriate equipment and tools are taken to the field with the operations crew. The types of equipment/tools will vary depending on the task at hand. Below is a list of tools, equipment, and material(s) that may be necessary to perform maintenance on an RP:

1.) Loppers/Tree Trimming Tools

2.) Mowing Tractors

3.) Trimmers (extra string)
4.) Shovels
5.) Rakes
6.) All Surface Vehicle (ASVs)
7.) Skid Steer
8.) Back Hoe
9.) Track Hoe/Long Reach Excavator
10.) Dump Truck
11.) Jet-Vac Machine
12.) Engineers Level (laser)
13.) Riprap (Minimum - Type M)
14.) Filter Fabric
15.) Erosion Control Blanket(s)
16.) Seed Mix (Native Mix)
17.) Illicit Discharge Cleanup Kits
18.) Trash Bags
19.) Tools (wrenches, screw drivers, hammers, etc)
20.) Chain Saw
21.) Confined Space Entry Equipment
22.) Approved Inspection and Maintenance Plan

Some of the items identified above may not be needed for every maintenance operation. However, this equipment should be available to the maintenance operations crews should the need arise.

RP-3.3 Safety

Vertical drops may be encountered in areas located within and around the facility. Avoid walking on top of retaining walls or other structures that have a significant vertical drop. If a vertical drop is identified within the RP that is greater than 48" in height, make the appropriate note/comment on the maintenance inspection form.

RP-3.4 Maintenance Forms

An RP Maintenance Form shall be filled out in the field after the completion of the maintenance operation. Maintenance forms shall be kept on record with the Homeowners Association.

RP-3.5 Maintenance Categories and Activities

A typical RP Maintenance Program will consist of three broad categories of work: Routine, Restoration (minor), and Rehabilitation (major). Within each category of work, a variety of maintenance activities can be performed on an RP. A maintenance activity can be specific to each feature within the RP, or general to the overall facility. This section of the O&M Manual explains each of the categories and briefly describes the typical maintenance activities for an RP.

A variety of maintenance activities are typical of RP's. The maintenance activities range in magnitude from routine trash pickup to the reconstruction of drainage infrastructure. Below is a description of each maintenance activity, the objectives, and frequency of actions:

RP-3.6 Routine Maintenance Activities

The majority of this work consists of regularly scheduled mowing and trash and debris pickups for stormwater management facilities during the growing season. This includes items such as the removal of debris/material that may be clogging the outlet structure. It also includes activities such as includes weed control, mosquito treatment, and algae treatment. These activities normally will be performed numerous times during the year.

The Maintenance Activities are summarized below, and further described in the following sections.

TABLE – RP-2
Summary of Routine Maintenance Activities

MAINTENANCE ACTIVITY	MINIMUM FREQUENCY	LOOK FOR:	MAINTENANCE ACTION
Mowing	Twice annually	Excessive grass height/aesthetics	Mow grass to a height of 4” to 6”
Trash/Debris Removal	Twice annually	Trash & debris in RP	Remove and dispose of trash and debris
Outlet Works Cleaning	As needed - after significant rain events – twice annually min.	Clogged outlet structure; ponding water	Remove and dispose of debris/trash/sediment to allow outlet to function properly
Weed control	Minimum twice annually	Noxious weeds; Unwanted vegetation	Treat w/ herbicide or hand pull; Consult the local weed specialist
Mosquito Treatment	As needed	Standing water/mosquito habitat	Treat w/ EPA approved chemicals
Algae Treatment	As needed	Standing water/ Algal growth/green color	Treat w/ EPA approved chemicals

RP-3.6.1 Mowing

Occasional mowing is necessary to limit unwanted vegetation and to improve the overall appearance of the RP. Native vegetation should be mowed to a height of 4-to-6 inches tall. Grass clippings should be collected and disposed of properly.

Frequency – Routine - Minimum of twice annually or depending on aesthetics.

RP-3.6.2 Trash/Debris Removal

Trash and debris must be removed from the entire RP area to minimize outlet clogging and to improve aesthetics. This activity must be performed prior to mowing operations.

Frequency – Routine – Prior to mowing operations and minimum of twice annually.

RP-3.6.3 Outlet Works Cleaning

Debris and other materials can clog the outlet works. This activity must be performed anytime other maintenance activities are conducted to ensure proper operation.

Frequency - Routine – After significant rainfall event or concurrently with other maintenance activities.

RP-3.6.4 Weed Control

Noxious weeds and other unwanted vegetation must be treated as needed throughout the RP. This activity can be performed either through mechanical means (mowing/pulling) or with herbicide. Consultation with the local Weed Inspector is highly recommended prior to the use of herbicide.

Frequency – Routine – As needed based on inspections.

RP-3.6.5 Mosquito/Algae Treatment

Treatment of permanent pools is necessary to control mosquitoes and undesirable aquatic vegetation that can create nuisances. Only EPA approved chemicals/materials can be used in areas that are warranted.

Frequency – As needed.

RP- 3.7 Restoration Maintenance Activities

This work consists of a variety of isolated or small-scale maintenance or operational problems. Most of this work can be completed by a small crew, tools, and small equipment.

Table – RP-3
Summary of Restoration Maintenance Activities

MAINTENANCE ACTIVITY	MINIMUM FREQUENCY	LOOK FOR:	MAINTENANCE ACTION
▨	▨	▨	▨
Sediment Removal	As needed; typically every 1 –2 years	Sediment build-up; decrease in pond volume	Remove and dispose of sediment
Erosion Repair	As needed, based upon inspection	Rills/gullies forming on side slopes, trickle channel, other areas	Repair eroded areas Revegetate; address source of erosion
Vegetation Removal/Tree Thinning	As needed, based upon inspection	Large trees/wood vegetation in lower chamber of pond	Remove vegetation; restore grade and surface
Drain Cleaning/Jet Vac	As needed, based upon inspection	Sediment build-up /non draining system	Clean drains; Jet Vac if needed

RP-3.7.1 Sediment Removal

Sediment removal is necessary to maintain the original design volume of the RP and to ensure proper function of the infrastructure. Regular sediment removal (minor) from the inflow(s) and trickle channel can significantly reduce the frequency of major sediment removal activities (dredging) in the upper and lower stages. The minor sediment removal activities can typically be addressed with shovels and smaller equipment. Major sediment removal activities will require larger and more specialized equipment. The major sediment activities may also require surveying with an engineer's level, and engineering consultation to ensure design volumes/grades are achieved.

Stormwater sediments removed from RP's do not meet the criteria of "hazardous waste". However, these sediments are contaminated with a wide array of organic and inorganic pollutants and handling must be done with care. Sediments from permanent pools must be carefully removed to minimize turbidity, further sedimentation, or other adverse water quality impacts. Sediments should be transported by motor vehicle only after they are dewatered. All sediments must be taken to a landfill for proper disposal. Prompt and thorough cleanup is important should a spill occur during transportation.

Frequency – Nonroutine – As necessary based upon inspections. Sediment removal in the forebay and trickle channel may be necessary as frequently as every 1-2 years.

RP-3.7.2 Erosion Repair

The repair of eroded areas is necessary to ensure the proper function of the RP, minimize sediment transport, and to reduce potential impacts to other features. Erosion can vary in magnitude from minor repairs to trickle channels, energy dissipaters, and rilling to major gullies in the embankments and spillways. The repair of eroded areas may require the use of excavators, earthmoving equipment, riprap, concrete, erosion control blankets, and turf reinforcement mats.

Frequency – Nonroutine – As necessary based upon inspections.

RP-3.7.3 Vegetation Removal/Tree Thinning

Dense stands of woody vegetation (willows, shrubs, etc) or trees can create maintenance problems for the infrastructure within an RP. Tree roots can damage structures and invade pipes/channels thereby blocking flows. Also, trees growing in the upper and lower stages of the RP will most likely have to be removed when sediment/dredging operations occur. A small tree is easier to remove than a large tree, therefore, regular removal/thinning is imperative. All trees and woody vegetation that is growing in the bottom of the RP or near structures (inflows, trickle channels, outlet works, emergency spillways, etc) should be removed. Any trees or woody vegetation in the RP should be limited to the upper portions of the pond banks.

Frequency – Nonroutine – As necessary based upon inspections.

RP-3.7.4 Clearing Drains/Jet-Vac

An RP may contain structures, openings, and pipes that can be frequently clogged with debris. These blockages can result in a decrease of hydraulic capacity and create standing water in areas outside of the micro-pool. Many times the blockage to this infrastructure can be difficult to access and/or clean. Specialized equipment (jet-vac machines) may be necessary to clear debris from these difficult areas.

Frequency – Nonroutine – As necessary based upon inspections.

RP-3.8 Rehabilitation Maintenance Activities

This work consists of larger maintenance/operational problems and failures within the stormwater management facilities. This work may require engineering consultation to ensure the proper maintenance is performed. This work requires that the engineering staff review the original design and construction drawings to access the situation and assign the necessary maintenance. This work may also require more specialized maintenance equipment, design/details, surveying, or assistance through private contractors and consultants. Any proper permits required for this activity must be obtained.

Table – RP-4
Summary of Rehabilitation Maintenance Activities

MAINTENANCE ACTIVITY	MINIMUM FREQUENCY	LOOK FOR:	MAINTENANCE ACTION
Major Sediment Removal	As needed – based upon scheduled inspections	Large quantities of sediment; reduced pond capacity	Remove and dispose of sediment. Repair vegetation as needed
Major Erosion Repair	As needed – based upon scheduled inspections	Severe erosion including gullies, excessive soil displacement, areas of settlement, holes	Repair erosion – find cause of problem and address to avoid future erosion
Structural Repair	As needed – based upon scheduled inspections	Deterioration and/or damage to structural components – broken concrete, damaged pipes, outlet works	Structural repair to restore the structure to its original design

RP-3.8.1 Major Sediment Removal

Major sediment removal consists of removal of large quantities of sediment or removal of sediment from vegetated areas. Care shall be given when removing large quantities of sediment and sediment deposited in vegetated areas. Large quantities of sediment need to be carefully removed, transported and disposed of. Vegetated areas need special care to ensure design volumes and grades are preserved.

Frequency – Nonroutine – Repair as needed based upon inspections.

RP-3.8.2 Major Erosion Repair

Major erosion repair consist of filling and revegetating areas of severe erosion. Determining the cause of the erosion as well as correcting the condition that caused the erosion should also be part of the erosion repair. Care should be given to ensure design grades and volumes are preserved.

Frequency – Nonroutine – Repair as needed based upon inspections.

RP-3.8.3 Structural Repair

An RP may include a variety of structures that can deteriorate or be damaged during the course of routine maintenance. These structures are constructed of steel and concrete that can degrade or be damaged and may need to be repaired or re-constructed from time to time. These structures include items like outlet works, trickle channels, forebays, inflows and other features. In-house operations staff can perform some of the minor structural repairs. Major repairs to structures may require input from a structural engineer and specialized contractors.

Frequency – Nonroutine – Repair as needed based upon inspections.

Reference:

This Manual is adapted from the City of Colorado Springs "Standard Operation Procedure for Inspection and Maintenance, Extended Detention Basins," May, 2008, which was adapted from SEMSWA (2007) and from the Town of Parker, Colorado (2004), STORMWATER PERMANENT BEST MANAGEMENT PRACTICES (PBMP) LONG-TERM OPERATION AND MAINTENANCE MANUAL

APPENDIX E

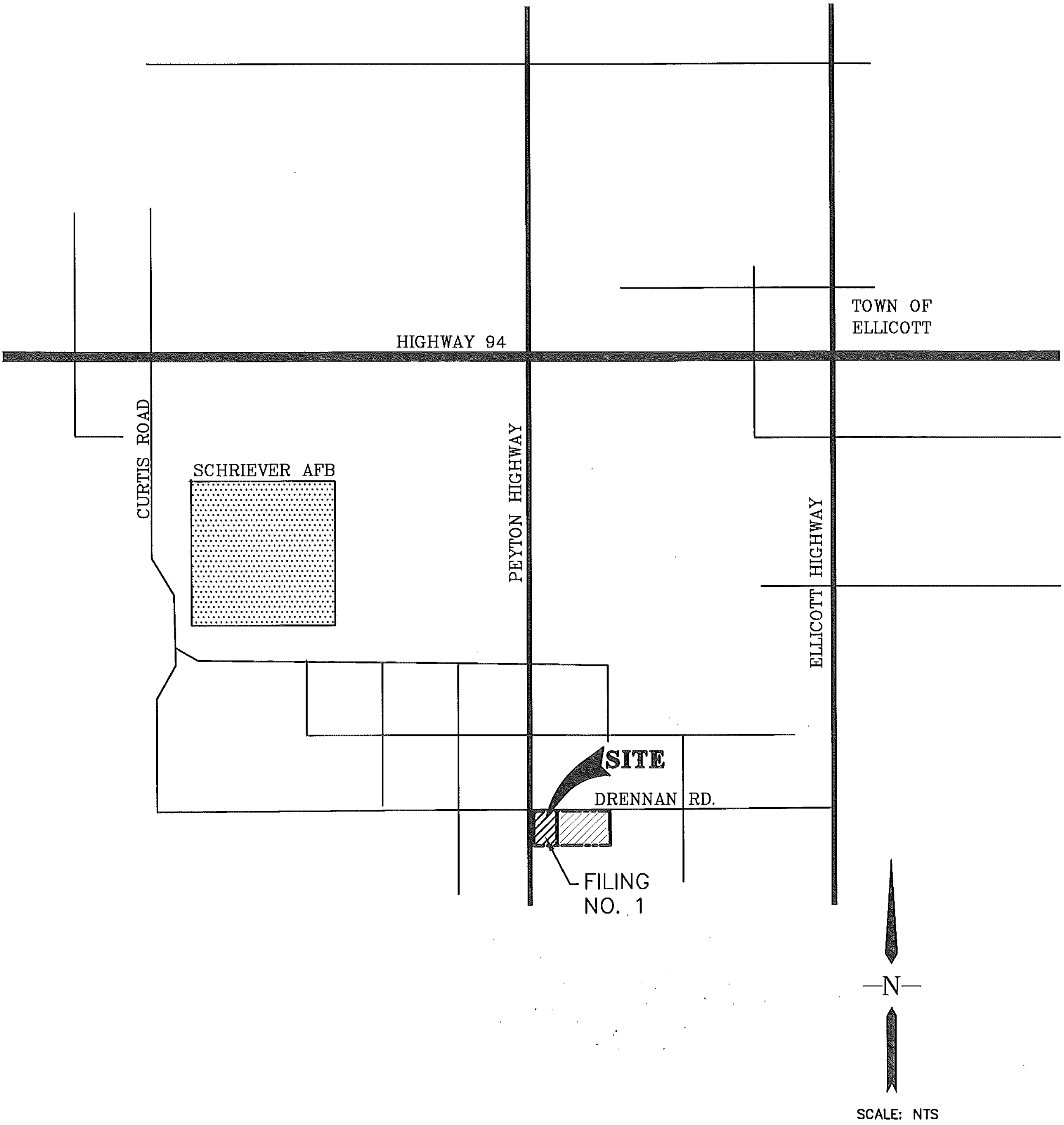
DRAINAGE COST ESTIMATE

SILVERADO RANCH - FILING NO. 1
DRAINAGE IMPROVEMENTS COST ESTIMATE

Item No.	Description	Quantity	Unit	Unit Cost ($$$)	Total Cost ($$$)
	DRAINAGE IMPROVEMENTS				
203	Grass-Lined Drainage Channels	2300	LF	$5	$11,500
506	Riprap Culvert Aprons (d_{50} = 12")	10	CY	$98	$980
603	18" RCP Culvert w/ FES	50	LF	$69	$3,450
603	24" RCP Culvert w/ FES	56	LF	$84	$4,704
	SUBTOTAL				**$20,634**
	Contingency @ 15%				**$3,095**
	TOTAL				**$23,729**

APPENDIX F

FIGURES



J:\jpsprojects\080603.silverado\dwg\Civil\A1-F1.dwg Sep 04, 2008 - 8:12am

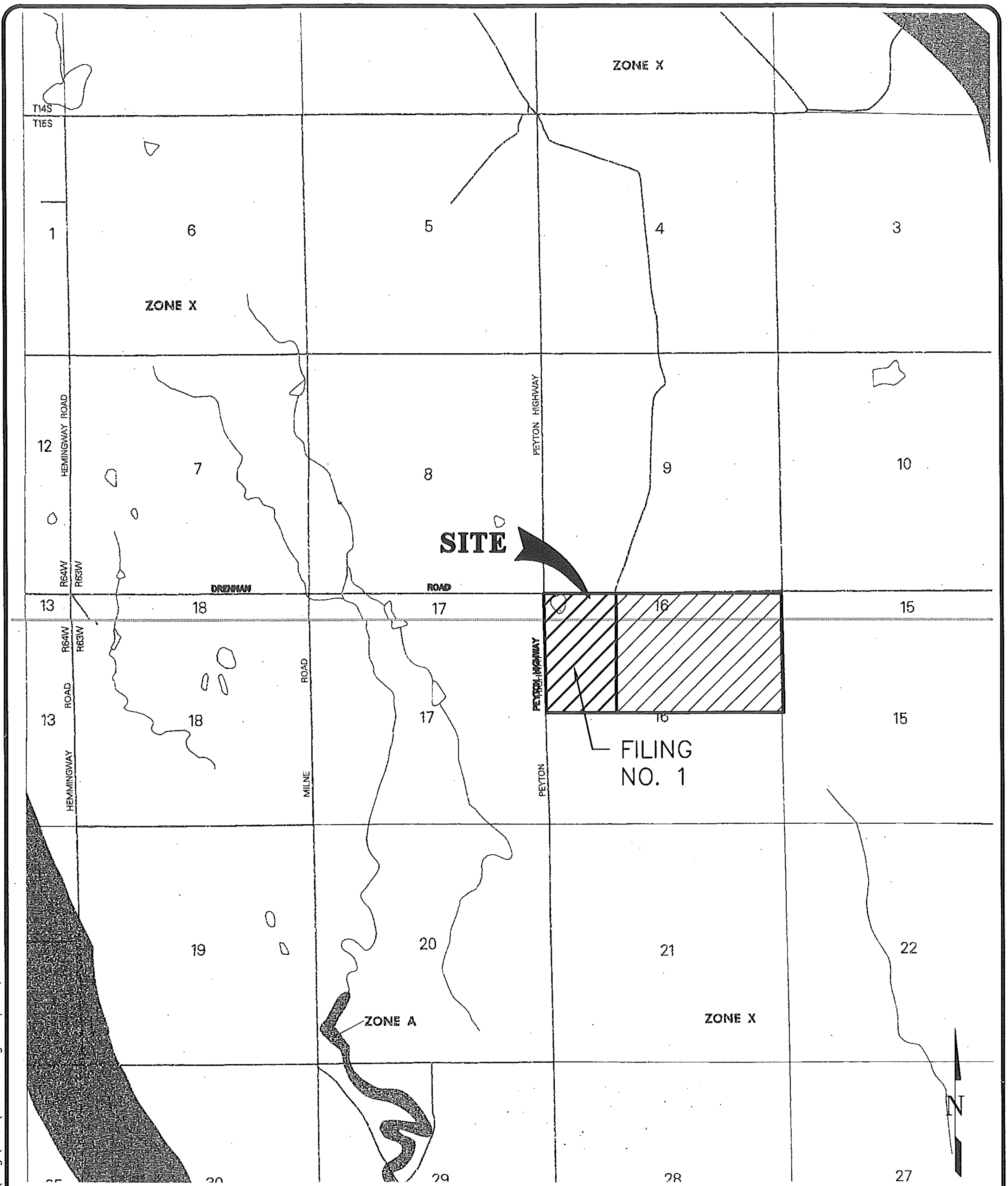
VICINITY MAP

JPS ENGINEERING

SILVERADO RANCH SUBDIVISION - FIL. #1

FIGURE A1

JPS PROJ NO. 080603



EL PASO COUNTY FIRM PANEL 08041C0825 F, & 08041C1025 F, DATED 3/17/97

SCALE: 1"=3000'

J:\jpsprojects\080603.silverado\dwg\Civil\A2-F1.dwg Sep 04, 2008 - 8:15am

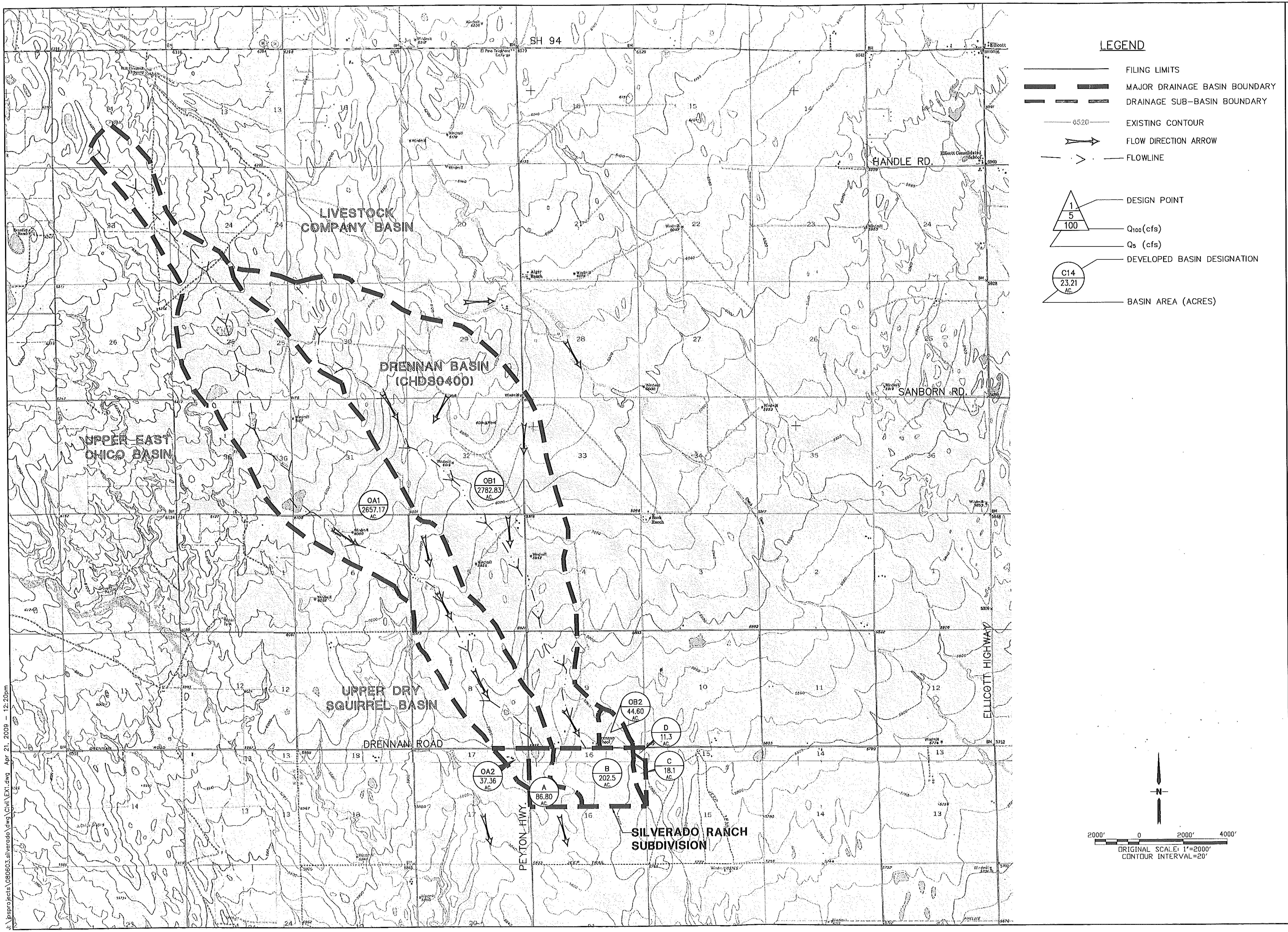
FLOODPLAIN MAP

JPS ENGINEERING

SILVERADO RANCH SUBDIVISION - FIL. #1

FIGURE A2

JPS PROJ NO. 080603



SILVERADO RANCH SUBDIVISION

MAJOR BASIN / HISTORIC DRAINAGE PLAN

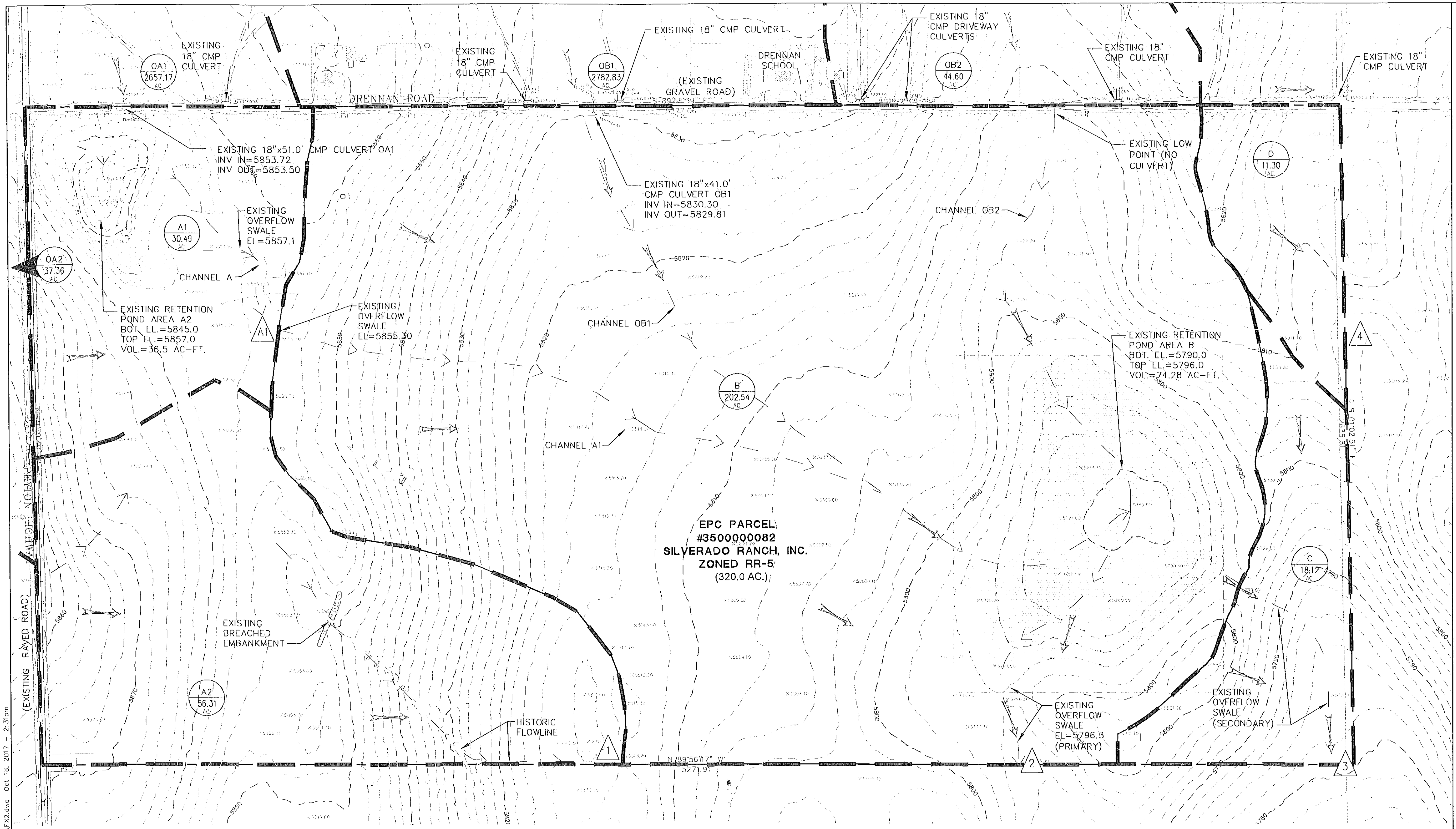
19 E. Willamette Ave.
Colorado Springs, CO
80903

PH: 719-477-9429
FAX: 719-471-0766

No.	REVISION	BY	DATE

HORZ. SCALE: 1"=2000'	DRAWN: RMD
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: UPE	CHECKED: JPS
CREATED: 8/28/06	LAST MODIFIED: 4/21/09
PROJECT NO: 080603	MODIFIED BY: BJJ

SHEET: EX1



EPC PARCEL
#3500000017
STATE OF COLORADO
ZONED RR-5
(320.0 AC.)

LEGEND

— - — - —	FILING LIMITS
▬ ▬ ▬	DRAINAGE BASIN BOUNDARY
——5820——	EXISTING CONTOUR
⇨	FLOW DIRECTION ARROW
—>— —>—	FLOWLINE
△ 1	DESIGN POINT
20.6	Q_5 (cfs)
50.3	Q_{100} (cfs)
C14	DEVELOPED BASIN DESIGNATION
23.21	BASIN AREA (ACRES)

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
A1	4.1	216.6
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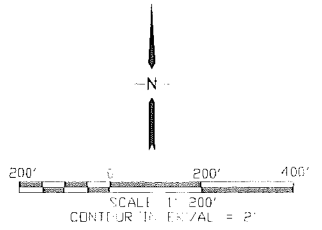
2	0	355.6
3	6.8	17.1
4	8.5	20.2



JPS ENGINEERING

19 E. Willamette Ave.
Colorado Springs, CO
80903

PH: 719-477-9429
FAX: 719-471-0766

SILVERADO RANCH

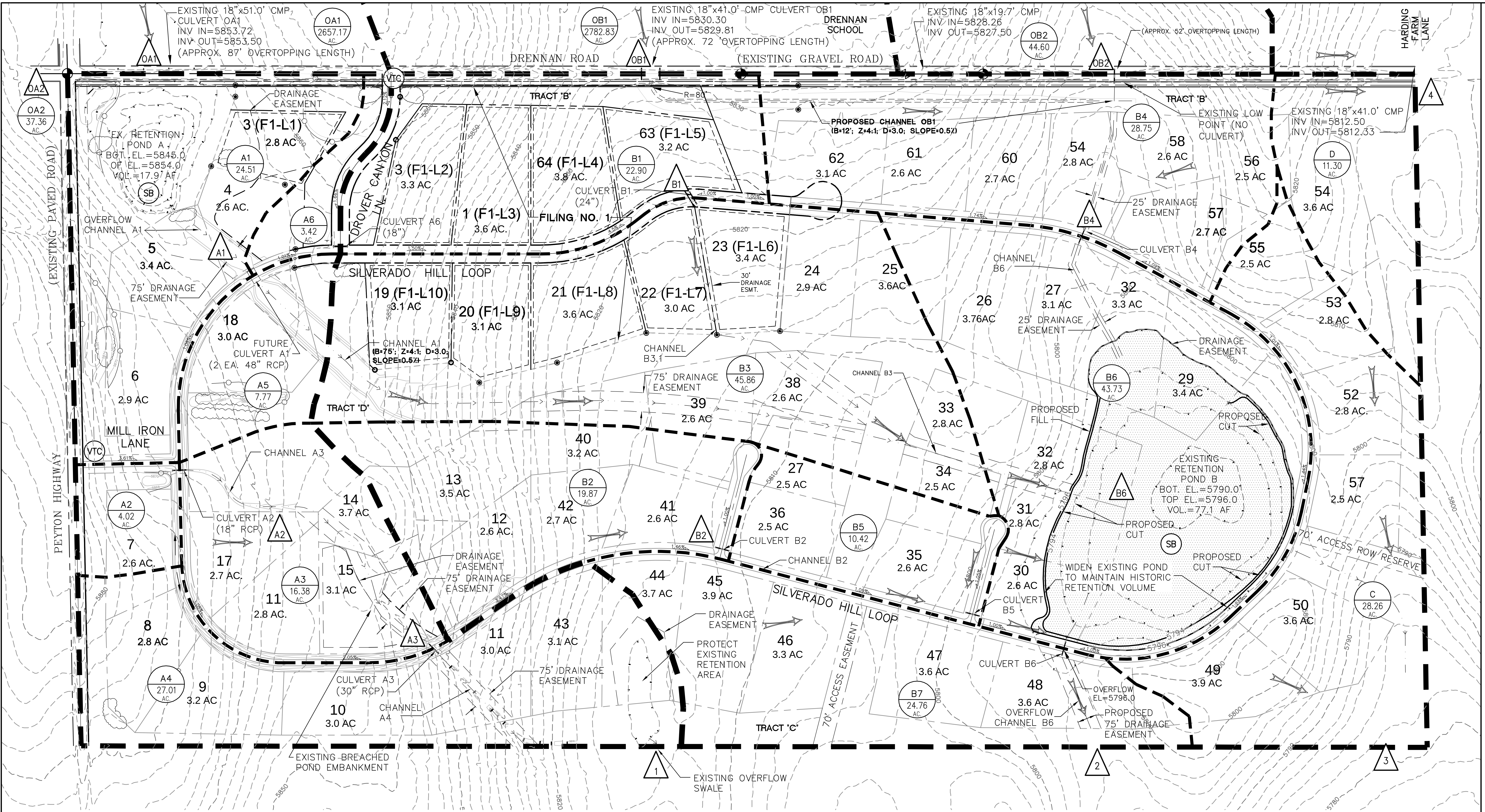
HISTORIC DRAINAGE PLAN

No.	REVISION	BY	DATE

HORZ SCALE: 1"=200'	DRAWN: RMD
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: UPE	CHECKED: JPS
CREATED: 8/28/06	LAST MODIFIED: 10/17/17
PROJECT NO: 080603	MODIFIED BY: MSP

SHEET: EX2

G:\Land Projects 2004\080603.silverado-msp\dwg\Drainage\EX2.dwg Oct 18, 2017 - 2:31pm



LEGEND

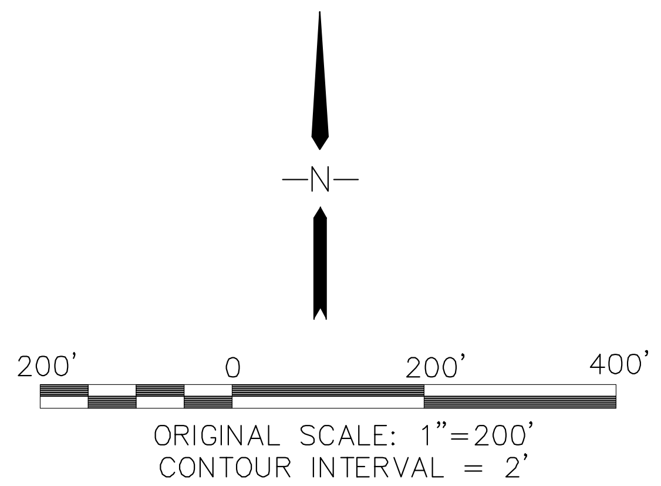
- FILING LIMITS
- MAJOR DRAINAGE BASIN BOUNDARY
- MINOR DRAINAGE BASIN BOUNDARY
- 6520 EXISTING CONTOUR
- FLOW DIRECTION ARROW
- FLOWLINE
- △3 DESIGN POINT
- C14 23.21 AC DEVELOPED BASIN DESIGNATION BASIN AREA (ACRES)

EROSION CONTROL LEGEND:

SF	SILT FENCE
VTC	VEHICLE TRACKING CONTROL PAD
TM	TEMPORARY SEED AND MULCH ON DISTURBED AREAS
IP	INLET PROTECTION
SB	SEDIMENT BASIN
ECB	EROSION CONTROL BLANKETS

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
A2	3.5	8.0
A3	13.6	31.5
1	27.4	64.1
OA1	34.9	263.1
OA2	4.2	28.6
A1	7.2	222.0
OB1	39.0	291.5
OB2	22.3	54.6
B1	19.2	45.1
B2	12.4	29.2
B4	41.9	299.2
B5	15.5	36.8
B6	18.7	77.9
2	12.1	342.2
3	12.3	28.9
4	9.8	22.7



ORIGINAL SCALE: 1"=200'
CONTOUR INTERVAL = 2'

JPS ENGINEERING

19 E. Willamette Ave.
Colorado Springs, CO
80903

PH: 719-477-9429
FAX: 719-471-0766
www.jpsengr.com

CALL UTILITY NOTIFICATION CENTER OF COLORADO
1-800-922-1987
CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

SILVERADO RANCH

No.	REVISION	BY	DATE
△	COUNTY SUBMITTAL	JPS	3/30/18

DEVELOPED DRAINAGE PLAN

HORZ. SCALE: 1"=200'	DRAWN: RMD
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: LWA	CHECKED: JPS
CREATED: 8/28/06	LAST MODIFIED: 4/2/18
PROJECT NO: 080603	MODIFIED BY: MSP

SHEET: D1

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