PRELIMINARY DRAINAGE REPORT

for

EAGLE FOREST SUBDIVISION

Prepared for:

Eagle Forest Development, LLC
4920 Northpark Loop
Colorado Springs, CO 80918

July 20, 2020
Revised November 30, 2020

Prepared by:

JPS ENGINEERING

19 E. Willamette Avenue
Colorado Springs, CO 80903
(719)-477-9429
www.jpsengr.com

JPS Project No. 010501
EPC Project No. PUDSP206

EAGLE FOREST SUBDIVISION
PRELIMINARY DRAINAGE REPORT
TABLE OF CONTENTS

APPENDICES

EAGLE FOREST SUBDIVISION
PRELIMINARY DRAINAGE REPORT
EXECUTIVE SUMMARY

A. Background

- Eagle Forest is a proposed rural residential subdivision of a 44.2-acre parcel located north of Shoup Road in the Black Forest Area of northern El Paso County. This project is the same proposed subdivision that was previously approved by BOCC in 2013, but never recorded.
- The development plan consists of 9 residential lots ranging in size from 2-1/2-acres to approximately 5-acres.
- JPS Engineering previously completed a "Final Drainage Report for Eagle Forest Subdivision" dated March 6, 2013, which was approved by El Paso County in support of the previous subdivision application. The current subdivision proposal and drainage plan is entirely in conformance with the previously approved drainage report for the site.

B. General Drainage Concept

- Developed drainage within the site will be conveyed through paved streets with roadside ditches and culverts, as well as grass-lined channels through open space areas following historic drainage patterns through the site.
- Developed runoff from Eagle Forest Subdivision will flow in a southwesterly direction, feeding into the existing main channel of Burgess Creek. Impacts of developed flows from the proposed subdivision will be mitigated through an on-site stormwater detention pond near the northwest corner of the parcel.

C. Drainage Impacts

- The proposed detention pond will release historic flows at the westerly property boundary, ensuring no increase in developed flow to downstream properties. Additionally, rain gardens will be constructed in selected locations to provide water quality treatment for roadway improvements.
- Drainage facilities within public road rights-of-way will be designed and constructed to El Paso County standards, and these facilities will be owned and maintained by the County upon acceptance.
- Drainage facilities such as swales running through private lots will be owned and maintained by the private lot owners or the Homeowners Association (HOA). The proposed private stormwater detention pond will be privately owned and maintained by the HOA.

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

____

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:

____

Date

Eagle Forest Development, LLC
4920 Northpark Loop
Colorado Springs, CO 80918

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.

____

Jennifer Irvine, P.E. Date
County Engineer / ECM Administrator

Conditions:

I. GENERAL LOCATION AND DESCRIPTION

A. Background

Eagle Forest Subdivision is a proposed rural residential development located in northeastern El Paso County, Colorado. The Eagle Forest parcel (El Paso County Assessor's Number 52080-00-071) is located on the north side of Shoup Road between Black Forest Road and Herring Road, as shown in Figure A1 (Appendix F). Eagle Forest Subdivision will consist of 9 residential lots on a 44.2-acre parcel. This subdivision was reviewed and approved by the Board of County Commissioners in 2013, but the subdivision was never recorded. Since the allowable time between approval and recording has elapsed, the new owners are processing a new Preliminary Plan and Final Plat for the subdivision. There are no significant changes from the previously approved subdivision proposal.

B. Scope

This report will provide a summary of site drainage issues impacting the proposed residential development. The report will analyze impacts from upstream drainage patterns, site-specific developed drainage patterns, and impacts on downstream facilities. This report is based on the guidelines and criteria presented in the El Paso County Drainage Criteria Manual.

C. Site Location and Description

The Eagle Forest parcel is located in the southeast quarter (SE1/4) of Section 8, Township 12 South, Range 65 West of the 6th Principal Meridian. The majority of the site is currently a vacant forest tract, with one existing residence and several accessory buildings located in the southwest corner of the property. The parcel was previously re-zoned from RR-3 (rural residential; 5-acre minimum lot sizes) to Planned Unit Development (PUD), allowing for 2.5–acre minimum lot sizes in combination with dedicated open space areas. A new public road extending north from Shoup Road will provide access to the subdivision. Associated site improvements will include grading, paving, and utility service improvements for the nine residential lots.

The parcel is bordered by existing rural residential lots on all sides, consisting of 5-acre minimum lot sizes. Shoup Road borders the south boundary of the parcel. Ground elevations within the site range from approximately 7,390 to 7,490 feet above mean sea level.

The site is located near the upstream end of the Kettle Creek Drainage Basin, and the site is bi-sected by the Burgess Creek channel, which is tributary to Kettle Creek. The terrain is rolling with average grades ranging from 2 to 15 percent. The site was historically a heavily forested area until the majority of trees within the property burned in the 2013 Black Forest Fire. The site is currently re-vegetated with meadow grasses.

D. General Soil Conditions

According to the Soil Survey of El Paso County prepared by the Soil Conservation Service (SCS), on-site soils are comprised of Type 40/41, "Kettle gravelly loamy sand" (see Appendix A). These soils are classified as hydrologic soils group "B," with rapid permeability, medium surface runoff characteristics, and moderate hazard of erosion.

The existing channel flowing southwesterly through the site has several segments with incised channel banks and some evidence of erosive conditions. The existing channel will be located within a dedicated open space area, and no development activity is planned in close proximity to the existing drainage channel, with the exception of a new culvert crossing for the public road extension northerly into the site.

E. References

City of Colorado Springs & El Paso County "Drainage Criteria Manual," revised October 12, 1994.

City of Colorado Springs "Drainage Criteria Manual, Volumes 1 and 2," revised May, 2014.

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

FEMA, Flood Insurance Rate Map (FIRM) Number 08041C0315G, December 7, 2018.

JPS Engineering, Inc., "Preliminary Drainage Report for Eagle Forest Subdivision," August 28, 2007 (approved by El Paso County September 14, 2007).

JPS Engineering, Inc., "Final Drainage Report for Eagle Forest Subdivision," March 6, 2013 (approved by El Paso County April 18, 2013).

USDA Natural Resources Conservation Service, "Soil Survey of El Paso County Area, Colorado," July 19, 2020.

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Basin Description

The proposed development lies completely within the Kettle Creek Drainage Basin (FOM 03000) as classified by El Paso County. Drainage from an off-site basin east of this site flows southwesterly across this site in the Burgess Creek channel, which ultimately flows to a downstream confluence with the main channel of Kettle Creek.

B. Floodplain Impacts

The project site is located beyond the limits of any 100-year floodplain delineated by the Federal Emergency Management Agency (FEMA). The floodplain limits in the vicinity of the site are shown in Flood Insurance Rate Map (FIRM) Panel Numbers 08041C0315G and 08041C0320G dated December 7, 2018 (see Firmette Exhibit in Appendix F).

C. Sub-Basin Description

The existing drainage basins lying in and around the proposed development are depicted in Figure EX1 (Appendix F). The site is impacted by a large off-site drainage basin to the east, flowing through the Burgess Creek channel towards the southwest corner of the site. The existing on-site topography has been delineated as three drainage basins, as shown in Figure EX2 (Appendix F). Basin A contributes flow to the Burgess Creek channel, while Basins B and C drain towards the westerly boundary of the parcel. The natural drainage patterns will be impacted through development by site grading and concentration of runoff in subdivision streets. Developed runoff will generally continue to follow historic paths.

III. DRAINAGE DESIGN CRITERIA

A. Development Criteria Reference

No Drainage Basin Planning Study (DBPS) has been completed for the Kettle Creek Drainage Basin. No Master Development Drainage Plan (MDDP) reports were found for any adjacent subdivisions.

B. Hydrologic Criteria

SCS procedures were utilized for analysis of the major off-site 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
- Storm distribution SCS Type IIA (eastern Colorado)
- 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 60-61 (meadow/forest)
- SCS curve number - developed conditions 98 (paved areas)

Rational Method procedures were utilized for calculation of peak flows within the smaller on-site drainage basins (basins less than 100 acres). 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 (300' max. developed)	
• 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 meadow/range areas	0.08	0.35
• Runoff Coefficients - developed:		
Proposed residential areas (5-acre lots)	0.137	0.392

Composite runoff curve numbers and runoff coefficients were calculated for the existing and proposed drainage basins, as detailed in Appendix B. Hydrologic calculations are enclosed in Appendix B, and peak design flows are identified on the drainage basin drawings.

IV. DRAINAGE PLANNING FOUR STEP PROCESS

El Paso County Drainage Criteria require drainage planning to include a Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

As stated in the El Paso County Engineering Criteria Manual (ECM Appendix 1.7.2.), the Four Step Process is applicable to all new and re-development projects with construction activities that disturb 1 acre or greater or that disturb less than 1 acre but are part of a larger common plan of development. The Four Step Process has been implemented as follows in the planning of this project:

Step 1: Employ Runoff Reduction Practices

- Minimize Impacts: The proposed rural residential subdivision development with 5-acre minimum lot sizes provides for inherently minimal drainage impacts based on the limited impervious areas associated with rural residential development.
- Minimize Directly Connected Impervious Areas (MDCIA): The rural residential development will have roadside ditches along all roads, providing for impervious areas to drain across pervious areas. Based on the roadside ditches throughout the subdivision, the subdivision is classified as MDCIA Level One.
- Grass Swales: The proposed rural residential roads will have grass-lined roadside ditches to encourage stormwater infiltration.

Step 2: Stabilize Drainageways

- Proper erosion control measures will be implemented along the roadside ditches and grass-lined drainage channels to provide stabilized drainageways within the site.

Step 3: Provide Water Quality Capture Volume (WQCV)

- FSD: A Full-Spectrum Detention Pond will be provided at the west boundary of the site to address the developed flow impacts from Basins B1-B2. On-site drainage will be routed through the extended detention basin, which will capture and slowly release the WQCV over an extended release period.
- The proposed subdivision consists of large rural residential lots (>2.5-acre minimum lot sizes), so the single family lots are excluded from water quality requirements per ECM Section I.7.1.B.5.
- Rain Gardens will be provided in selected locations to mitigate drainage impacts from the subdivision roadway improvements.
- ECM Section I.7.1.C.4. specifies that stormwater from a developed site must not discharge to a water of the state before being discharged to a WQCV control measure. The Burgess Creek channel flowing through this site is not delineated as a FEMA 100-year floodplain, so our understanding is that this channel is not classified as a "water of the state."

Step 4: Consider Need for Industrial and Commercial BMPs

- No industrial or commercial land uses are proposed within this rural residential subdivision.

V. GENERAL DRAINAGE RECOMMENDATIONS

The developed drainage plan for the site is to provide and maintain positive drainage away from structures and conform to the established drainage patterns for the overall site. JPS Engineering recommends that positive drainage be established and maintained away from all structures within the site in conformance with applicable building codes and geotechnical engineering recommendations.

Site grading and drainage improvements performed as a part of subdivision infrastructure development includes public road improvements and limited overlot grading as depicted on the subdivision construction drawings. Individual lot grading is the sole responsibility of the individual builders and property owners. Final grading of each home site should establish proper protective slopes and positive drainage in accordance with HUD guidelines and building codes. In general, main floor elevations for each home should be established a minimum of 2 feet above the top of curb (finished grade) of the adjoining street.

In general, we recommend a minimum of 6 inches clearance from the top of concrete foundation walls to adjacent finished site grades. Positive drainage slopes should be maintained away from all structures, with a minimum recommended slope of 5 percent for the first 10 feet away from buildings in landscaped areas, a minimum recommended slope of 2 percent for the first 10 feet away from buildings in paved areas, and a minimum slope of 1 percent for paved areas beyond buildings.

VI. DRAINAGE FACILITY DESIGN

A. General Concept

Development of the proposed subdivision will require site grading and paving work within nine residential lots, resulting in additional impervious areas across the site. The general concept for management of developed storm runoff is to grade the home sites to provide positive drainage away from the building pads, and divert runoff to the proposed roadside ditches and existing grass-lined swales running through the property. A stormwater detention pond will be constructed near the northwesterly corner of the site to attenuate developed flows to historic rates leaving the site. Additionally, rain gardens will be constructed in selected locations to mitigate water quality impacts from roadway improvements.

B. Specific Details

1. Existing Drainage Conditions

Historic drainage conditions are depicted in Figure EX1. The Burgess Creek channel is the primary existing drainage facility within the parcel. Off-site flows from Basins OA1 and OA2 combine with on-site drainage from Basin A, flowing through the Burgess Creek channel to Design Point #1 at the southwest corner of the site, with historic peak flows (SCS Method) of Q_5 = 67.7 cfs and Q_{100} = 287.1 cfs. Basin B flows towards the northwest corner of the site, with historic peak flows (Rational Method) of Q_5 = 3.1 cfs and Q_{100} = 22.9 cfs at Design Point #2. Basin C sheet flows towards the westerly site boundary, with historic peak flows (Rational Method) of Q_5 = 0.6 cfs and Q_{100} = 4.5 cfs at Design Point #3.

2. Developed Drainage Conditions

The developed drainage basins and projected flows are shown in the Developed Drainage and Erosion Control Plan (Figure D1, Appendix A). Off-site flows from Basins OA1 and OA2 will continue to combine with on-site drainage from Sub-Basins A1-A3, flowing through the Burgess Creek channel to Design Point #1, with developed peak flows (SCS Method) of Q_5 = 68.1 cfs and Q_{100} = 285.2 cfs.

A 24-inch culvert will be installed where flows from Off-Site Basin OA2 crosses Eagle Forest Drive (new public road). A 60-inch culvert will be installed where the main channel of Burgess Creek crosses Eagle Forest Drive.

Sub-Basins B1-B3 will combine at Design Point #2, with developed peak flows (Rational Method) of Q_5 = 6.0 cfs and Q_{100} = 28.7 cfs. An 18-inch culvert will be installed where Sub-

Basin B1 crosses Eagle Forest Drive. A drainage detention pond will be constructed at Design Point #B2 (within a drainage easement on Lot 5), with the pond outlet structure designed to maintain historic flows discharging to the existing swale west of the site.

Basin C will continue sheet flowing towards the westerly site boundary, with developed peak flows (Rational Method) of Q_5 = 1.1 cfs and Q_{100} = 5.2 cfs at Design Point #3, representing an insignificant increase in comparison to historic flows.

C. Comparison of Developed to Historic Discharges

Based on the hydrologic calculations in Appendix B, the total undetained flow from the site would slightly exceed historic flow from the site. The increase in developed flow will be mitigated through an on-site detention pond. 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_5/Q_{100}, cfs)
	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)	Area (ac)	Q_5 (cfs)	Q_{100} (cfs)	
1	336.9	67.7	287.1	336.9	68.1	285.2	+0.4 / -1.9 (negligible change)
2 (dev)	17.4	3.1	22.9	17.5	6.0	28.7	+2.9 / +5.8 (increase)
2 (det)	17.4	3.1	22.9	17.5	3.3	21.2	+0.2 / -1.7 (decrease)
3	2.2	0.6	4.5	2.2	1.1	5.2	+0.5 / +0.7 (negligible increase)

Based on the large size of the off-site basin draining through the site in comparison the relatively small developed flow impact, the increase in 100-year flow in the main channel is negligible at Design Point #1.

D. Stormwater Detention and Water Quality

Detention Pond

The total developed storm runoff downstream of Design Point 2 will be maintained at historic levels by constructing a stormwater detention pond located near the northwest corner of the property. Detention Pond B will be constructed as Full-Spectrum Detention (FSD) Pond to mitigate developed flow and water quality impacts from Basins B1-B2. The pond outlet structure has been designed to detain the full spectrum of storm events, as well as provide water quality.

The detention pond will be placed in a dedicated drainage easement, and maintenance access to the pond will be provided directly from Eagle Forest Drive. The proposed detention pond will be privately owned and maintained by the subdivision homeowners association (HOA).

The proposed detention pond has been sized based on the impervious areas for developed Basin B.

Detailed pond routing calculations have been performed utilizing the Denver Urban Drainage and Flood Control District "UD-Detention_v3.07" software package (see Appendix D1). The pond outlet structure configuration has been designed to maintain the calculated pond discharge below the target outflow while maintaining the maximum water surface elevation below the pond spillway.

Detention pond design parameters are summarized as follows:

Pond	Min. 100-Yr FSD Volume (ac-ft)	Design Volume (ac-ft)	Outlet Structure
Pond B	0.27	0.6	12-inch SD w/ orifice plate

Water Quality Facilities

The Eagle Forest Subdivision will implement permanent water quality facilities in two locations to satisfy current County stormwater quality requirements for roadway improvements. The two proposed rain gardens will provide water quality mitigation for the segment of Eagle Forest Drive within Basins A1 and A3 on the north side of the Burgess Creek channel. The limited area of roadway improvements excluded from water quality measures at the south end of Eagle Forest Drive (Basins OA2 and A2) is less than one acre and within the allowable ECM limits in the County ECM.

The proposed drainage and grading plan for this site includes a Rain Garden (RG) along the east side of Eagle Forest Drive on the north side of the Burgess Creek channel to provide the required stormwater quality mitigation to address the roadway construction impacts within Basin A1.1. According to the calculations in Appendix D2, the required Water Quality Capture Volume (WQCV) for Design Point A1.1 is 589 cubic feet, and the proposed Rain Garden A1.1 provides a volume of 625 cubic feet.

An additional Rain Garden (RG) will be constructed along the west side of Eagle Forest Drive on the north side of the Burgess Creek channel to provide the required stormwater quality mitigation to address the roadway construction impacts within Basin A3.1. According to the calculations in Appendix D2, the required Water Quality Capture Volume (WQCV) for Design Point A3.1 is 540 cubic feet, and the proposed Rain Garden A3.1 provides a volume of 625 cubic feet.

The proposed stormwater quality facilities will be privately owned and maintained by the subdivision homeowners association (HOA), and maintenance access is readily available from the adjoining public roads.

E. On-Site Drainage Facility Design

Developed sub-basins and proposed drainage improvements are depicted on the enclosed Drainage Plan (Sheet D1). In accordance with El Paso County standards, new roadways 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.

While further review of the hydraulic design will be provided with the final plat application, preliminary hydraulic calculations for sizing of on-site drainage facilities are enclosed in Appendix C and design criteria are summarized as follows:

1. Culverts

The road system will be graded to convey surface drainage in 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. Preliminary 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 design parameters are tabulated in Appendix C.

2. Open Channels

Open space tracts and drainage easements will be dedicated along major drainage channels following historic drainage paths through the subdivision. These channels are generally grass-lined channels sized for adequate conveyance of 100-year flows.

Design criteria for new channels include a trapezoidal cross-section, variable bottom width and depth, 3:1 maximum side slopes, 1-foot minimum freeboard, and a minimum slope of 0.5 percent.

The existing and proposed drainage channels have been evaluated utilizing Manning's equation for open channel flow, assuming a friction factor ("n") of 0.030 for new dry-land grass channels, and a Manning's "n" of 0.045 for existing highly vegetated channels. Maximum allowable velocities have been evaluated based on El Paso County drainage criteria, generally allowing for a maximum 100-year velocity of 5 feet per second. The proposed channels will be seeded with native grasses for erosion control. Erosion control blanket / turf reinforcement mat linings have been specified where required along the roadside ditches based on erosive velocities. Ditch flows will be diverted to drainage channels at the nearest practical location to minimize excessive roadside ditch sizes. Detailed channel hydraulic calculations are enclosed in Appendix C).

The proposed development plan for Eagle Forest Subdivision provides a substantial open space buffer (Tract A) along the existing Burgess Creek Channel running through the site, with the intention of protecting this existing greenway and drainage corridor. While the major channel will generally be protected from development impacts, selective channel improvements will be implemented to maintain a stable channel running through the site. Bank stabilization improvements will include laying back excessively steep slopes along the channel walls in selected locations to mitigate erosion concerns. Additionally, fill will be placed to repair eroded areas of the channel bottom in a few selected areas. Based on the highly vegetated condition of the existing channel, development and construction impacts to the existing natural channel will be minimized.

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 majority of the proposed subdivision is located within Basin A, which drains to the existing Burgess Creek channel running through the site. The existing channel is generally vegetated, and the channel is in reasonably stable condition. An existing bridge crosses Shoup Road immediately downstream of this site. The existing bridge is a single-span structure with a clear opening of approximately 27-feet wide by 14-feet high. According to the calculations in Appendix C, the existing bridge has a hydraulic capacity in excess of 4,000 cfs, so the bridge appears to be more than adequate to convey the calculated 100-year flows without overtopping.

As previously stated, based on the large size of the off-site basin draining through the site in comparison the relatively small developed flow impact, the increase in 100-year flow in the main channel is negligible. As such, development within Basin A will have no significant impact on existing downstream drainage facilities.

The existing natural swale west of Basin B runs through several private ranch and rural residential properties downstream. Although the proposed rural residential development within Basin B will consist of low-density lots, additional impervious areas will result in increased developed flows at Design Point #2. The proposed stormwater Detention Pond B has been designed to mitigate the impacts of developed flows from this site, so that historic flows are maintained discharging to the existing natural swale downstream of Basin B. The existing downstream drainage swale is a grass-lined channel in stable condition. A riprap outlet apron will be provided at the downstream end of the pond discharge pipe to mitigate the concentration of flow at the discharge point.

G. Anticipated Drainage Problems and Solutions

The proposed construction of the stormwater Detention Pond B is designed to mitigate the impacts of developed drainage from this project. The overall drainage plan for the subdivision includes a system of roadside ditches, channels, and culverts to convey developed flows through the site. The primary drainage problems anticipated within this development will consist of maintenance of these drainage channels, culverts, and detention pond facilities. Care will need to be taken to implement proper erosion control measures in the proposed roadside ditches, channels, and swales. Ditches will be designed to meet allowable velocity criteria. Erosion control mats, ditch checks, and/or riprap channel lining will be installed where necessary to minimize erosion concerns. Proper construction and maintenance of the proposed detention facility will minimize downstream drainage impacts. Proposed drainage facilities outside the public right-of-way will be owned and maintained by the subdivision HOA or individual lot owners.

VII. EROSION CONTROL / SEDIMENT CONTROL

Best management practices (BMP's) will be implemented for erosion control during construction. The preliminary erosion control plan for Eagle Forest Subdivision is shown in Figure D1. Erosion control measures will include installation of silt fence at the toe of disturbed slopes, straw or hay bales protecting drainage ditches, vehicle tracking control pads at access points, and revegetation of disturbed areas. Cut slopes will be stabilized during excavation as necessary and vegetation will be re-established as soon as possible for stabilization of the graded areas. The proposed detention pond will also serve as a sediment basin during construction and future operations.

VIII. COST ESTIMATE AND DRAINAGE FEES

The developer will be responsible for all construction costs associated with the proposed roadway, drainage, and subdivision infrastructure improvements. As detailed in Appendix E, the estimated non-reimbursable cost of proposed drainage improvements is approximately $79,635.

The site lies completely within the Kettle Creek Drainage Basin (FOM 03000), which has a 2020 basin fee of $10,305 per impervious acre and no bridge fee requirement. Drainage basin fees are calculated as follows:

> Average residential lot size = 5 acre/lot
> Subdivision Area = 44.19 acres
> Percent impervious = 7.0%
> Total Impervious area = (7.0% * 44.19 ac.) = 3.09 ac.
> Adjusted Impervious area = (3.09 ac) * 75% = 2.32 ac.
> (includes 25% reduction in drainage fees for 5-acre lots)
> **Drainage Basin Fee = (2.32 ac.) @ $10,305 ac. = <u>$23,907.60</u>**

IX. SUMMARY

Development of the proposed 44-acre Eagle Forest Subdivision will result in a minor increase in developed runoff from the site, which will be mitigated by construction of an on-site stormwater detention pond near the westerly boundary of the parcel. Additionally, two rain gardens will be constructed to meet current County stormwater quality requirements. The proposed rural residential subdivision (gross density of 5-acres per lot) is consistent with the surrounding zoning and character of this site.

The proposed drainage patterns will remain consistent with historic conditions, and new drainage facilities will be constructed to El Paso County standards to safely convey runoff to adequate outfalls. Construction and proper maintenance of the proposed drainage facilities and stormwater detention pond, in conjunction with proper erosion control measures, will ensure that this development has no significant adverse drainage impact on downstream properties.

APPENDIX A

SOILS INFORMATION

United States Department of Agriculture

NRCS

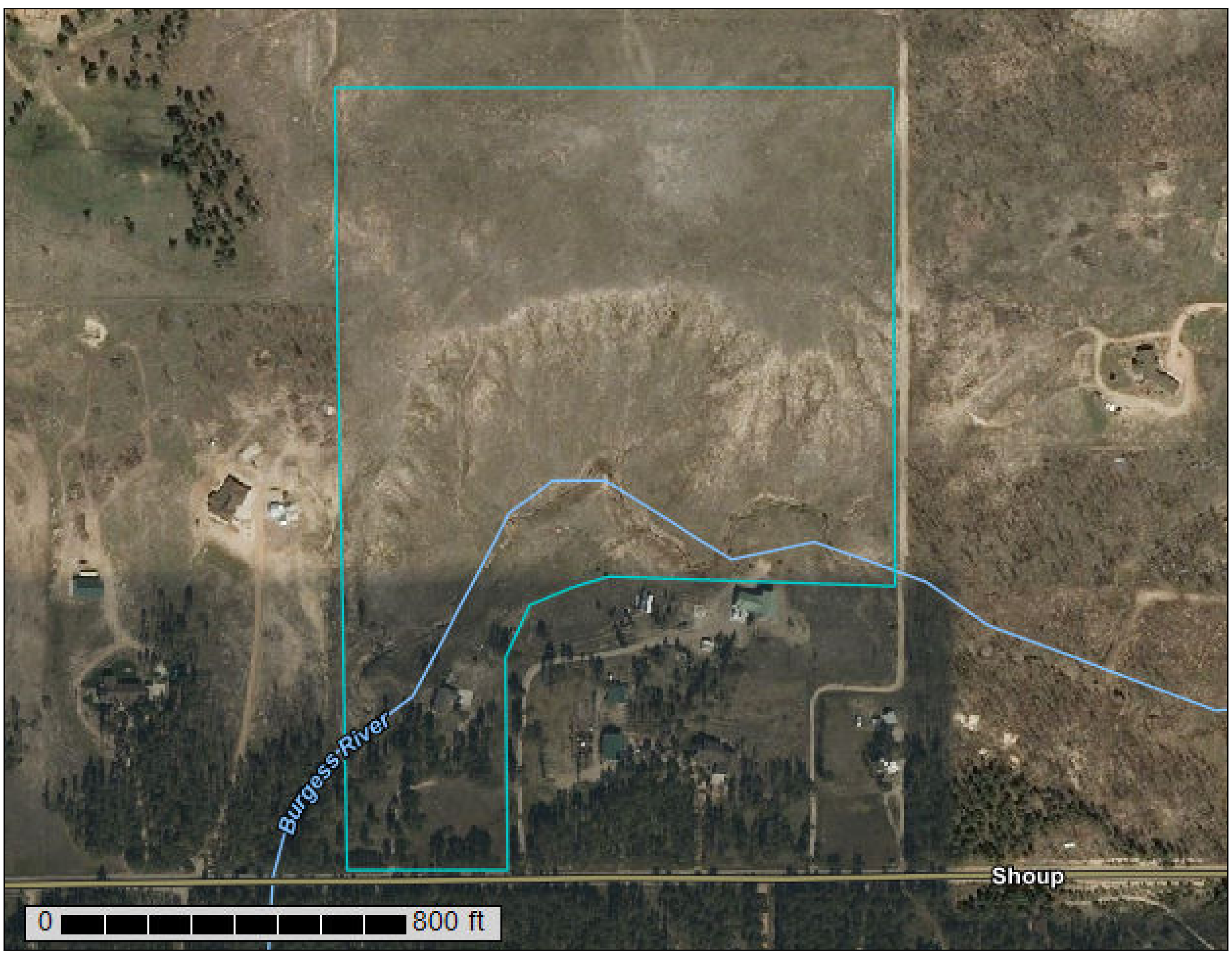
Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

El Paso County Area, Colorado

Eagle Forest



July 19, 2020

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

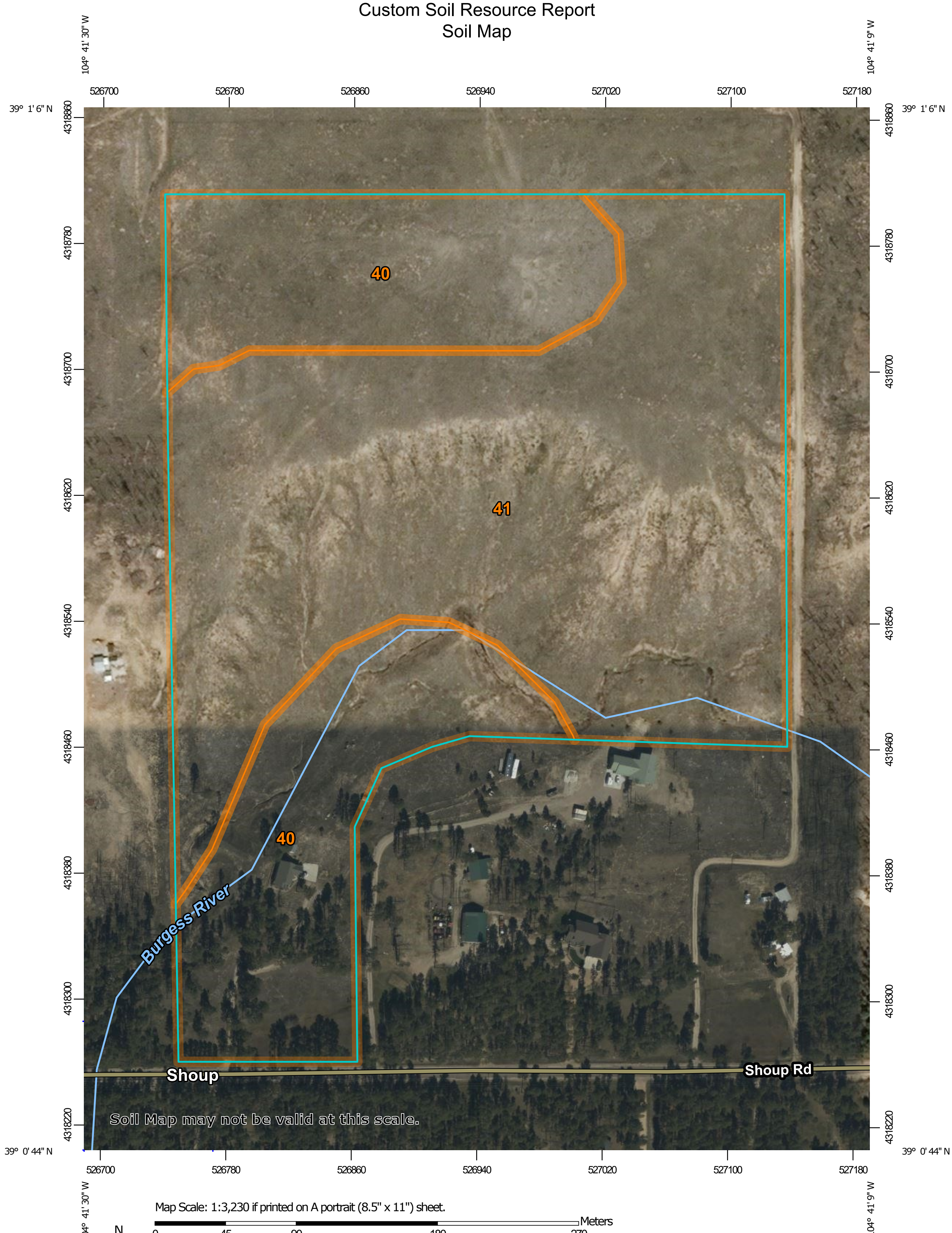
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:3,230 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 45, 90, 180, 270

Feet: 0, 150, 300, 600, 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 18, Jun 5, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 8, 2018—May 26, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	14.9	37.2%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	25.1	62.8%
Totals for Area of Interest		**40.0**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

El Paso County Area, Colorado

40—Kettle gravelly loamy sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 368g
Elevation: 7,000 to 7,700 feet
Farmland classification: Not prime farmland

Map Unit Composition

Kettle and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kettle

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from arkose

Typical profile

E - 0 to 16 inches: gravelly loamy sand
Bt - 16 to 40 inches: gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

41—Kettle gravelly loamy sand, 8 to 40 percent slopes

Map Unit Setting

National map unit symbol: 368h
Elevation: 7,000 to 7,700 feet
Farmland classification: Not prime farmland

Map Unit Composition

Kettle and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kettle

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from arkose

Typical profile

E - 0 to 16 inches: gravelly loamy sand
Bt - 16 to 40 inches: gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 8 to 40 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Other soils

Percent of map unit:
Hydric soil rating: No

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

APPENDIX B

HYDROLOGIC CALCULATIONS

Table 6-6. Runoff Coefficients for Rational Method
(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis-- Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

$$t_c = t_i + t_t \quad \text{(Eq. 6-7)}$$

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

t_t = travel time in the ditch, channel, gutter, storm sewer, etc. (min)

3.2.1 Overland (Initial) Flow Time

The overland flow time, t_i, may be calculated using Equation 6-8.

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad \text{(Eq. 6-8)}$$

Where:

t_i = overland (initial) flow time (min)
C_5 = runoff coefficient for 5-year frequency (see Table 6-6)
L = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)
S = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time, t_t, which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time, t_t, can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad \text{(Eq. 6-9)}$$

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

Table 6-7. Conveyance Coefficient, C_v

Type of Land Surface	C_v
Heavy meadow	2.5
Tillage/field	5
Riprap (not buried)*	6.5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

* For buried riprap, select C_v value based on type of vegetative cover.

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration (t_c) is then the sum of the overland flow time (t_i) and the travel time (t_t) per Equation 6-7.

3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \quad \text{(Eq. 6-10)}$$

Where:

t_c = maximum time of concentration at the first design point in an urban watershed (min)

L = waterway length (ft)

Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional “calibration” of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

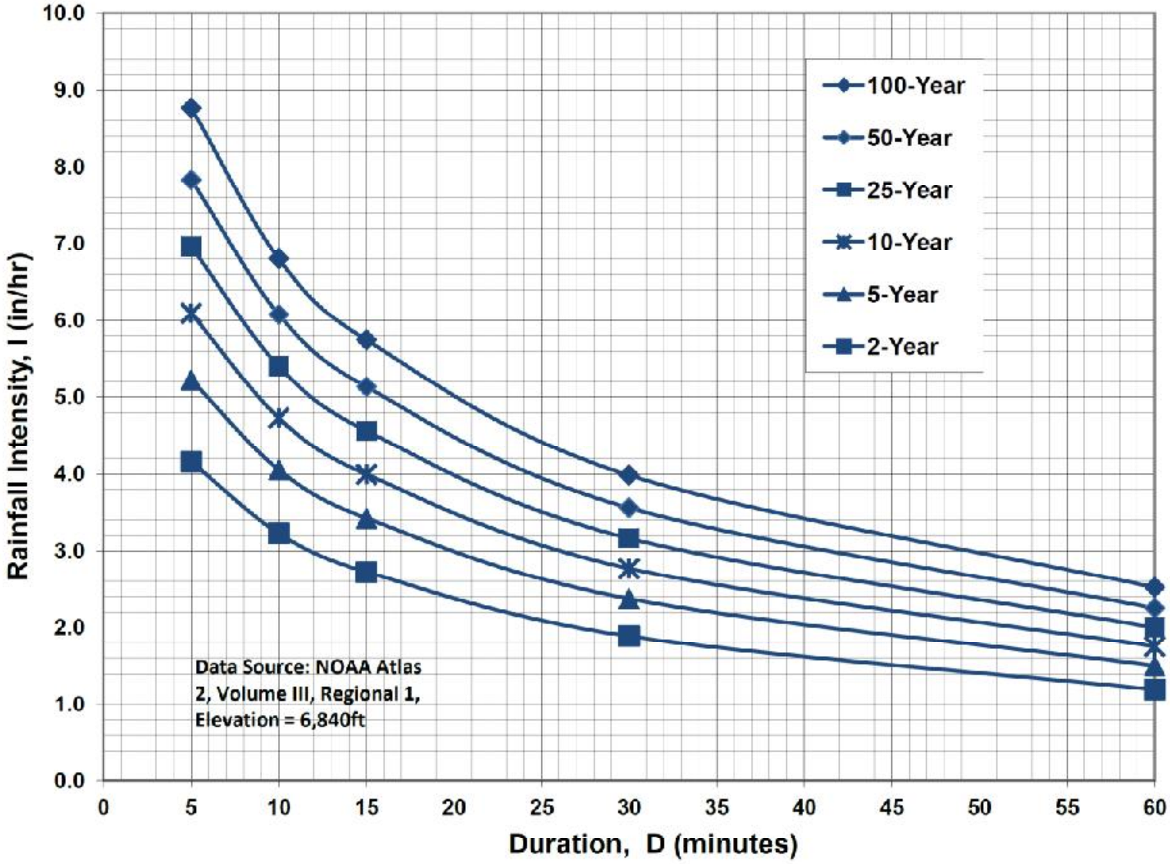
3.2.4 Minimum Time of Concentration

If the calculations result in a t_c of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum t_c for urbanized areas is 5 minutes.

3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

$$I_{100} = -2.52 \ln(D) + 12.735$$

$$I_{50} = -2.25 \ln(D) + 11.375$$

$$I_{25} = -2.00 \ln(D) + 10.111$$

$$I_{10} = -1.75 \ln(D) + 8.847$$

$$I_{5} = -1.50 \ln(D) + 7.583$$

$$I_{2} = -1.19 \ln(D) + 6.035$$

Note: Values calculated by equations may not precisely duplicate values read from figure.

EAGLE FOREST
COMPOSITE RUNOFF COEFFICIENTS

HISTORIC CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	SOIL TYPE	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1	297.5	B	100.00	5-AC LOTS (ZONED RR5)	0.137							0.137
A1	21.6	B	100.00	MEADOW	0.080							0.080
OA2	15.5	B	100.00	5-AC LOTS (ZONED RR5)	0.137							0.137
A2	2.3	B	100.00	5-AC LOT	0.137							0.137
OA1,OA2,A1,A2	336.9	B										0.133
B	17.4	B	100.00	MEADOW	0.080							0.080
C	2.2	B	100.00	MEADOW	0.080							0.080

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	SOIL TYPE	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	AREA (%)	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1	297.5	B	100.00	5-AC LOTS (ZONED RR5)	0.392							0.392
A1	21.6	B	100.00	MEADOW	0.350							0.350
OA2	15.5	B	100.00	5-AC LOTS (ZONED RR3)	0.392							0.392
A2	2.3	B	100.00	5-AC LOT	0.392							0.392
OA1,OA2,A1,A2	336.9	B										0.389
B	17.4	B	100.00	MEADOW	0.350							0.350
C	2.2	B	100.00	MEADOW	0.350							0.350

EAGLE FOREST SUBDIVISION

COMPOSITE RUNOFF COEFFICIENTS - TYPICAL 5-ACRE DEVELOPED RESIDENTIAL AREA

DEVELOPED CONDITIONS

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	SOIL TYPE	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	B	7.00	BLDG/DRIVEWAY	0.9	93.00	LAWN/MEADOW	0.08				0.137

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	SOIL TYPE	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	B	7.00	BLDG/DRIVEWAY	0.95	93.00	LAWN/MEADOW	0.35				0.392

EAGLE FOREST
COMPOSITE RUNOFF COEFFICIENTS

DEVELOPED CONDITIONS

5-YEAR C VALUES

BASIN	TOTAL AREA (AC)	SOIL TYPE	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1	297.5	B	100.00	5-AC LOTS (ZONED RR5)	0.137							0.137
A1.1	1.43	B	27.00	ROADWAY	0.9	73.00	MEADOW	0.08				0.301
A1.2	4.70	B	100.00	5-AC LOT	0.137							0.137
OA1,A1.1,A1.2	303.6	B										0.138
OA2	15.5	B	100.00	5-AC LOTS (ZONED RR3)	0.137							0.137
A2	2.3	B	100.00	5-AC LOT	0.137							0.137
OA2,A2	17.8	B										0.137
A3.1	1.87	B	16.30	ROADWAY	0.9	83.70	MEADOW	0.08				0.214
A3.2	13.64	B	100.00	5-AC LOTS	0.137							0.137
OA1-OA2,A1-A3	336.9	B										0.138
B1	5.6	B	100.00	5-AC LOTS	0.137							0.137
B2	11.9	B	100.00	5-AC LOTS	0.137							0.137
B1,B2	17.5	B										0.137
C	2.2	B	100.00	5-AC LOTS	0.137							0.137

100-YEAR C VALUES

BASIN	TOTAL AREA (AC)	SOIL TYPE	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1	297.5	B	100.00	5-AC LOTS (ZONED RR5)	0.392							0.392
A1.1	1.43	B	27.00	ROADWAY	0.96	73.00	MEADOW	0.35				0.515
A1.2	4.70	B	100.00	5-AC LOT	0.392							0.392
OA1,A1.1,A1.2	303.6	B										0.393
OA2	15.5	B	100.00	5-AC LOTS (ZONED RR3)	0.392							0.392
A2	2.3	B	100.00	5-AC LOT	0.392							0.392
OA2,A2	17.8	B										0.392
A3.1	1.87	B	16.30	ROADWAY	0.96	83.70	MEADOW	0.35				0.449
A3.2	13.64	B	100.00	5-AC LOTS	0.392							0.392
OA1-OA2,A1-A3	336.9	B										0.393
B1	5.6	B	100.00	5-AC LOTS	0.392							0.392
B2	11.9	B	100.00	5-AC LOTS	0.392							0.392
B1,B2	17.5	B										0.392
C	2.2	B	100.00	5-AC LOTS	0.392							0.392

EAGLE FOREST SUBDIVISION
HISTORIC FLOWS

BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR	C 100-YEAR	Overland Flow LENGTH (FT)	Overland Flow SLOPE (FT/FT)	Overland Flow Tco (1) (MIN)	Channel flow CHANNEL LENGTH (FT)	Channel flow CONVEYANCE COEFFICIENT C	Channel flow SLOPE (FT/FT)	Channel flow SCS (2) VELOCITY (FT/S)	Channel flow Tt (3) (MIN)	TOTAL Tc (4) (MIN)	TOTAL Tc (4) (MIN)	INTENSITY (5) 5-YR (IN/HR)	INTENSITY (5) 100-YR (IN/HR)	PEAK FLOW Q5 (6) (CFS)	PEAK FLOW Q100 (6) (CFS)
OA1	OA1	297.5	0.137	0.392	300	0.067	16.2	5800	15	0.032	2.68	36.0	52.2	52.2	1.65	2.77	67.2	322.6
A1	A1	21.6	0.080	0.350	0		0.0	2030	15	0.022	2.22	15.2	15.2	15.2	3.50	5.88	6.0	44.4
OA2	OA2	15.5	0.137	0.392	300	0.050	17.9	1150	15	0.048	3.29	5.8	23.7	23.7	2.83	4.76	6.0	28.9
A2		2.3	0.137	0.392	0		0.0	430	15	0.021	2.17	3.3	3.3	5.0	5.17	8.68	1.6	7.8
OA2,A2	A2.1	17.8	0.137	0.392									27.0	27.0	2.64	4.43	6.4	30.9
OA1,OA2,A1,A2	1	336.9	0.133	0.389									67.4	60.0	1.44	2.42	64.6	316.8
B	2	17.4	0.080	0.350	550	0.036	28.6	1000	15	0.029	2.55	6.5	35.1	35.1	2.25	3.77	3.1	22.9
C	3	2.2	0.080	0.350	230	0.065	15.2	0				0.0	15.2	15.2	3.50	5.88	0.6	4.5

1) OVERLAND FLOW Tco = (0.395*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
2) SCS VELOCITY = C * ((SLOPE(FT/FT)^0.5)
C = 2.5 FOR HEAVY MEADOW
C = 5 FOR TILLAGE/FIELD
C = 7 FOR SHORT PASTURE AND LAWNS
C = 10 FOR NEARLY BARE GROUND
C = 15 FOR GRASSED WATERWAY
C = 20 FOR PAVED AREAS AND SHALLOW PAVED SWALES

3) MANNING'S CHANNEL TRAVEL TIME = L/V (WHEN CHANNEL VELOCITY IS KNOWN)
4) Tc = Tco + Tt
*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED
5) INTENSITY BASED ON I-D-F EQUATIONS IN CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL
$I_5 = -1.5 * \ln(Tc) + 7.583$
$I_{100} = -2.52 * \ln(Tc) + 12.735$
6) Q = CiA

EAGLE FOREST SUBDIVISION
DEVELOPED FLOWS

BASIN	DESIGN POINT	AREA (AC)	C 5-YEAR	C 100-YEAR	Overland Flow LENGTH (FT)	Overland Flow SLOPE (FT/FT)	Overland Flow Tco [1] (MIN)	Channel flow CHANNEL LENGTH (FT)	Channel flow CONVEYANCE COEFFICIENT C	Channel flow SLOPE (FT/FT)	Channel flow SCS [2] VELOCITY (FT/S)	Channel flow Tt [3] (MIN)	TOTAL Tc [4] (MIN)	TOTAL Tc [4] (MIN)	INTENSITY [5] 5-YR (IN/HR)	INTENSITY [5] 100-YR (IN/HR)	PEAK FLOW Q5 [6] (CFS)	PEAK FLOW Q100 [6] (CFS)
OA1	OA1	297.5	0.137	0.392	300	0.067	16.2	5800	15	0.032	2.68	36.0	52.2	52.2	1.65	2.77	67.2	322.6
A1.1	A1.1	1.43	0.301	0.515	300	0.060	14.0	1100	15	0.046	3.22	5.7	19.6	19.6	3.12	5.23	1.3	3.9
A1.2	A1.2	4.70	0.137	0.392	0		0.0	840	15	0.023	2.27	6.2	6.2	6.2	4.86	8.16	3.1	15.0
OA1,A1.1,A1.2	A1A	303.6	0.138	0.393									58.4	58.4	1.48	2.49	62.1	296.6
OA2	OA2	15.5	0.137	0.392	300	0.050	17.9	1150	15	0.048	3.29	5.8	23.7	23.7	2.83	4.76	6.0	28.9
A2	A2	2.3	0.137	0.392	0		0.0	430	15	0.021	2.17	3.3	3.3	5.0	5.17	8.68	1.6	7.8
OA2,A2	A2.1	17.8	0.137	0.392									27.0	27.0	2.64	4.43	6.4	30.9
A3.1	A3.1	1.87	0.214	0.449	100	0.080	8.1	850	15	0.057	3.58	4.0	12.1	12.1	3.85	6.46	1.5	5.4
A3.2	A3.2	13.64	0.137	0.392	0		0.0	1190	15	0.021	2.17	9.1	9.1	9.1	4.27	7.16	8.0	38.3
OA1,OA2,A1-A3	1	336.9	0.138	0.393									67.5	60.0	1.44	2.42	67.0	320.1
B1	B1	5.6	0.137	0.392	300	0.027	21.9	550	15	0.025	2.37	3.9	25.8	25.8	2.71	4.54	2.1	10.0
B2	B2	3.0	0.137	0.392	250	0.048	16.5	800	15	0.028	2.51	5.3	21.8	21.8	2.96	4.96	1.2	5.8
B2.1	B2.1	8.6	0.137	0.392									25.8	25.8	2.71	4.54	3.2	15.3
Channel B2 to DP2			0.137	0.392				580	15	0.026	2.42	4.0						
B3	B3	8.9	0.137	0.392	300	0.040	19.2	1030	15	0.036	2.85	6.0	25.3	25.3	2.74	4.60	3.3	16.0
B1-B3	**2 (Dev)**	**17.5**	**0.137**	**0.392**									**29.8**	**29.8**	**2.49**	**4.18**	**6.0**	**28.7**
Detained Flow at DP2:																		
B3	B3	8.9	0.137	0.392	300	0.040	19.2	1030	15	0.036	2.85	6.0	25.3	25.3	2.74	4.60	3.3	16.0
Pond B Discharge																	0.0	5.2
B3,Pond B Discharge	**2 (Det)**	17.5	0.137	0.392													**3.3**	**21.2**
C	**3**	**2.2**	**0.137**	**0.392**	**230**	**0.065**	**14.3**	**0**				**0.0**	**14.3**	**14.3**	**3.59**	**6.03**	**1.1**	**5.2**

1) OVERLAND FLOW Tco = (0.395*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
2) SCS VELOCITY = C * ((SLOPE(FT/FT)^0.5)
C = 2.5 FOR HEAVY MEADOW
C = 5 FOR TILLAGE/FIELD
C = 7 FOR SHORT PASTURE AND LAWNS
C = 10 FOR NEARLY BARE GROUND
C = 15 FOR GRASSED WATERWAY
C = 20 FOR PAVED AREAS AND SHALLOW PAVED SWALES

3) MANNING'S CHANNEL TRAVEL TIME = L/V (WHEN CHANNEL VELOCITY IS KNOWN)
4) Tc = Tco + Tt
*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED
5) INTENSITY BASED ON I-D-F EQUATIONS IN CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL
$I_5 = -1.5 * \ln(Tc) + 7.583$
$I_{100} = -2.52 * \ln(Tc) + 12.735$
6) Q = CiA

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)

Land Use		A	B	C	D
		Hydrologic Soil Group			
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.

EAGLE FOREST
COMPOSITE RUNOFF CURVE NUMBERS

HISTORIC CONDITIONS

BASIN	TOTAL AREA (AC)	SOIL TYPE	(%)	SUB-AREA 1 DEVELOPMENT/ COVER	CN	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	CN	(%)	SUB-AREA 3 DEVELOPMENT/ COVER	CN	WEIGHTED CN-VALUE
OA1	297.50	B	100.00	5-AC LOTS	62.925							62.925
OA2	15.30	B	100.00	5-AC LOTS	62.925							62.925
A	24.50	B	30.00	MEADOW	61	70.00	FOREST	60				60.300
OA1,OA2,A	337.30	B										62.734

DEVELOPED CONDITIONS

BASIN	TOTAL AREA (AC)	SOIL TYPE	(%)	SUB-AREA 1 DEVELOPMENT/ COVER	CN	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	CN	(%)	SUB-AREA 3 DEVELOPMENT/ COVER	CN	WEIGHTED CN-VALUE
OA1	297.50	B	100.00	5-AC LOTS	62.925							62.925
A1	6.10	B	100.00	5-AC LOTS	62.925							62.925
OA1,A4,A1	303.60	B										62.925
OA2	15.30	B	100.00	5-AC LOTS	62.925							62.925
A2	2.30	B	100.00	5-AC LOTS	62.925							62.925
OA2,A2	17.60	B										62.925
A3	15.50	B	100.00	5-AC LOTS	62.925							62.925
OA1-OA2,A1-A3	336.70	B										62.925

EAGLE FOREST SUBDIVISION

SCS HYDROLOGIC CALCULATIONS (HEC-HMS)

JPS ENGINEERING

HISTORIC FLOWS

BASIN	DESIGN POINT	AREA (AC)	AREA (SM)	RUNOFF COEFFICIENT (C_5)	CURVE No. (CN)	S	Ia	PERCENT IMPERVIOUS (%)	Overland Flow: LENGTH (FT)	Overland Flow: SLOPE (%)	Overland Flow: Tco [1] (HR)	Channel flow: HIGH ELEV. (FT)	Channel flow: LOW ELEV. (FT)	Channel flow: H (FT)	Channel flow: CHANNEL LENGTH (FT)	Channel flow: CHANNEL LENGTH (MI)	Channel flow: SLOPE (%)	Channel flow: Tt [2] (HR)	Time of Concentration Tc [3] (HR)	Total Lag Time Tl [4] (HR)	Total Lag Time Tl [4] (MIN)	Peak Flow SCS Q5 [5] (CFS)	Peak Flow SCS Q100 [5] (CFS)
OA1		297.5	0.4648	0.196	62.93	5.89	1.18	7	300	6.7%	0.25	7620	7428	192	5800	1.10	3.3%	0.38	0.63	0.38	22.73		
OA2		15.5	0.0242	0.196	62.93	5.89	1.18	7	300	5.0%	0.27	7470	7410	60	1150	0.22	5.2%	0.09	0.37	0.22	13.22		
OA1,OA2	OA1	313.0	0.4891	0.192	62.73	5.94	1.19	7											0.63	0.38	22.73	66.7	280.9
A		23.9	0.0373	0.145	60.3	6.58	1.32	2			0.00	7428	7390	38	2030	0.38	1.9%	0.21	0.21	0.13	7.63		
REACH A											0.00	7428	7390	38	2030	0.38	1.9%	0.21	0.21	0.13	7.63		
OA1,OA2,A	1	336.9	0.5264	0.192	62.73	5.94	1.19	7											0.84	0.51	30.36	67.7	287.1

DEVELOPED FLOWS

BASIN	DESIGN POINT	AREA (AC)	AREA (SM)	RUNOFF COEFFICIENT (C_5)	CURVE No. (CN)	S	Ia	PERCENT IMPERVIOUS (%)	Overland Flow: LENGTH (FT)	Overland Flow: SLOPE (%)	Overland Flow: Tco [1] (HR)	Channel flow: HIGH ELEV. (FT)	Channel flow: LOW ELEV. (FT)	Channel flow: H (FT)	Channel flow: CHANNEL LENGTH (FT)	Channel flow: CHANNEL LENGTH (MI)	Channel flow: SLOPE (%)	Channel flow: Tt [2] (HR)	Time of Concentration Tc [3] (HR)	Total Lag Time Tl [4] (HR)	Total Lag Time Tl [4] (MIN)	Peak Flow SCS Q5 [5] (CFS)	Peak Flow SCS Q100 [5] (CFS)
OA1		297.5	0.4648	0.196	62.93	5.89	1.18	7	300	6.7%	0.25	7620	7428	192	5800	1.10	3.3%	0.38	0.63	0.38	22.73		
OA2		15.5	0.0242	0.196	62.93	5.89	1.18	7	300	5.0%	0.27	7470	7410	60	1150	0.22	5.2%	0.09	0.37	0.22	13.22		
OA1,OA2	OA1	313.0	0.4891	0.196	62.93	5.89	1.18	7											0.63	0.38	22.73	66.7	280.9
A1		6.1	0.0095	0.196	62.93	5.89	1.18	7			0.00	7428	7414	14	840	0.16	1.7%	0.11	0.11	0.07	4.05		
OA1, A1	A1	319.1	0.4986	0.196	62.93	5.89	1.18	7											0.63	0.38	22.73	66.7	282.0
A2		2.3	0.0036	0.196	62.93	5.89	1.18	7			0.00	7410	7401	9	430	0.08	2.1%	0.06	0.06	0.04	2.21		
A3		15.5	0.0242	0.196	62.93	5.89	1.18	7			0.00	7414	7390	24	1190	0.23	2.0%	0.14	0.14	0.08	4.92		
A2,A3	A3	17.8	0.0278	0.196	62.93	5.89	1.18	7											0.06	0.04	2.21		
OA1,OA2,A1-A3	1	336.9	0.5264	0.196	62.93	5.89	1.18	7											0.77	0.46	27.65	68.1	285.2

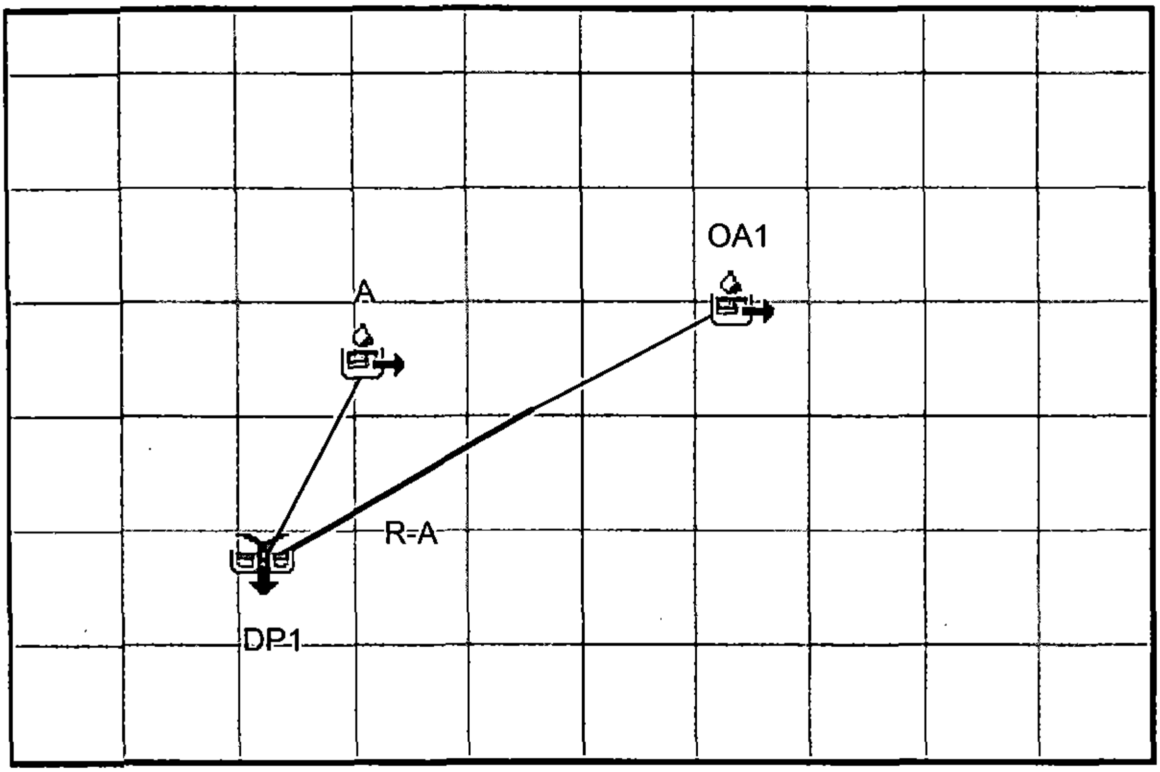
1) OVERLAND FLOW Tco = (1.8*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
2) TRAVEL TIME, Tt = ((11.9*L^3)/H)^(0.385)
3) Tc = Tco + Tt
4) SCS LAG TIME, Tl = 0.6 * Tt
5) PEAK FLOWS CALCULATED BY HEC-HMS 3.5; 5-YR RAINFALL DEPTH = 2.6 IN; 100-YR RAINFALL DEPTH = 4.4 IN

HEC-HMS

Project : EAGLE_H

Basin Model : Basin 1

May 23 10:38:08 MDT 2012



Project: EAGLE_H Simulation Run: Run 1

Start of Run: 01Jan3000, 01:00 Basin Model: Basin 1
End of Run: 02Jan3000, 01:30 Meteorologic Model: Met 1
Compute Time: 23May2012, 10:37:35 Control Specifications: Control 1

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
OA1	0.4891	66.7	01Jan3000, 13:18	11.4
R-A	0.4891	66.2	01Jan3000, 13:24	11.4
A	0.0373	3.8	01Jan3000, 13:06	0.5
DP1	0.5264	67.7	01Jan3000, 13:24	11.9

Project: EAGLE_H Simulation Run: Run 1

Start of Run: 01Jan3000, 01:00 Basin Model: Basin 1
End of Run: 02Jan3000, 01:30 Meteorologic Model: Met 1
Compute Time: 23May2012, 10:38:17 Control Specifications: Control 1

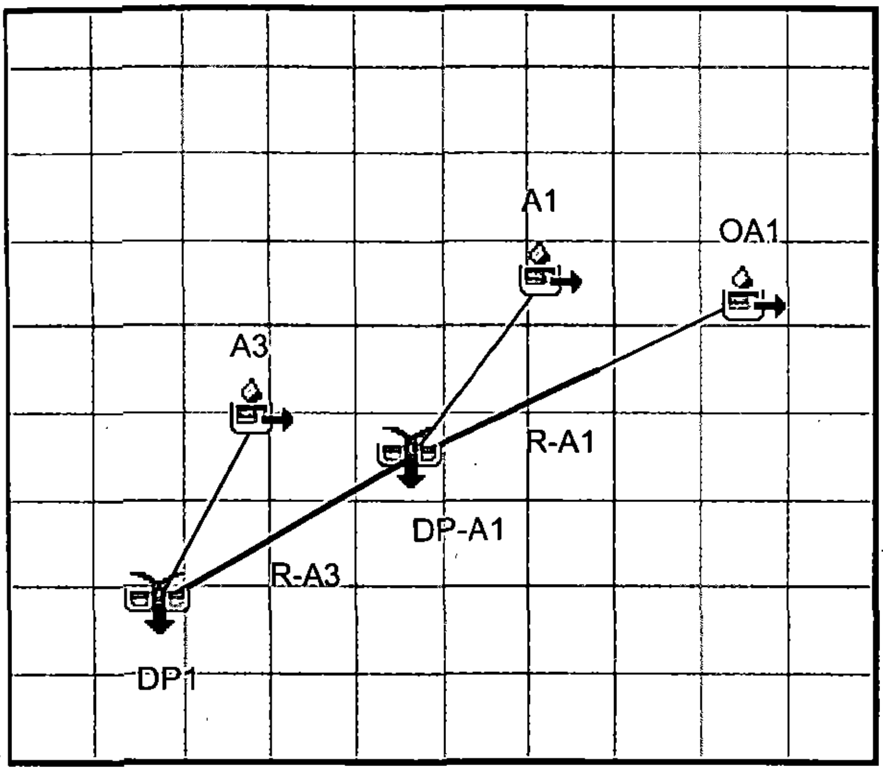
Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
OA1	0.4891	280.9	01Jan3000, 13:18	35.6
R-A	0.4891	280.2	01Jan3000, 13:24	35.5
A	0.0373	28.8	01Jan3000, 13:03	2.1
DP1	0.5264	287.1	01Jan3000, 13:24	37.6

HEC-HMS

Project : EAGLE-D

Basin Model : Basin 1

May 23 10:31:53 MDT 2012



Project: EAGLE-D Simulation Run: Run 1

Start of Run:	01Jan3000, 01:00	Basin Model:	Basin 1
End of Run:	02Jan3000, 01:30	Meteorologic Model:	Met 1
Compute Time:	23May2012, 10:32:13	Control Specifications:	Control 1

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
OA1	0.4891	66.7	01Jan3000, 13:18	11.4
R-A1	0.4891	66.2	01Jan3000, 13:21	11.4
A1	0.0095	2.7	01Jan3000, 13:00	0.2
DP-A1	0.4986	66.7	01Jan3000, 13:21	11.6
R-A3	0.4986	66.7	01Jan3000, 13:27	11.6
A3	0.0278	7.7	01Jan3000, 13:00	0.7
DP1	0.5264	68.1	01Jan3000, 13:27	12.3

Project: EAGLE-D Simulation Run: Run 1

Start of Run: 01Jan3000, 01:00 Basin Model: Basin 1
End of Run: 02Jan3000, 01:30 Meteorologic Model: Met 1
Compute Time: 23May2012, 10:30:47 Control Specifications: Control 1

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
OA1	0.4891	280.9	01Jan3000, 13:18	35.6
R-A1	0.4891	280.2	01Jan3000, 13:21	35.5
A1	0.0095	11.2	01Jan3000, 12:57	0.7
DP-A1	0.4986	282.0	01Jan3000, 13:21	36.2
R-A3	0.4986	280.0	01Jan3000, 13:24	36.2
A3	0.0278	32.4	01Jan3000, 13:00	2.0
DP1	0.5264	285.2	01Jan3000, 13:24	38.2

APPENDIX C

HYDRAULIC CALCULATIONS

TABLE 10-4

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

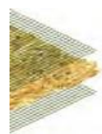
Channel Slope	Lining	Permissible Mean Channel Velocity * (ft/sec)
0 - 5%	Sodded grass	7
	Bermudagrass	6
	Reed canarygrass	5
	Tall fescue	5
	Kentucky bluegrass	5
	Grass-legume mixture	4
	Red fescue	2.5
	Redtop	2.5
	Sericea lespedeza	2.5
	Annual lespedeza	2.5
	Small grains (temporary)	2.5
5 - 10%	Sodded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

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

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

The complete line of RollMax™ products offers a variety of options for both short-term and permanent erosion control needs. Reference the RollMax Products Chart below to find the right solution for your next project.

RollMax Product Selection Chart

	TEMPORARY						
	ERONET						BIONET
							
	DS75	**DS150**	**S75**	**S150**	**SC150**	**C125**	**S75BN**
Longevity	45 days	60 days	12 mo.	12 mo.	24 mo.	36 mo.	12 mo.
Applications	Low Flow Channels 4:1-3:1 Slopes	Moderate Flow Channels 3:1-2:1 Slopes	Low Flow Channels 4:1-3:1 Slopes	Moderate Flow Channels 3:1-2:1 Slopes	Medium Flow Channels 2:1-1:1 Slopes	High-Flow Channels 1:1 and Greater Slopes	Low Flow Channels 4:1-3:1 Slopes
Design Permissible Shear Stress lbs/ft^2 (Pa)	Unvegetated 1.55 (74)	Unvegetated 1.75 (84)	Unvegetated 1.55 (74)	Unvegetated 1.75 (84)	Unvegetated 2.00 (96)	Unvegetated 2.25 (108)	Unvegetated 1.60 (76)
Design Permissible Velocity ft/s (m/s)	Unvegetated 5.00 (1.52)	Unvegetated 6.00 (1.52)	Unvegetated 5.00 (1.2)	Unvegetated 6.00 (1.83)	Unvegetated 8.00 (2.44)	Unvegetated 10.00 (3.05)	Unvegetated 5.00 (1.52)
Top Net	Lightweight accelerated photodegradable polypropylene 1.50 lbs/1000 ft^2 (0.73 kg/100 m^2) approx wt	Lightweight accelerated photodegradable polypropylene 1.50 lbs/1000 ft^2 (0.73 kg/100 m^2) approx wt	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft^2 (0.73 kg/100 m^2) approx wt	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft^2 (0.73 kg/100 m^2) approx wt	Heavyweight UV-stabilized polypropylene 2.9 lbs/1000 ft^2 (1.47 kg/100 m^2) approx wt	Heavyweight UV-stabilized polypropylene 2.9 lbs/1000 ft^2 (1.47 kg/100 m^2) approx wt	Leno woven. 100% biodegradable jute fiber 9.30 lbs/1000 ft^2 (4.53 kg/100 m^2) approx wt
Center Net	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fiber Matrix	Straw fiber 0.50 lbs/yd^2 (0.27 kg/m^2)	Straw fiber 0.50 lbs/yd^2 (0.27 kg/m^2)	Straw fiber 0.50 lbs/yd^2 (0.27 kg/m^2)	Straw fiber 0.50 lbs/yd^2 (0.27 kg/m^2)	Straw/coconut matrix 70% Straw 0.35 lbs/yd^2 (0.19 kg/m^2) 30% Coconut 0.15 lbs/yd^2 (0.08 kg/m^2)	Coconut fiber 0.50 lbs/yd^2 (0.27 kg/m^2)	Straw fiber 0.50 lbs/yd^2 (0.27 kg/m^2)
Bottom Net	N/A	Lightweight accelerated photodegradable polypropylene 1.50 lbs/1000 ft^2 (0.73 kg/100 m^2) approx wt	N/A	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft^2 (0.73 kg/100 m^2) approx wt	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft^2 (0.73 kg/100 m^2) approx wt	Heavyweight UV-stabilized polypropylene 2.9 lbs/1000 ft^2 (1.47 kg/100 m^2) approx wt	N/A
Thread	Accelerated degradable	Accelerated degradable	Degradable	Degradable	Degradable	UV-stabilized polypropylene	Biodegradable

EAGLE FOREST SUBDIVISION
DITCH CALCULATION SUMMARY

PROPOSED ROADSIDE DITCHES

ROADWAY	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 VELOCIT (FT/S)	DITCH LINING
EAGLE FOREST DRIVE	10+00	11+35	E	2.00	4:1/3:1	2.0	0.030	60	OA2	28.9	20	5.8	0.55	2.90	GRASS
EAGLE FOREST DRIVE	10+00	11+35	W	2.00	4:1/3:1	2.0	0.030	60	A2	7.8	10	0.8	0.33	2.06	GRASS
EAGLE FOREST DRIVE	11+35	19+65	E	3.00	4:1/3:1	2.0	0.030	60	OA2	28.9	20	5.8	0.65	3.94	GRASS
EAGLE FOREST DRIVE	11+35	19+65	W	3.00	4:1/3:1	2.0	0.030	60	A2	7.8	10	0.8	0.31	2.40	GRASS
EAGLE FOREST DRIVE	19+65	25+50	E	7.98	4:1/3:1	2.0	0.030	60	A1	19.5	20	3.9	0.47	5.15	**GRASS/ECB**
EAGLE FOREST DRIVE	19+65	25+50	W	7.98	4:1/3:1	2.0	0.030	60	A3	43.5	10	4.4	0.49	5.31	**GRASS/ECB**
EAGLE FOREST DRIVE	25+50	31+01	E	5.00	4:1/3:1	2.0	0.030	60	A1	19.5	10	2.0	0.40	3.66	GRASS
EAGLE FOREST DRIVE	25+50	31+01	W	5.00	4:1/3:1	2.0	0.030	60	A3	43.5	10	4.4	0.53	4.46	GRASS
EAGLE FOREST DRIVE	31+01	38+57	N	3.53	4:1/3:1	2.0	0.030	60	B2	5.8	75	4.4	0.57	3.91	GRASS
EAGLE FOREST DRIVE	31+01	38+57	S	3.53	4:1/3:1	2.0	0.030	60	B1	10.0	75	7.5	0.69	4.47	GRASS
EAGLE FOREST DRIVE	38+57	40+67	N	2.23	4:1/3:1	2.0	0.030	60	B2	5.8	100	5.8	0.69	3.53	GRASS
EAGLE FOREST DRIVE	38+57	40+67	S	2.23	4:1/3:1	2.0	0.030	60	B1	10.0	100	10.0	0.84	4.04	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 = 0.04 for riprap-lined channels
5) Vmax = 5.0 fps for 100-year flows w/ Native Grass-Lining (per ECM Table 10-4)
6) Vmax = 8.0 fps with Erosion Control Blankets (Tensar Eronet SC150 or equal)

Hydraulic Analysis Report

Project Data

Project Title: Project - Eagle Forest - Roadside Ditches

Designer: JPS

Project Date: Monday, July 20, 2020

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Ditch-EFD-1000-1135-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: 0.0200 ft/ft

Manning's n: 0.0300

Flow: 3.1000 cfs

Result Parameters

Depth: 0.5531 ft

Area of Flow: 1.0707 ft^2

Wetted Perimeter: 4.0295 ft

Hydraulic Radius: 0.2657 ft

Average Velocity: 2.8953 ft/s

Top Width: 3.8717 ft

Froude Number: 0.9702

Critical Depth: 0.5487 ft

Critical Velocity: 2.9418 ft/s

Critical Slope: 0.0209 ft/ft

Critical Top Width: 3.92 ft

Calculated Max Shear Stress: 0.6903 lb/ft^2

Calculated Avg Shear Stress: 0.3316 lb/ft^2

Channel Analysis: Ditch-EFD-1000-1135-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: 0.0200 ft/ft

Manning's n: 0.0300

Flow: 0.8000 cfs

Result Parameters

Depth: 0.3328 ft

Area of Flow: 0.3877 ft^2

Wetted Perimeter: 2.4247 ft

Hydraulic Radius: 0.1599 ft

Average Velocity: 2.0636 ft/s

Top Width: 2.3297 ft

Froude Number: 0.8915

Critical Depth: 0.3192 ft

Critical Velocity: 2.2436 ft/s

Critical Slope: 0.0250 ft/ft

Critical Top Width: 2.28 ft

Calculated Max Shear Stress: 0.4153 lb/ft^2

Calculated Avg Shear Stress: 0.1995 lb/ft^2

Channel Analysis: Ditch-EFD-1135-1965-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: 0.0300 ft/ft

Manning's n: 0.0300

Flow: 5.8000 cfs

Result Parameters

Depth: 0.6483 ft

Area of Flow: 1.4713 ft^2

Wetted Perimeter: 4.7235 ft

Hydraulic Radius: 0.3115 ft

Average Velocity: 3.9422 ft/s

Top Width: 4.5384 ft

Froude Number: 1.2202

Critical Depth: 0.7050 ft

Critical Velocity: 3.3344 ft/s

Critical Slope: 0.0192 ft/ft

Critical Top Width: 5.04 ft

Calculated Max Shear Stress: 1.2137 lb/ft^2

Calculated Avg Shear Stress: 0.5831 lb/ft^2

Channel Analysis: Ditch-EFD-1135-1965-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: 0.0300 ft/ft

Manning's n: 0.0300

Flow: 0.8000 cfs

Result Parameters

Depth: 0.3084 ft

Area of Flow: 0.3330 ft^2

Wetted Perimeter: 2.2472 ft

Hydraulic Radius: 0.1482 ft

Average Velocity: 2.4025 ft/s

Top Width: 2.1591 ft

Froude Number: 1.0781

Critical Depth: 0.3192 ft

Critical Velocity: 2.2436 ft/s

Critical Slope: 0.0250 ft/ft

Critical Top Width: 2.28 ft

Calculated Max Shear Stress: 0.5774 lb/ft^2

Calculated Avg Shear Stress: 0.2774 lb/ft^2

Channel Analysis: Ditch-EFD-1965-2550-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: 0.0798 ft/ft

Manning's n: 0.0300

Flow: 3.9000 cfs

Result Parameters

Depth: 0.4651 ft

Area of Flow: 0.7570 ft^2

Wetted Perimeter: 3.3881 ft

Hydraulic Radius: 0.2234 ft

Average Velocity: 5.1521 ft/s

Top Width: 3.2554 ft

Froude Number: 1.8828

Critical Depth: 0.6015 ft

Critical Velocity: 3.0800 ft/s

Critical Slope: 0.0202 ft/ft

Critical Top Width: 4.30 ft

Calculated Max Shear Stress: 2.3158 lb/ft^2

Calculated Avg Shear Stress: 1.1125 lb/ft^2

Channel Analysis: Ditch-EFD-1965-2550-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: 0.0798 ft/ft

Manning's n: 0.0300

Flow: 4.4000 cfs

Result Parameters

Depth: 0.4866 ft

Area of Flow: 0.8287 ft^2

Wetted Perimeter: 3.5449 ft

Hydraulic Radius: 0.2338 ft

Average Velocity: 5.3098 ft/s

Top Width: 3.4061 ft

Froude Number: 1.8971

Critical Depth: 0.6312 ft

Critical Velocity: 3.1552 ft/s

Critical Slope: 0.0199 ft/ft

Critical Top Width: 4.51 ft

Calculated Max Shear Stress: 2.4229 lb/ft^2

Calculated Avg Shear Stress: 1.1640 lb/ft^2

Channel Analysis: Ditch-EFD-2550-3101-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: 0.0500 ft/ft

Manning's n: 0.0300

Flow: 2.0000 cfs

Result Parameters

Depth: 0.3952 ft

Area of Flow: 0.5466 ft^2

Wetted Perimeter: 2.8792 ft

Hydraulic Radius: 0.1899 ft

Average Velocity: 3.6588 ft/s

Top Width: 2.7664 ft

Froude Number: 1.4505

Critical Depth: 0.4605 ft

Critical Velocity: 2.6949 ft/s

Critical Slope: 0.0221 ft/ft

Critical Top Width: 3.29 ft

Calculated Max Shear Stress: 1.2330 lb/ft^2

Calculated Avg Shear Stress: 0.5924 lb/ft^2

Channel Analysis: Ditch-EFD-2550-3101-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: 0.0500 ft/ft

Manning's n: 0.0300

Flow: 4.4000 cfs

Result Parameters

Depth: 0.5312 ft

Area of Flow: 0.9874 ft^2

Wetted Perimeter: 3.8697 ft

Hydraulic Radius: 0.2552 ft

Average Velocity: 4.4560 ft/s

Top Width: 3.7181 ft

Froude Number: 1.5238

Critical Depth: 0.6312 ft

Critical Velocity: 3.1552 ft/s

Critical Slope: 0.0199 ft/ft

Critical Top Width: 4.51 ft

Calculated Max Shear Stress: 1.6572 lb/ft^2

Calculated Avg Shear Stress: 0.7961 lb/ft^2

Channel Analysis: Ditch-EFD-3101-3857-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: 0.0353 ft/ft

Manning's n: 0.0300

Flow: 4.4000 cfs

Result Parameters

Depth: 0.5670 ft

Area of Flow: 1.1251 ft^2

Wetted Perimeter: 4.1307 ft

Hydraulic Radius: 0.2724 ft

Average Velocity: 3.9106 ft/s

Top Width: 3.9689 ft

Froude Number: 1.2943

Critical Depth: 0.6312 ft

Critical Velocity: 3.1552 ft/s

Critical Slope: 0.0199 ft/ft

Critical Top Width: 4.51 ft

Calculated Max Shear Stress: 1.2489 lb/ft^2

Calculated Avg Shear Stress: 0.6000 lb/ft^2

Channel Analysis: Ditch-EFD-3101-3857-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: 0.0353 ft/ft

Manning's n: 0.0300

Flow: 7.5000 cfs

Result Parameters

Depth: 0.6925 ft

Area of Flow: 1.6785 ft^2

Wetted Perimeter: 5.0452 ft

Hydraulic Radius: 0.3327 ft

Average Velocity: 4.4683 ft/s

Top Width: 4.8475 ft

Froude Number: 1.3382

Critical Depth: 0.7813 ft

Critical Velocity: 3.5103 ft/s

Critical Slope: 0.0185 ft/ft

Critical Top Width: 5.58 ft

Calculated Max Shear Stress: 1.5254 lb/ft^2

Calculated Avg Shear Stress: 0.7328 lb/ft^2

Channel Analysis: Ditch-EFD-3857-4067-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: 0.0223 ft/ft

Manning's n: 0.0300

Flow: 5.8000 cfs

Result Parameters

Depth: 0.6854 ft

Area of Flow: 1.6443 ft^2

Wetted Perimeter: 4.9936 ft

Hydraulic Radius: 0.3293 ft

Average Velocity: 3.5272 ft/s

Top Width: 4.7980 ft

Froude Number: 1.0618

Critical Depth: 0.7050 ft

Critical Velocity: 3.3344 ft/s

Critical Slope: 0.0192 ft/ft

Critical Top Width: 5.04 ft

Calculated Max Shear Stress: 0.9538 lb/ft^2

Calculated Avg Shear Stress: 0.4582 lb/ft^2

Channel Analysis: Ditch-EFD-3857-4067-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: 0.0223 ft/ft

Manning's n: 0.0300

Flow: 10.0000 cfs

Result Parameters

Depth: 0.8408 ft

Area of Flow: 2.4741 ft^2

Wetted Perimeter: 6.1253 ft

Hydraulic Radius: 0.4039 ft

Average Velocity: 4.0418 ft/s

Top Width: 5.8854 ft

Froude Number: 1.0986

Critical Depth: 0.8766 ft

Critical Velocity: 3.7182 ft/s

Critical Slope: 0.0179 ft/ft

Critical Top Width: 6.26 ft

Calculated Max Shear Stress: 1.1699 lb/ft^2

Calculated Avg Shear Stress: 0.5621 lb/ft^2

EAGLE FOREST SUBDIVISION
CHANNEL CALCULATIONS
DEVELOPED FLOWS

EXISTING & PROPOSED CHANNELS

CHANNEL	DESIGN POINT	EXISTING SLOPE (%)	PROPOSED SLOPE (%)	BOTTOM WIDTH (B, FT)	SIDE SLOPE (Z)	CHANNEL DEPTH (FT)	FRICTION FACTOR (n)	EASEMENT WIDTH (ft)	Q100 FLOW (CFS)	Q100 DEPTH (FT)	Q100 VELOCITY (FT/S)	CHANNEL LINING
A1 (EXISTING CHANNEL)	A1	2.3		12	4:1	4.0	0.045		282.0	2.1	6.5	GRASS
A3 (EXISTING CHANNEL)	1	2.1		12	4:1	4.0	0.045		285.2	2.2	6.3	GRASS
B3 (POND DISCHARGE)	B2		2.7	0	3:1	2.0	0.030		1.4	0.4	2.7	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 fps per El Paso County criteria (p. 10-13) for fescue (dry land grass) for 100-year flows

Worksheet

Worksheet for Trapezoidal Channel

Channel A1

Project Description	
Worksheet	Trapezoidal Chann
Flow Element	Trapezoidal Chann
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.045	
Slope	023000	ft/ft
Left Side Slope	4.00	H : V
Right Side Slope	4.00	H : V
Bottom Width	12.00	ft
Discharge	282.00	cfs

≈ Q_{100}

Results		
Depth	2.12	ft
Flow Area	43.5	ft²
Wetted Perim	29.50	ft
Top Width	28.98	ft
Critical Depth	2.04	ft
Critical Slope	0.026663	ft/ft
Velocity	6.49	ft/s
Velocity Head	0.65	ft
Specific Energ	2.78	ft
Froude Numb	0.93	
Flow Type	Subcritical	

Existing Conditions

Worksheet
Worksheet for Trapezoidal Channel

Channel A3

Project Description	
Worksheet	Trapezoidal Chann(
Flow Element	Trapezoidal Chann(
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.045	
Slope	021000	ft/ft
Left Side Slope	4.00	H : V
Right Side Slope	4.00	H : V
Bottom Width	12.00	ft
Discharge	285.20	cfs

= Q100

Results		
Depth	2.18	ft
Flow Area	45.3	ft²
Wetted Perim(	30.01	ft
Top Width	29.47	ft
Critical Depth	2.06	ft
Critical Slope	0.026619	ft/ft
Velocity	6.30	ft/s
Velocity Head	0.62	ft
Specific Energ	2.80	ft
Froude Numb(	0.90	
Flow Type	Subcritical	

Existing Conditions

Worksheet
Worksheet for Trapezoidal Channel

Channel 03

Project Description	
Worksheet	Trapezoidal Channe
Flow Element	Trapezoidal Channe
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.030	
Slope	027000	ft/ft
Left Side Slope	3.00	H : V
Right Side Slope	3.00	H : V
Bottom Width	0.00	ft
Discharge	1.40	cfs

Results		
Depth	0.41	ft
Flow Area	0.5	ft²
Wetted Perim	2.61	ft
Top Width	2.47	ft
Critical Depth	0.42	ft
Critical Slope	0.023614	ft/ft
Velocity	2.74	ft/s
Velocity Head	0.12	ft
Specific Energ	0.53	ft
Froude Numb	1.06	
Flow Type	Supercritical	

JPS ENGINEERING

EAGLE FOREST SUBDIVISION
CULVERT DESIGN SUMMARY

Culvert	Selected Pipe Size	Road CL EL	Inv. In EL	Inv. Out EL	L (ft)	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)
A1	60" RCP	7423.74	7413.37	7412.32	108	66.7	7418.37	7416.62	282.0	7423.92	7423.33	H (18")
A2	24" RCP	7411.07	7407.38	7405.86	64	9.2	7409.38	7408.92	21.7	7411.25	7410.24	M (12")
B1	18" RCP	7454.79	7452.44	7449.00	64	3.0	7453.94	7453.33	7.1	7454.97	7453.95	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: 05-23-2012
CURRENT TIME: 11:01:41

FILE DATE: 05-23-2012
FILE NAME: EF-A1

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

C U L V NO.	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	7413.37	7412.32	108.01	1 RCP	5.00	5.00	.013	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: EF-A1 DATE: 05-23-2012

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
7413.37	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7415.30	28.2	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7416.31	56.4	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7416.62	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7417.77	112.8	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7418.43	141.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7419.16	169.2	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7419.99	197.4	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7420.96	225.6	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7422.08	253.8	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7423.33	282.0	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: EF-A1 DATE: 05-23-2012

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
7413.37	0.000	0.00	0.00	0.00
7415.30	0.000	28.20	0.00	0.00
7416.31	0.000	56.40	0.00	0.00
7416.62	0.000	66.70	0.00	0.00
7417.77	0.000	112.80	0.00	0.00
7418.43	0.000	141.00	0.00	0.00
7419.16	0.000	169.20	0.00	0.00
7419.99	0.000	197.40	0.00	0.00
7420.96	0.000	225.60	0.00	0.00
7422.08	0.000	253.80	0.00	0.00
7423.33	0.000	282.00	0.00	0.00

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

CURRENT DATE: 05-23-2012
CURRENT TIME: 11:01:41

FILE DATE: 05-23-2012
FILE NAME: EF-A1

PERFORMANCE CURVE FOR CULVERT 1 - 1(5.00 (ft) BY 5.00 (ft)) RCP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	7413.37	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
28.20	7415.30	1.93	1.93	1-S2n	1.10	1.47	1.13	0.73	8.37	4.76
56.40	7416.31	2.94	2.94	1-S2n	1.58	2.10	1.65	1.05	9.96	5.84
66.70	7416.62	3.25	3.25	1-S2n	1.73	2.29	1.81	1.15	10.38	6.13
112.80	7417.77	4.40	4.40	1-S2n	2.31	3.03	2.45	1.51	11.80	7.10
141.00	7418.43	5.06	5.06	5-S2n	2.64	3.39	2.79	1.69	12.50	7.55
169.20	7419.16	5.79	5.79	5-S2n	2.96	3.71	3.13	1.85	13.08	7.93
197.40	7419.99	6.62	6.62	5-S2n	3.29	4.01	3.45	1.99	13.67	8.27
225.60	7420.96	7.59	7.59	5-S2n	3.64	4.22	3.79	2.13	14.16	8.57
253.80	7422.08	8.71	8.71	5-S2n	4.06	4.43	4.16	2.25	14.58	8.84
282.00	7423.33	9.97	8.30	2-M2c	5.00	4.64	4.64	2.37	14.92	9.09

El. inlet face invert 7413.37 ft El. outlet invert 7412.32 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	7413.37 ft
OUTLET STATION	108.00 ft
OUTLET ELEVATION	7412.32 ft
NUMBER OF BARRELS	1
SLOPE (V/H)	0.0097
CULVERT LENGTH ALONG SLOPE	108.01 ft

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	CIRCULAR
BARREL DIAMETER	5.00 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: 05-23-2012
CURRENT TIME: 11:01:41

FILE DATE: 05-23-2012
FILE NAME: EF-A1

TAILWATER

******* REGULAR CHANNEL CROSS SECTION ****************

BOTTOM WIDTH	6.00 ft
SIDE SLOPE H/V (X:1)	3.0
CHANNEL SLOPE V/H (ft/ft)	0.020
MANNING'S n (.01-0.1)	0.030
CHANNEL INVERT ELEVATION	7412.32 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	7412.32 ft

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

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	7412.32	0.000	0.00	0.00	0.00
28.20	7413.04	0.985	0.73	4.76	0.90
56.40	7413.37	1.003	1.05	5.84	1.32
66.70	7413.47	1.007	1.15	6.13	1.44
112.80	7413.83	1.019	1.51	7.10	1.88
141.00	7414.01	1.024	1.69	7.55	2.11
169.20	7414.17	1.028	1.85	7.93	2.31
197.40	7414.31	1.033	1.99	8.27	2.49
225.60	7414.45	1.036	2.13	8.57	2.65
253.80	7414.57	1.039	2.25	8.84	2.81
282.00	7414.69	1.042	2.37	9.09	2.95

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	32.00 ft
CREST LENGTH	100.00 ft
OVERTOPPING CREST ELEVATION	7423.74 ft

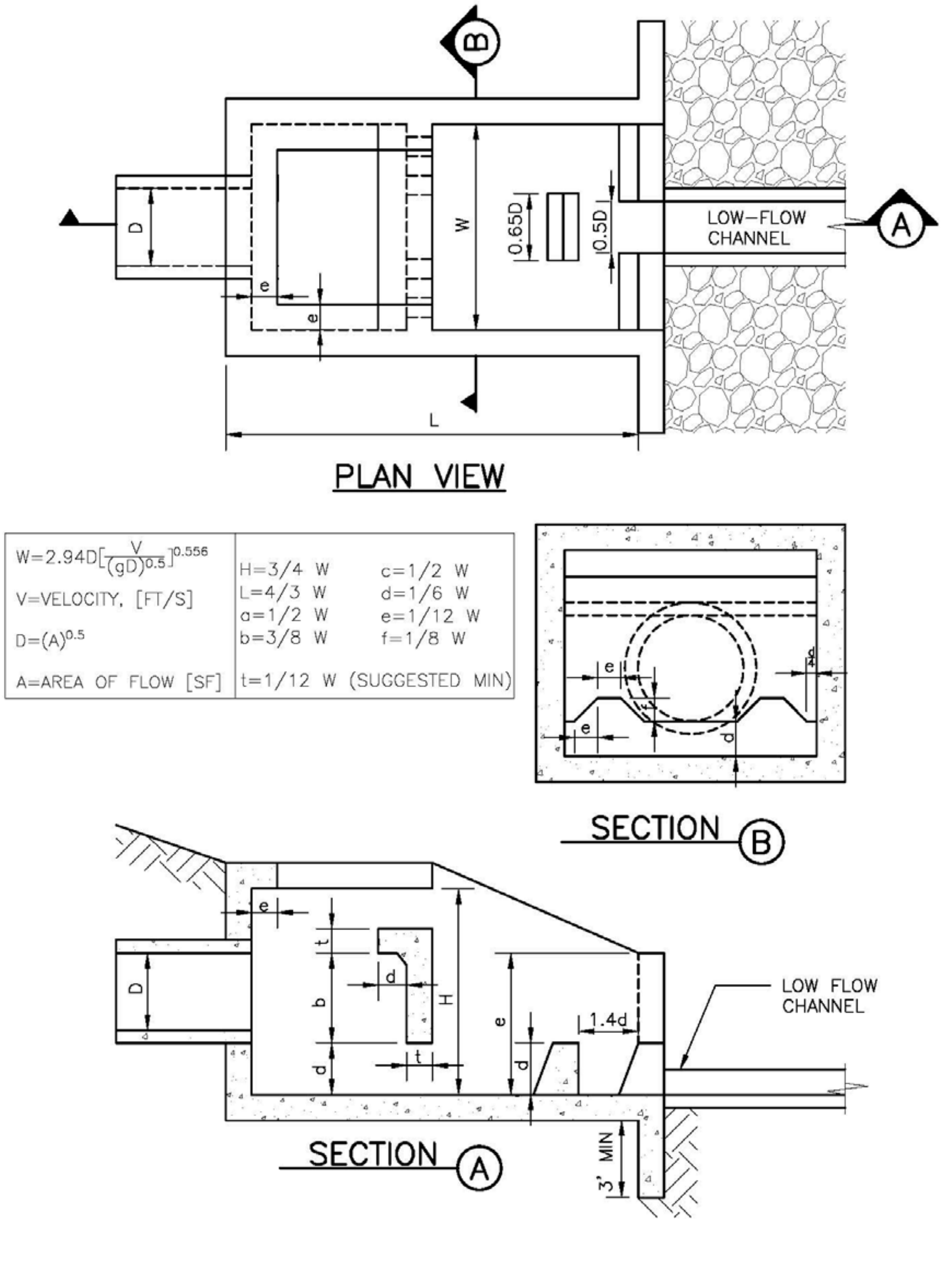


Figure 9-45. UDFCD modified USBR type VI impacts stilling basin (general design dimensions)

CURRENT DATE: 05-23-2012
CURRENT TIME: 11:01:13

FILE DATE: 05-23-2012
FILE NAME: EF-A2

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

CULV NO.	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	7407.38	7405.86	64.02	1 RCP	2.00	2.00	.013	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: EF-A2 DATE: 05-23-2012

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
7407.38	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7408.02	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7408.36	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7408.64	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7408.87	8.7	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7408.92	9.2	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7409.27	13.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7409.48	15.2	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7409.71	17.4	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7409.96	19.5	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7410.24	21.7	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: EF-A2 DATE: 05-23-2012

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
7407.38	0.000	0.00	0.00	0.00
7408.02	0.000	2.17	0.00	0.00
7408.36	0.000	4.34	0.00	0.00
7408.64	0.000	6.51	0.00	0.00
7408.87	0.000	8.68	0.00	0.00
7408.92	0.000	9.20	0.00	0.00
7409.27	0.000	13.02	0.00	0.00
7409.48	0.000	15.19	0.00	0.00
7409.71	0.000	17.36	0.00	0.00
7409.96	0.000	19.53	0.00	0.00
7410.24	0.000	21.70	0.00	0.00

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

CURRENT DATE: 05-23-2012
CURRENT TIME: 11:01:13

FILE DATE: 05-23-2012
FILE NAME: EF-A2

PERFORMANCE CURVE FOR CULVERT 1 - 1(2.00 (ft) BY 2.00 (ft)) RCP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	7407.38	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
2.17	7408.02	0.64	0.64	1-S2n	0.32	0.50	0.20	0.21	13.27	2.24
4.34	7408.36	0.98	0.98	1-S2n	0.47	0.73	0.48	0.31	7.44	2.83
6.51	7408.64	1.26	1.26	1-S2n	0.58	0.90	0.50	0.39	10.53	3.22
8.68	7408.87	1.49	1.49	1-S2n	0.67	1.05	0.70	0.46	8.89	3.52
9.20	7408.92	1.54	1.54	1-S2n	0.70	1.08	0.72	0.47	9.03	3.59
13.02	7409.27	1.89	1.89	1-S2n	0.84	1.29	0.87	0.57	9.86	3.98
15.19	7409.48	2.10	2.10	5-S2n	0.92	1.40	0.96	0.62	10.13	4.17
17.36	7409.71	2.33	2.33	5-S2n	1.00	1.50	1.05	0.67	10.45	4.34
19.53	7409.96	2.58	2.58	5-S2n	1.07	1.59	1.13	0.71	10.71	4.49
21.70	7410.24	2.86	2.86	5-S2n	1.14	1.65	1.20	0.75	10.97	4.62

El. inlet face invert 7407.38 ft El. outlet invert 7405.86 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	7407.38 ft
OUTLET STATION	64.00 ft
OUTLET ELEVATION	7405.86 ft
NUMBER OF BARRELS	1
SLOPE (V/H)	0.0238
CULVERT LENGTH ALONG SLOPE	64.02 ft

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	CIRCULAR
BARREL DIAMETER	2.00 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: 05-23-2012
CURRENT TIME: 11:01:13

FILE DATE: 05-23-2012
FILE NAME: EF-A2

TAILWATER

******* REGULAR CHANNEL CROSS SECTION ****************

BOTTOM WIDTH	4.00 ft
SIDE SLOPE H/V (X:1)	3.0
CHANNEL SLOPE V/H (ft/ft)	0.020
MANNING'S n (.01-0.1)	0.030
CHANNEL INVERT ELEVATION	7405.86 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	7405.86 ft

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

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	7405.86	0.000	0.00	0.00	0.00
2.17	7406.07	0.865	0.21	2.24	0.26
4.34	7406.17	0.895	0.31	2.83	0.39
6.51	7406.25	0.909	0.39	3.22	0.49
8.68	7406.32	0.917	0.46	3.52	0.57
9.20	7406.33	0.919	0.47	3.59	0.59
13.02	7406.43	0.928	0.57	3.98	0.71
15.19	7406.48	0.932	0.62	4.17	0.77
17.36	7406.53	0.935	0.67	4.34	0.83
19.53	7406.57	0.938	0.71	4.49	0.89
21.70	7406.61	0.940	0.75	4.62	0.94

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	32.00 ft
CREST LENGTH	100.00 ft
OVERTOPPING CREST ELEVATION	7411.07 ft

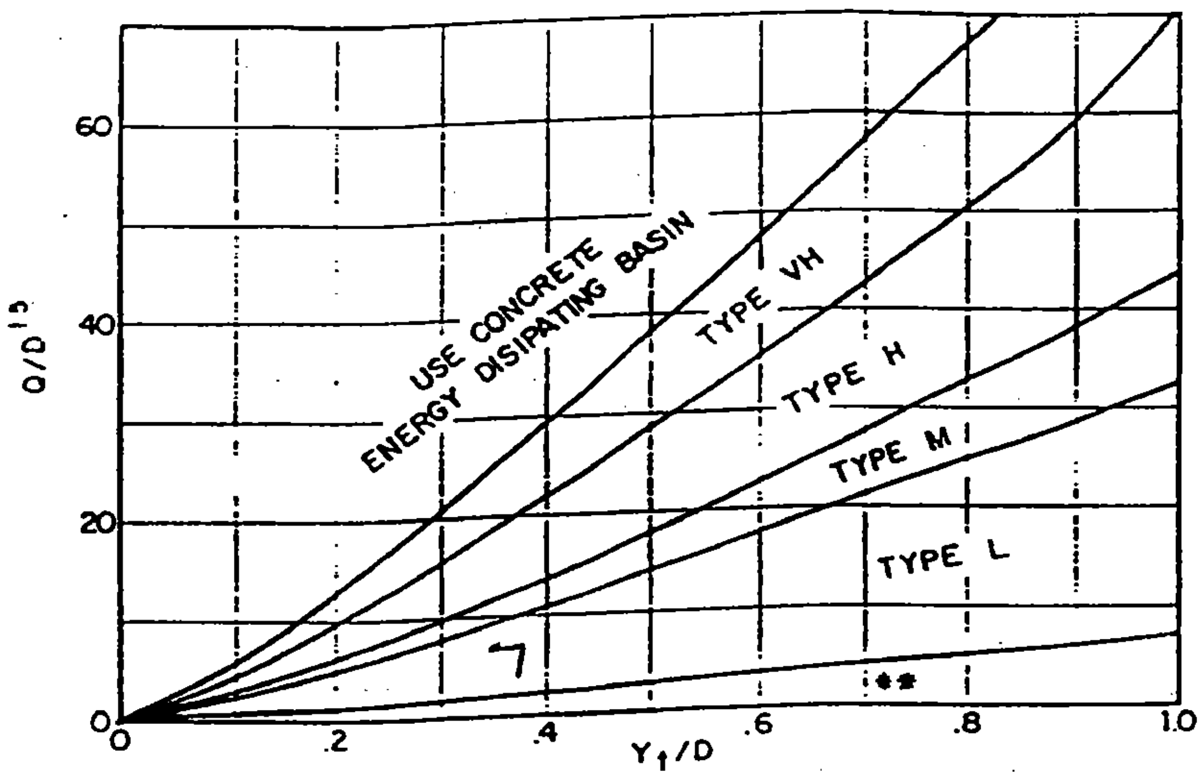
Culvert A2, $Q_{100} = 21.7$ cfs

$D = 24'' = 2.0'$

$$\frac{Q}{D^{1.5}} = \frac{21.7}{(2)^{1.5}} = 7.7$$

$Y_t = 0.75'$ (From HY8)

$$\frac{Y_t}{D} = \frac{0.75}{2.0} = 0.38$$



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

→ Use Type L (min.)

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

CURRENT DATE: 05-23-2012
CURRENT TIME: 11:04:53

FILE DATE: 05-23-2012
FILE NAME: EF-B1

FHWA CULVERT ANALYSIS
HY-8, VERSION 6.1

CULV NO.	SITE DATA			CULVERT SHAPE, MATERIAL, INLET				
	INLET ELEV. (ft)	OUTLET ELEV. (ft)	CULVERT LENGTH (ft)	BARRELS SHAPE MATERIAL	SPAN (ft)	RISE (ft)	MANNING n	INLET TYPE
1	7452.44	7449.00	64.09	1 RCP	1.50	1.50	.013	CONVENTIONAL
2								
3								
4								
5								
6								

SUMMARY OF CULVERT FLOWS (cfs) FILE: EF-B1 DATE: 05-23-2012

ELEV (ft)	TOTAL	1	2	3	4	5	6	ROADWAY	ITR
7452.44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7452.80	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7452.99	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7453.16	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7453.30	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7453.33	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7453.54	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7453.64	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7453.74	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7453.84	6.4	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0
7453.95	7.1	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: EF-B1 DATE: 05-23-2012

HEAD ELEV (ft)	HEAD ERROR (ft)	TOTAL FLOW (cfs)	FLOW ERROR (cfs)	% FLOW ERROR
7452.44	0.000	0.00	0.00	0.00
7452.80	0.000	0.71	0.00	0.00
7452.99	0.000	1.42	0.00	0.00
7453.16	0.000	2.13	0.00	0.00
7453.30	0.000	2.84	0.00	0.00
7453.33	0.000	3.00	0.00	0.00
7453.54	0.000	4.26	0.00	0.00
7453.64	0.000	4.97	0.00	0.00
7453.74	0.000	5.68	0.00	0.00
7453.84	0.000	6.39	0.00	0.00
7453.95	0.000	7.10	0.00	0.00

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

CURRENT DATE: 05-23-2012 FILE DATE: 05-23-2012
CURRENT TIME: 11:04:53 FILE NAME: EF-B1

PERFORMANCE CURVE FOR CULVERT 1 - 1(1.50 (ft) BY 1.50 (ft)) RCP

DIS-CHARGE FLOW (cfs)	HEAD-WATER ELEV. (ft)	INLET CONTROL DEPTH (ft)	OUTLET CONTROL DEPTH (ft)	FLOW TYPE <F4>	NORMAL DEPTH (ft)	CRIT. DEPTH (ft)	OUTLET DEPTH (ft)	TW DEPTH (ft)	OUTLET VEL. (fps)	TW VEL. (fps)
0.00	7452.44	0.00	0.00	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
0.71	7452.80	0.36	0.36	1-S2n	0.17	0.31	0.01	0.09	56.02	0.96
1.42	7452.99	0.55	0.55	1-S2n	0.23	0.45	0.15	0.13	15.45	1.26
2.13	7453.16	0.72	0.72	1-S2n	0.30	0.55	0.30	0.17	8.46	1.46
2.84	7453.30	0.86	0.86	1-S2n	0.34	0.64	0.24	0.20	15.39	1.63
3.00	7453.33	0.89	0.89	1-S2n	0.35	0.65	0.25	0.21	14.73	1.66
4.26	7453.54	1.10	1.10	1-S2n	0.42	0.79	0.42	0.26	10.52	1.88
4.97	7453.64	1.20	1.20	1-S2n	0.46	0.85	0.35	0.28	15.40	1.99
5.68	7453.74	1.30	1.30	1-S2n	0.49	0.92	0.42	0.31	14.04	2.09
6.39	7453.84	1.40	1.40	1-S2n	0.52	0.97	0.53	0.33	11.29	2.18
7.10	7453.95	1.51	1.51	5-S2n	0.55	1.03	0.57	0.35	11.55	2.26

El. inlet face invert 7452.44 ft El. outlet invert 7449.00 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	7452.44 ft
OUTLET STATION	64.00 ft
OUTLET ELEVATION	7449.00 ft
NUMBER OF BARRELS	1
SLOPE (V/H)	0.0537
CULVERT LENGTH ALONG SLOPE	64.09 ft

***** CULVERT DATA SUMMARY ************************

BARREL SHAPE	CIRCULAR
BARREL DIAMETER	1.50 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: 05-23-2012
CURRENT TIME: 11:04:53

FILE DATE: 05-23-2012
FILE NAME: EF-B1

TAILWATER

******* REGULAR CHANNEL CROSS SECTION ****************

BOTTOM WIDTH	8.00 ft
SIDE SLOPE H/V (X:1)	3.0
CHANNEL SLOPE V/H (ft/ft)	0.010
MANNING'S n (.01-0.1)	0.030
CHANNEL INVERT ELEVATION	7449.00 ft
CULVERT NO.1 OUTLET INVERT ELEVATION	7449.00 ft

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

FLOW (cfs)	W.S.E. (ft)	FROUDE NUMBER	DEPTH (ft)	VEL. (f/s)	SHEAR (psf)
0.00	7449.00	0.000	0.00	0.00	0.00
0.71	7449.09	0.569	0.09	0.96	0.06
1.42	7449.13	0.603	0.13	1.26	0.08
2.13	7449.17	0.623	0.17	1.46	0.11
2.84	7449.20	0.636	0.20	1.63	0.13
3.00	7449.21	0.638	0.21	1.66	0.13
4.26	7449.26	0.654	0.26	1.88	0.16
4.97	7449.28	0.661	0.28	1.99	0.18
5.68	7449.31	0.666	0.31	2.09	0.19
6.39	7449.33	0.671	0.33	2.18	0.20
7.10	7449.35	0.675	0.35	2.26	0.22

ROADWAY OVERTOPPING DATA

ROADWAY SURFACE	PAVED
EMBANKMENT TOP WIDTH	32.00 ft
CREST LENGTH	100.00 ft
OVERTOPPING CREST ELEVATION	7454.79 ft

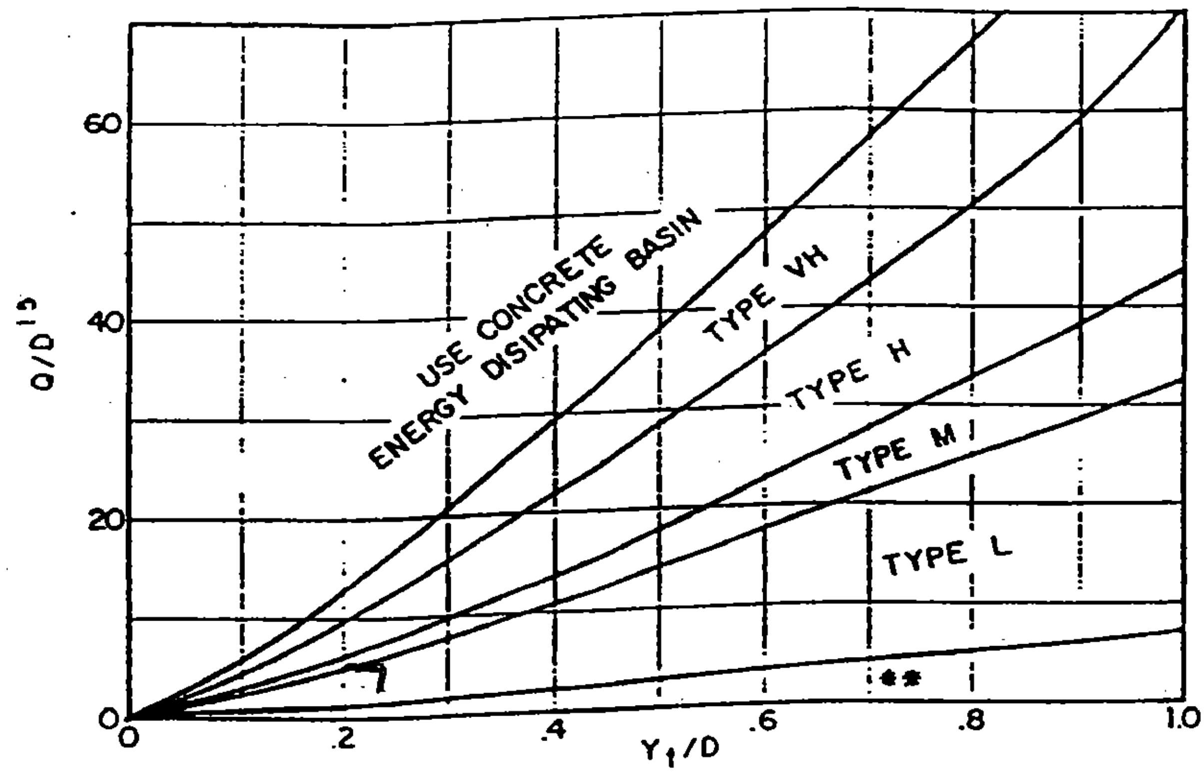
Culvert B1, $Q_{100} = 7.1$ cfs

$\Delta = 18'' = 1.5'$

$$\frac{Q}{\Delta^{1.5}} = \frac{7.1}{(1.5)^{1.5}} = 3.9$$

$Y_t = 0.35'$ (From HY8)

$$\frac{Y_t}{\Delta} = \frac{0.35}{1.5} = 0.23$$



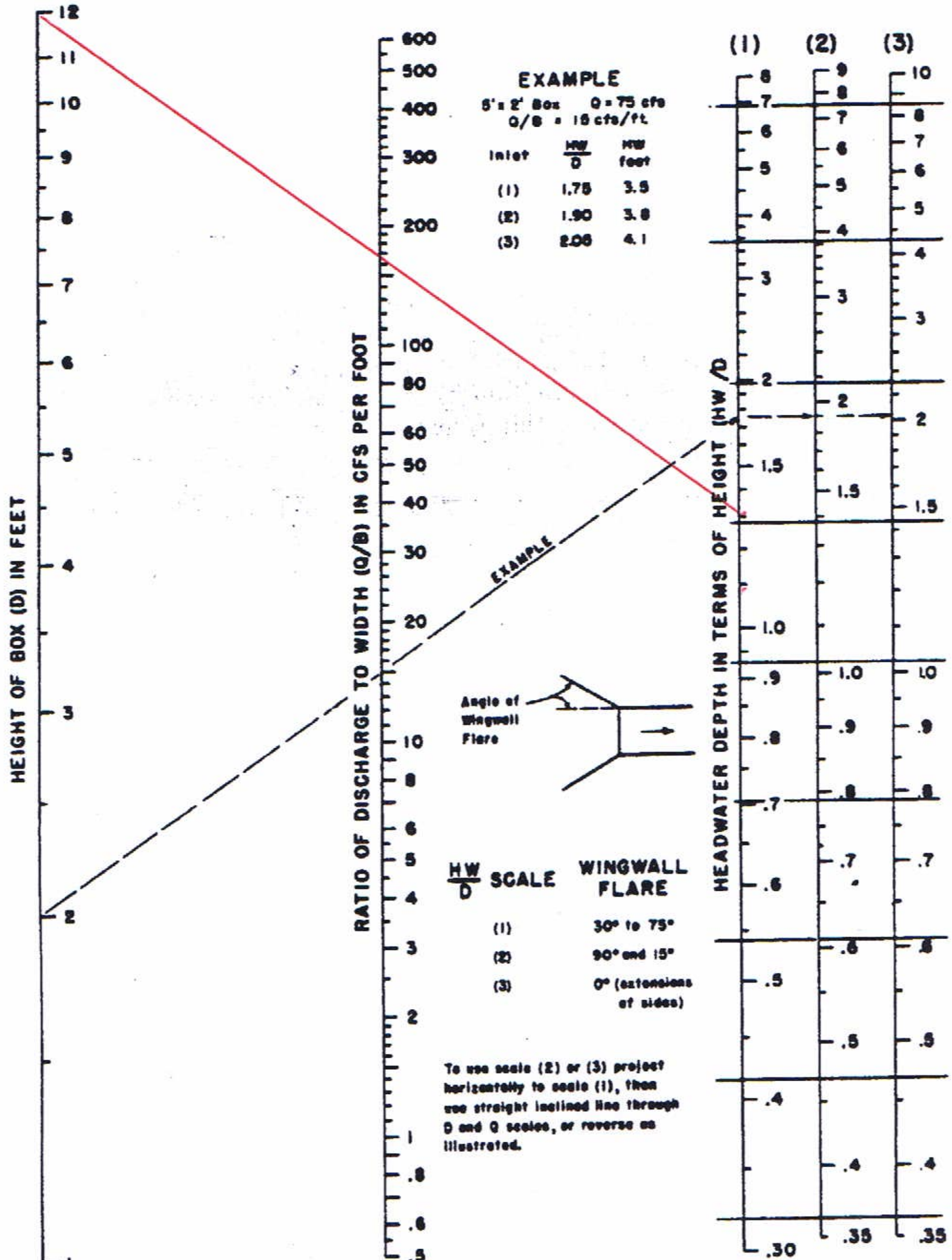
Use D_o instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

→ Use Type L (min.)

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

Approximate Capacity of Existing Bridge - Shoup Road

~ 27'W × 14'H Single-Span



HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

Existing HW/D ~ 18'/14' = 1.3

Q/B = 165; Existing B ~ 27'; Existing Capacity, Q = 165 * 27 = 4,455 CFS

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

HDR Infrastructure, Inc.
A Centerra Company

Date: OCT. 1987

Figure 9-30

APPENDIX D1

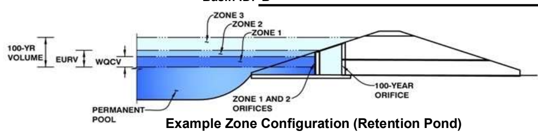
DETENTION POND CALCULATIONS

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Eagle Forest Subdivision

Basin ID: B



Example Zone Configuration (Retention Pond)

Required Volume Calculation

			Optional User Override 1-hr Precipitation	
Selected BMP Type =	**EDB**			
Watershed Area =	8.60	acres		
Watershed Length =	850	ft		
Watershed Slope =	0.026	ft/ft		
Watershed Imperviousness =	7.00%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	100.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	User Input			
Water Quality Capture Volume (WQCV) =	0.035	acre-feet		
Excess Urban Runoff Volume (EURV) =	0.055	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	0.036	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.058	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.161	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.489	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.692	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.958	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	1.472	acre-feet	3.14	inches
Approximate 2-yr Detention Volume =	0.034	acre-feet		
Approximate 5-yr Detention Volume =	0.055	acre-feet		
Approximate 10-yr Detention Volume =	0.135	acre-feet		
Approximate 25-yr Detention Volume =	0.198	acre-feet		
Approximate 50-yr Detention Volume =	0.205	acre-feet		
Approximate 100-yr Detention Volume =	0.270	acre-feet		

Stage-Storage Calculation

Zone 1 Volume (WQCV) =	0.035	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.020	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.215	acre-feet
Total Detention Basin Volume =	0.270	acre-feet

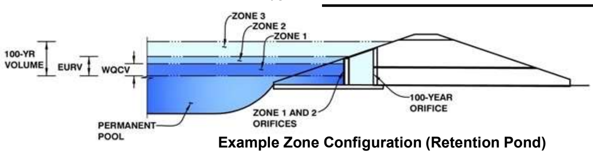
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	10	0.000		
Bot EL=7448.0	--	1.00	--	--	--	5,726	0.131	2,811	0.065
	--	3.00	--	--	--	8,427	0.193	17,021	0.391
Spillway=7451.0	--	4.00	--	--	--	9,834	0.226	26,151	0.600
Top EL=7453.0	--	6.00	--	--	--	13,000	0.298	48,985	1.125
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				
	--		--	--	--				

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Eagle Forest Subdivision
Basin ID: B



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.74	0.035	Orifice Plate
Zone 2 (EURV)	0.92	0.020	Orifice Plate
Zone 3 (100-year)	2.34	0.215	Weir&Pipe (Restrict)
		0.270	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	0.92	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	3.70	inches
Orifice Plate: Orifice Area per Row =	0.34	sq. inches (diameter = 5/8 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	2.361E-03	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.31	0.61					
Orifice Area (sq. inches)	0.34	0.34	0.34					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	5.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	1.00	N/A	feet
Over Flow Weir Slope Length =	5.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	25.17	N/A	should be $\geq$ 4
Overflow Grate Open Area w/o Debris =	14.00	N/A	ft^2
Overflow Grate Open Area w/ Debris =	7.00	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	12.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	8.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.56	N/A	ft^2
Outlet Orifice Centroid =	0.37	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.91	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	6.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

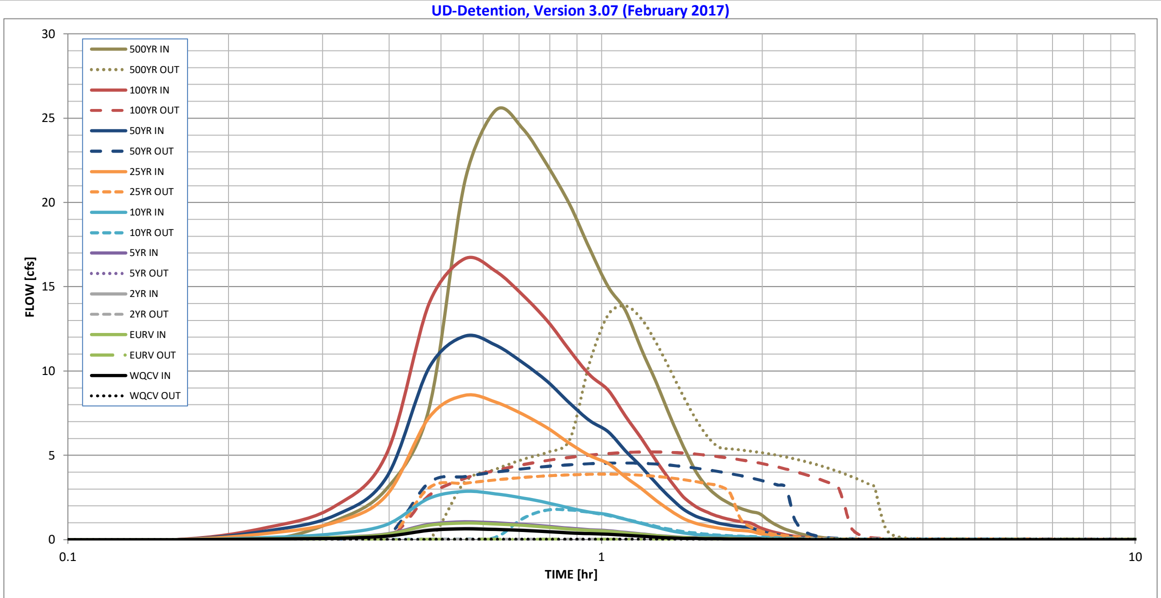
Spillway Design Flow Depth=	0.75	feet
Stage at Top of Freeboard =	5.75	feet
Basin Area at Top of Freeboard =	0.29	acres

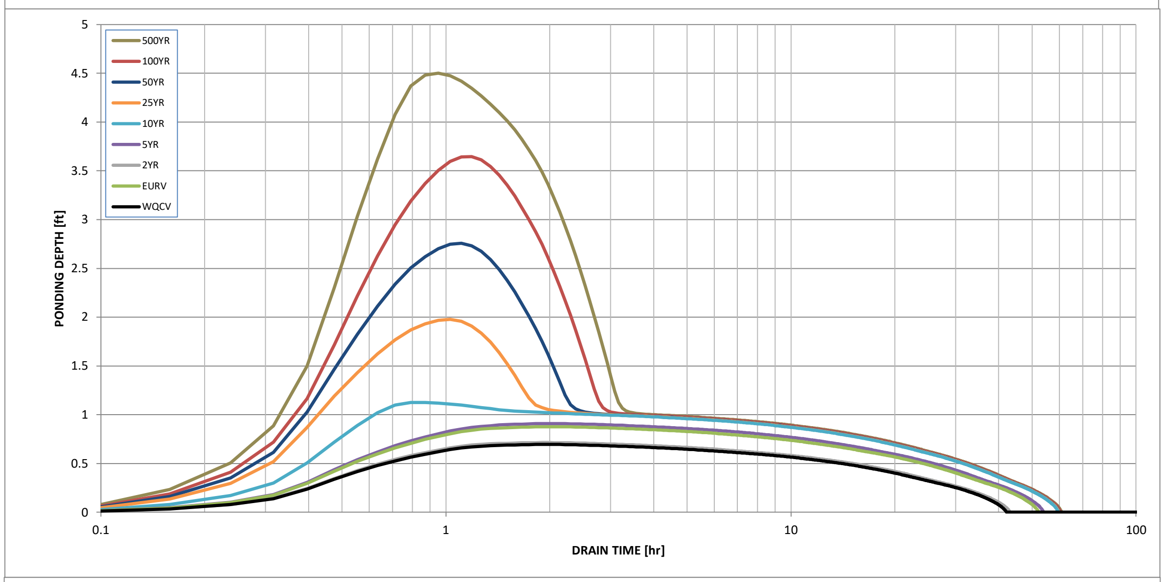
Routed Hydrograph Results

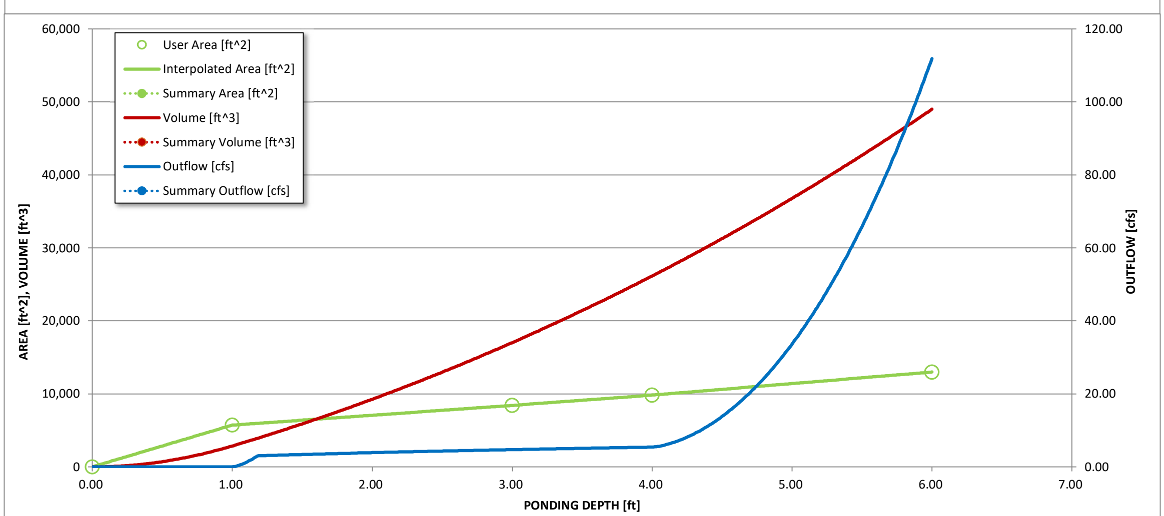
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.14
Calculated Runoff Volume (acre-ft) =	0.035	0.055	0.036	0.058	0.161	0.489	0.692	0.958	1.472
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.034	0.054	0.036	0.058	0.160	0.488	0.691	0.957	1.471
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.22	0.71	0.98	1.31	1.93
Predevelopment Peak Q (cfs) =	0.0	0.0	0.1	0.2	1.9	6.1	8.4	11.3	16.6
Peak Inflow Q (cfs) =	0.6	1.0	0.7	1.0	2.9	8.6	12.1	16.7	25.5
Peak Outflow Q (cfs) =	0.0	0.0	0.0	0.0	1.8	3.9	4.5	5.2	13.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.9	0.6	0.5	0.5	0.8
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.1	0.3	0.3	0.4	0.4
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	46	39	48	46	34	28	23	14
Time to Drain 99% of Inflow Volume (hours) =	**40**	50	41	51	54	47	43	40	35
Maximum Ponding Depth (ft) =	0.70	0.88	0.71	0.91	1.13	1.98	2.76	3.65	4.50
Area at Maximum Ponding Depth (acres) =	0.09	0.11	0.09	0.12	0.14	0.16	0.19	0.21	0.24
Maximum Volume Stored (acre-ft) =	0.031	0.050	0.033	0.053	0.082	0.208	0.343	0.521	0.718

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename:

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

Time Interval	Hydrograph Constant
4.75 min	1.052

SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:04:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:09:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0:14:15	0.03	0.05	0.03	0.05	0.13	0.38	0.53	0.73	1.10
0:19:00	0.08	0.12	0.08	0.13	0.35	1.02	1.44	1.98	3.01
0:23:45	0.20	0.31	0.21	0.33	0.89	2.63	3.70	5.08	7.72
0:28:30	0.55	0.85	0.58	0.91	2.45	7.24	10.17	13.96	21.20
0:33:15	0.63	0.98	0.66	1.05	2.85	8.56	12.08	16.66	25.47
0:38:00	0.59	0.93	0.63	0.99	2.71	8.16	11.53	15.92	24.37
0:42:45	0.54	0.84	0.57	0.90	2.47	7.43	10.49	14.49	22.18
0:47:30	0.47	0.74	0.50	0.79	2.18	6.62	9.38	12.97	19.89
0:52:15	0.40	0.63	0.42	0.67	1.87	5.71	8.10	11.22	17.26
0:57:00	0.35	0.55	0.37	0.59	1.63	4.98	7.06	9.77	15.00
1:01:45	0.31	0.50	0.33	0.53	1.48	4.51	6.39	8.86	13.60
1:06:30	0.25	0.40	0.27	0.43	1.20	3.71	5.28	7.33	11.31
1:11:15	0.20	0.32	0.21	0.34	0.97	3.02	4.31	6.01	9.31
1:16:00	0.14	0.23	0.15	0.25	0.73	2.32	3.33	4.66	7.26
1:20:45	0.10	0.16	0.11	0.18	0.53	1.72	2.48	3.49	5.50
1:25:30	0.08	0.12	0.08	0.13	0.39	1.25	1.79	2.53	4.02
1:30:15	0.06	0.10	0.07	0.11	0.31	0.97	1.39	1.95	3.07
1:35:00	0.05	0.08	0.05	0.09	0.25	0.80	1.14	1.60	2.51
1:39:45	0.04	0.07	0.05	0.07	0.22	0.68	0.97	1.36	2.12
1:44:30	0.04	0.06	0.04	0.07	0.19	0.60	0.85	1.19	1.85
1:49:15	0.04	0.06	0.04	0.06	0.17	0.54	0.77	1.07	1.67
1:54:00	0.03	0.05	0.04	0.06	0.16	0.50	0.71	0.98	1.53
1:58:45	0.02	0.04	0.03	0.04	0.12	0.36	0.52	0.72	1.13
2:03:30	0.02	0.03	0.02	0.03	0.09	0.27	0.38	0.53	0.82
2:08:15	0.01	0.02	0.01	0.02	0.06	0.20	0.28	0.39	0.61
2:13:00	0.01	0.01	0.01	0.02	0.05	0.14	0.21	0.29	0.45
2:17:45	0.01	0.01	0.01	0.01	0.03	0.10	0.15	0.21	0.32
2:22:30	0.00	0.01	0.00	0.01	0.02	0.07	0.10	0.15	0.23
2:27:15	0.00	0.00	0.00	0.01	0.02	0.05	0.07	0.10	0.17
2:32:00	0.00	0.00	0.00	0.00	0.01	0.03	0.05	0.07	0.11
2:36:45	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.04	0.07
2:41:30	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.04
2:46:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
2:51:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:55:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:00:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:05:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:14:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:19:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:24:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:29:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:33:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:38:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:43:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:48:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:52:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:57:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:02:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:07:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:11:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:16:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:21:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:26:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:30:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:35:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:40:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:49:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:54:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:59:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:04:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:08:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:13:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:18:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:23:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:27:45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:32:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:37:15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:42:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.06, November 2016)

Designer: JPS
Company: JPS
Date: July 19, 2020
Project: EAGLE FOREST SUBDIVISION
Location: FSD BASIN B

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 7.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.070

C) Contributing Watershed Area — Area = 8.600 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = ______ in

E) Design Concept (Select EURV when also designing for flood control)

Choose One
- ◯ Water Quality Capture Volume (WQCV)
- ◉ Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time ($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area)$) — V_{DESIGN}= 0.035 ac-ft

G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume ($V_{WQCV\ OTHER} = (d_6*(V_{DESIGN}/0.43))$) — $V_{DESIGN\ OTHER}$= ______ ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired) — $V_{DESIGN\ USER}$= ______ ac-ft

I) Predominant Watershed NRCS Soil Group

Choose One
- ◯ A
- ◉ B
- ◯ C / D

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
— EURV = 0.055 ac-f t

2. Basin Shape: Length to Width Ratio (A basin length to width ratio of at least 2:1 will improve TSS reduction.) — L : W = 3.0 : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred) — Z = 3.00 ft / ft

DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations: — Concrete Forebay

Design Procedure Form: Extended Detention Basin (EDB)

Designer: JPS
Company: JPS
Date: July 19, 2020
Project: EAGLE FOREST SUBDIVISION
Location: FSD BASIN B

5. Forebay	
A) Minimum Forebay Volume (V_{FMIN} = 0% of the WQCV)	V_{FMIN} = 0.000 ac-ft — A FOREBAY MAY NOT BE NECESSARY FOR THIS SIZE SITE
B) Actual Forebay Volume	V_F = ______ ac-ft
C) Forebay Depth (D_F = 12 inch maximum)	D_F = ______ in
D) Forebay Discharge	
i) Undetained 100-year Peak Discharge	Q_{100} = ______ cfs
ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$)	Q_F = ______ cfs
E) Forebay Discharge Design	Choose One: ○ Berm With Pipe ○ Wall with Rect. Notch ○ Wall with V-Notch Weir — (flow too small for berm w/ pipe)
F) Discharge Pipe Size (minimum 8-inches)	Calculated D_P = ______ in
G) Rectangular Notch Width	Calculated W_N = ______ in
6. Trickle Channel	Choose One: ◉ Concrete ○ Soft Bottom
A) Type of Trickle Channel	
F) Slope of Trickle Channel	S = 0.0050 ft / ft
7. Micropool and Outlet Structure	
A) Depth of Micropool (2.5-feet minimum)	D_M = 2.5 ft
B) Surface Area of Micropool (10 ft^2 minimum)	A_M = 10 sq ft
C) Outlet Type	Choose One: ◉ Orifice Plate ○ Other (Describe):
D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing (Use UD-Detention)	$D_{orifice}$ = 0.63 inches
E) Total Outlet Area	A_{ot} = 1.02 square inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: JPS
Company: JPS
Date: July 19, 2020
Project: EAGLE FOREST SUBDIVISION
Location: FSD BASIN B

8. Initial Surcharge Volume	
A) Depth of Initial Surcharge Volume (Minimum recommended depth is 4 inches)	D_{IS} = 6 in
B) Minimum Initial Surcharge Volume (Minimum volume of 0.3% of the WQCV)	V_{IS} = cu ft
C) Initial Surcharge Provided Above Micropool	V_s= 5.0 cu ft
9. Trash Rack	
A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$	A_t = 37 square inches
B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.) Other (Y/N): N	*S.S. Well Screen with 60% Open Area*
C) Ratio of Total Open Area to Total Area (only for type 'Other')	User Ratio =
D) Total Water Quality Screen Area (based on screen type)	A_{total} = 62 sq. in.
E) Depth of Design Volume (EURV or WQCV) (Based on design concept chosen under 1E)	H= 1 feet
F) Height of Water Quality Screen (H_{TR})	H_{TR}= 40 inches
G) Width of Water Quality Screen Opening ($W_{opening}$) (Minimum of 12 inches is recommended)	$W_{opening}$ = 12.0 inches

Design Procedure Form: Extended Detention Basin (EDB)

Designer: JPS
Company: JPS
Date: July 19, 2020
Project: EAGLE FOREST SUBDIVISION
Location: FSD BASIN B

10. Overflow Embankment A) Describe embankment protection for 100-year and greater overtopping:	Buried Riprap
B) Slope of Overflow Embankment (Horizontal distance per unit vertical, 4:1 or flatter preferred)	3.00 DIFFICULT TO MAINTAIN, INCREASE WHERE POSSIBLE
11. Vegetation	Choose One ○ Irrigated ◉ Not Irrigated
12. Access A) Describe Sediment Removal Procedures	Periodic inspection and maintenance by property owner as required Ramp provided for skid-loader access to pond bottom

Notes:

APPENDIX D2

RAIN GARDEN CALCULATIONS

EAGLE FOREST
COMPOSITE IMPERVIOUS AREAS

DEVELOPED CONDITIONS

IMPERVIOUS AREAS

BASIN	TOTAL AREA (AC)	SOIL TYPE	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	% IMP	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	% IMP	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	% IMP	WEIGHTED % IMP
OA1	297.5	B	100.00	5-AC LOTS (ZONED RR5)	7							7.000
A1.1	1.43	B	27.00	ROADWAY	100	73.00	MEADOW	0				27.000
A1.2	4.70	B	100.00	5-AC LOT	7							7.000
OA1,A1.1,A1.2	303.6	B										7.094
OA2	15.5	B	100.00	5-AC LOTS (ZONED RR3)	7							7.000
A2	2.3	B	100.00	5-AC LOT	7							7.000
OA2,A2	17.8	B										7.000
A3.1	1.87	B	16.30	ROADWAY	100	83.70	MEADOW	0				16.300
A3.2	13.64	B	100.00	5-AC LOTS	7							7.000
OA1-OA2,A1-A3	336.9	B										7.136
B1	5.6	B	100.00	5-AC LOTS	7							7.000
B2	3.0	B	100.00	5-AC LOTS	7							7.000
B1,B2	8.6	B										7.000
B3	8.9	B	100.00	5-AC LOTS	7							7.000
B1-B3	17.5	B										7.000
C	2.2	B	100.00	5-AC LOTS	7							7.000

Design Procedure Form: Rain Garden (RG)

UD-BMP (Version 3.06, November 2016)

Designer: JPS
Company: JPS
Date: December 1, 2020
Project: EAGLE FOREST SUBDIVISION
Location: BASIN A1.1

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of rain garden)	I_a = 27.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i = 0.270
C) Water Quality Capture Volume (WQCV) for a 12-hour Drain Time (WQCV= 0.8 * (0.91* i^3 - 1.19 * i^2 + 0.78 * i)	WQCV = 0.11 watershed inches
D) Contributing Watershed Area (including rain garden area)	Area = 62,291 sq ft
E) Water Quality Capture Volume (WQCV) Design Volume Vol = (WQCV / 12) * Area	V_{WQCV} = 589 cu ft
F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = ____ in
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume	$V_{WQCV\ OTHER}$ = ____ cu ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{WQCV\ USER}$ = ____ cu ft
2. Basin Geometry	
A) WQCV Depth (12-inch maximum)	D_{WQCV} = 12 in
B) Rain Garden Side Slopes (Z = 4 min., horiz. dist per unit vertical) (Use "0" if rain garden has vertical walls)	Z = 4.00 ft / ft
C) Mimimum Flat Surface Area	A_{Min} = 336 sq ft
D) Actual Flat Surface Area	A_{Actual} = 435 sq ft
E) Area at Design Depth (Top Surface Area)	A_{Top} = 815 sq ft
F) Rain Garden Total Volume (V_T= ((A_{Top} + A_{Actual}) / 2) * Depth)	V_T= 625 cu ft
3. Growing Media	Choose One: (●) 18" Rain Garden Growing Media; ( ) Other (Explain):
4. Underdrain System	Choose One: ( ) YES; (●) NO
A) Are underdrains provided?	
B) Underdrain system orifice diameter for 12 hour drain time	
i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice	y = N/A ft
ii) Volume to Drain in 12 Hours	Vol_{12} = N/A cu ft
iii) Orifice Diameter, 3/8" Minimum	D_O = N/A in

Design Procedure Form: Rain Garden (RG)

Designer: JPS
Company: JPS
Date: December 1, 2020
Project: EAGLE FOREST SUBDIVISION
Location: BASIN A1.1

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?	Choose One ○ YES ◉ NO
6. Inlet / Outlet Control A) Inlet Control	Choose One ○ Sheet Flow- No Energy Dissipation Required ◉ Concentrated Flow- Energy Dissipation Provided
7. Vegetation	Choose One ◉ Seed (Plan for frequent weed control) ○ Plantings ○ Sand Grown or Other High Infiltration Sod
8. Irrigation A) Will the rain garden be irrigated?	Choose One ○ YES ○ NO

Notes:

Design Procedure Form: Rain Garden (RG)

UD-BMP (Version 3.06, November 2016)

Designer: JPS
Company: JPS
Date: December 1, 2020
Project: EAGLE FOREST SUBDIVISION
Location: BASIN A3.1

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of rain garden)	I_a = 16.3 %
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i = 0.163
C) Water Quality Capture Volume (WQCV) for a 12-hour Drain Time (WQCV= 0.8 * (0.91* i^3 - 1.19 * i^2 + 0.78 * i)	WQCV = 0.08 watershed inches
D) Contributing Watershed Area (including rain garden area)	Area = 81,457 sq ft
E) Water Quality Capture Volume (WQCV) Design Volume Vol = (WQCV / 12) * Area	V_{WQCV} = 540 cu ft
F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = ____ in
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume	$V_{WQCV\ OTHER}$ = ____ cu ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{WQCV\ USER}$ = ____ cu ft
2. Basin Geometry	
A) WQCV Depth (12-inch maximum)	D_{WQCV} = 12 in
B) Rain Garden Side Slopes (Z = 4 min., horiz. dist per unit vertical) (Use "0" if rain garden has vertical walls)	Z = 4.00 ft / ft
C) Mimimum Flat Surface Area	A_{Min} = 266 sq ft
D) Actual Flat Surface Area	A_{Actual} = 435 sq ft
E) Area at Design Depth (Top Surface Area)	A_{Top} = 815 sq ft
F) Rain Garden Total Volume (V_T= ((A_{Top} + A_{Actual}) / 2) * Depth)	V_T= 625 cu ft
3. Growing Media	Choose One: (●) 18" Rain Garden Growing Media; ( ) Other (Explain):
4. Underdrain System	
A) Are underdrains provided?	Choose One: ( ) YES; (●) NO
B) Underdrain system orifice diameter for 12 hour drain time	
i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice	y = N/A ft
ii) Volume to Drain in 12 Hours	Vol_{12} = N/A cu ft
iii) Orifice Diameter, 3/8" Minimum	D_O = N/A in

Design Procedure Form: Rain Garden (RG)

Designer:	**JPS**
Company:	**JPS**
Date:	**December 1, 2020**
Project:	**EAGLE FOREST SUBDIVISION**
Location:	**BASIN A3.1**

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?	Choose One ○ YES ◉ NO
6. Inlet / Outlet Control A) Inlet Control	Choose One ○ Sheet Flow- No Energy Dissipation Required ◉ Concentrated Flow- Energy Dissipation Provided
7. Vegetation	Choose One ◉ Seed (Plan for frequent weed control) ○ Plantings ○ Sand Grown or Other High Infiltration Sod
8. Irrigation A) Will the rain garden be irrigated?	Choose One ○ YES ○ NO

Notes:

APPENDIX E

DRAINAGE COST ESTIMATE

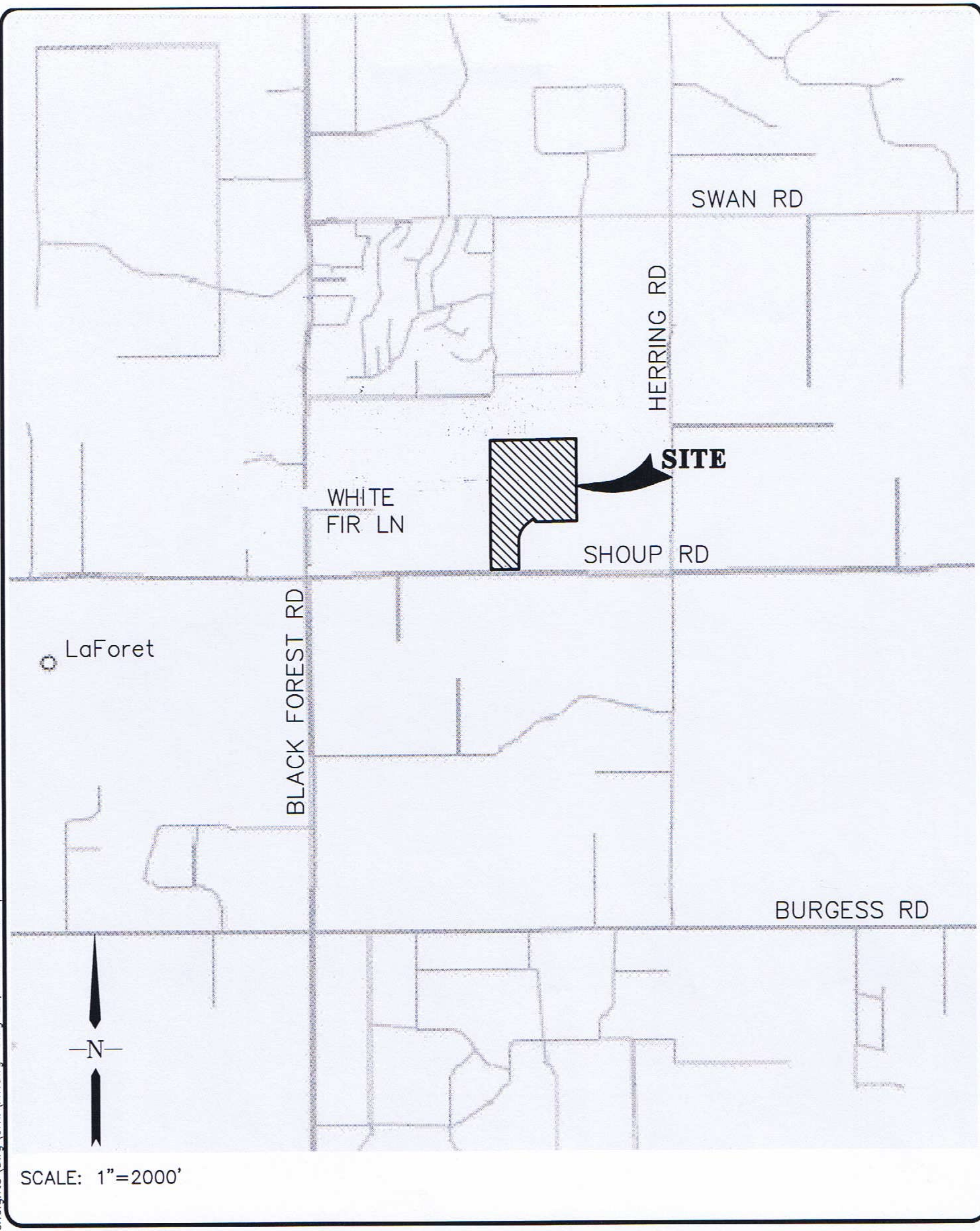
the stilling basin should be included in the improvements

EAGLE FOREST SUBDIVISION
DRAINAGE IMPROVEMENTS COST ESTIMATE

Item No.	Description	Quantity	Unit	Unit Cost ($$$)	Total Cost ($$$)
	PRIVATE DRAINAGE IMPROVEMENTS				
506	Riprap Aprons (d_{50} = 12")	10	CY	$98	$980
603	12" HDPE Pond Discharge Pipe w/ FES	78	LF	$55	$4,290
604	Detention Pond Grading	500	CY	$5	$2,500
604	Detention Pond Outlet Structure	1	LS	$8,000	$8,000
604	Detention Pond Spillway	1	LS	$3,000	$3,000
	SUBTOTAL				**$18,770**
	Contingency @ 15%				$2,816
	TOTAL				**$21,586**
	PUBLIC DRAINAGE IMPROVEMENTS (NON-REIMBURSABLE)				
506	Riprap Culvert Aprons (d_{50} = 12")	25	CY	$98	$2,450
603	18" RCP Culvert w/ FES	104	LF	$65	$6,760
603	24" RCP Culvert w/ FES	64	LF	$78	$4,992
603	60" RCP Culvert w/ FES	108	LF	$288	$31,104
603	18" FES	2	EA	$390	$780
603	24" FES	2	EA	$468	$936
603	60" FES	2	EA	$1,728	$3,456
	SUBTOTAL				**$50,478**
	Contingency @ 15%				$7,572
	TOTAL				**$58,050**
	TOTAL DRAINAGE IMPROVEMENTS				**$79,635**

APPENDIX F

FIGURES



J:\jpsprojects\010501.eagleheights\dwg\civil\A1.dwg Aug 28, 2007 - 3:21pm

J:\jpsprojects\010501.eagleheights\dwg\civil\A1.dwg, 8/28/2007 3:21:01 PM

VICINITY MAP	JPS ENGINEERING	EAGLE FOREST SUBDIVISION FIGURE A1 JPS PROJ NO. 010501

National Flood Hazard Layer FIRMette

FEMA

104°41'43"W 39°1'5"N

Feet
0 250 500 1,000 1,500 2,000

1:6,000

104°41'5"W 39°0'37"N

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) *Zone A, V, A99*
	With BFE or Depth *Zone AE, AO, AH, VE, AR*
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
	Area with Flood Risk due to Levee *Zone D*
OTHER AREAS	NO SCREEN Area of Minimal Flood Hazard *Zone X*
	Effective LOMRs
	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Levee, Dike, or Floodwall
OTHER FEATURES	20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
	Coastal Transect
	513 Base Flood Elevation Line (BFE)
	Limit of Study
	Jurisdiction Boundary
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
MAP PANELS	Digital Data Available
	No Digital Data Available
	Unmapped

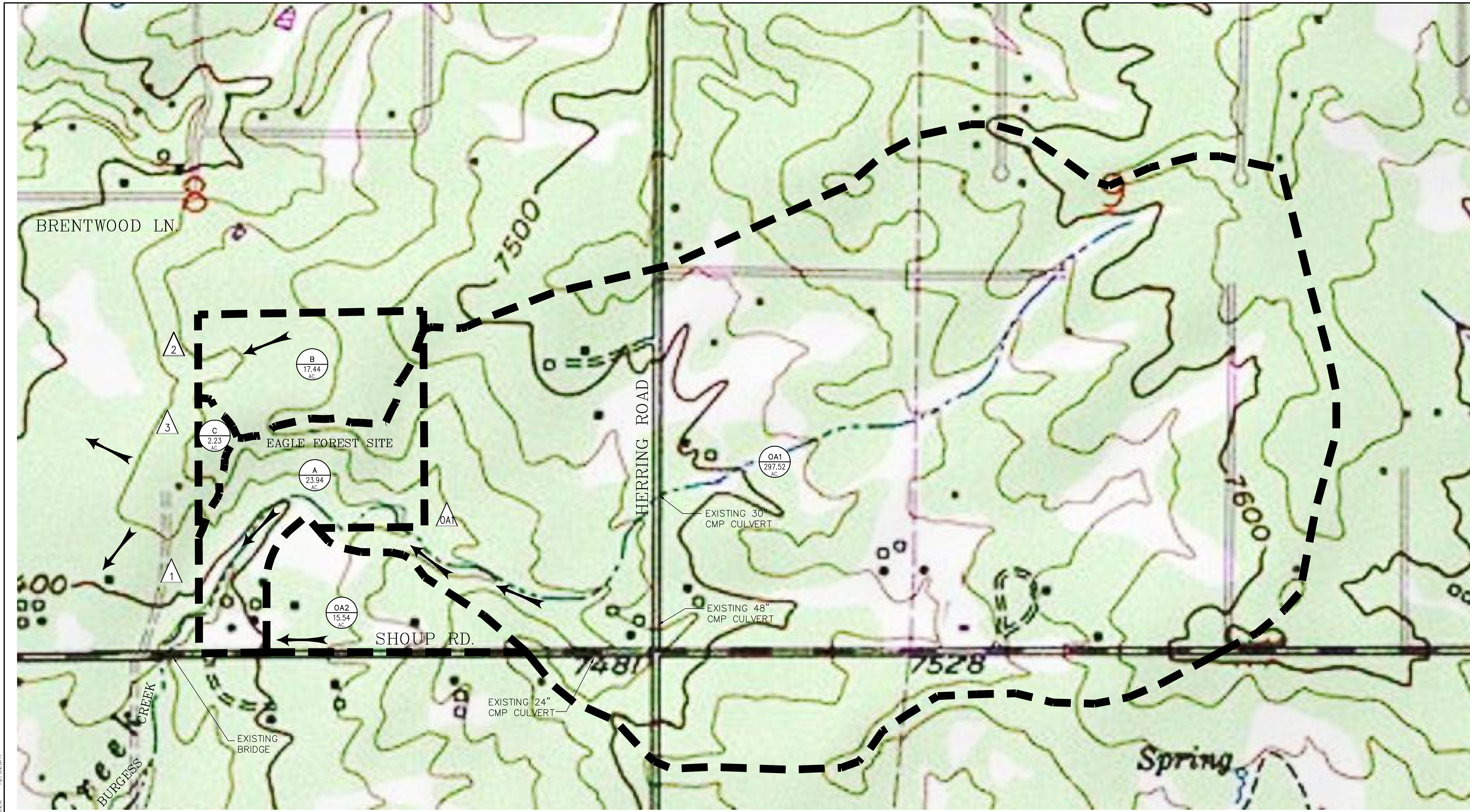
N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 7/20/2020 at 6:48 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.



LEGEND

- FILING LIMITS
- MAJOR BASIN BOUNDARY
- 6520 EXISTING CONTOUR
- DRAINAGE CHANNEL
- FLOW DIRECTION ARROW
- 1 DESIGN POINT
- A BASIN DESIGNATION
- 3 AC BASIN AREA (ACRES)

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
A2.1	6.4	30.9
1	67.7	287.1
2	3.1	22.9
3	0.6	4.5

N

GRAPHIC SCALE

300 0 300 600

ORIGINAL SCALE: 1"=300'
CONTOUR INTERVAL=20'

JPS ENGINEERING

19 E. Willamette Ave.
Colorado Springs, CO
80903

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

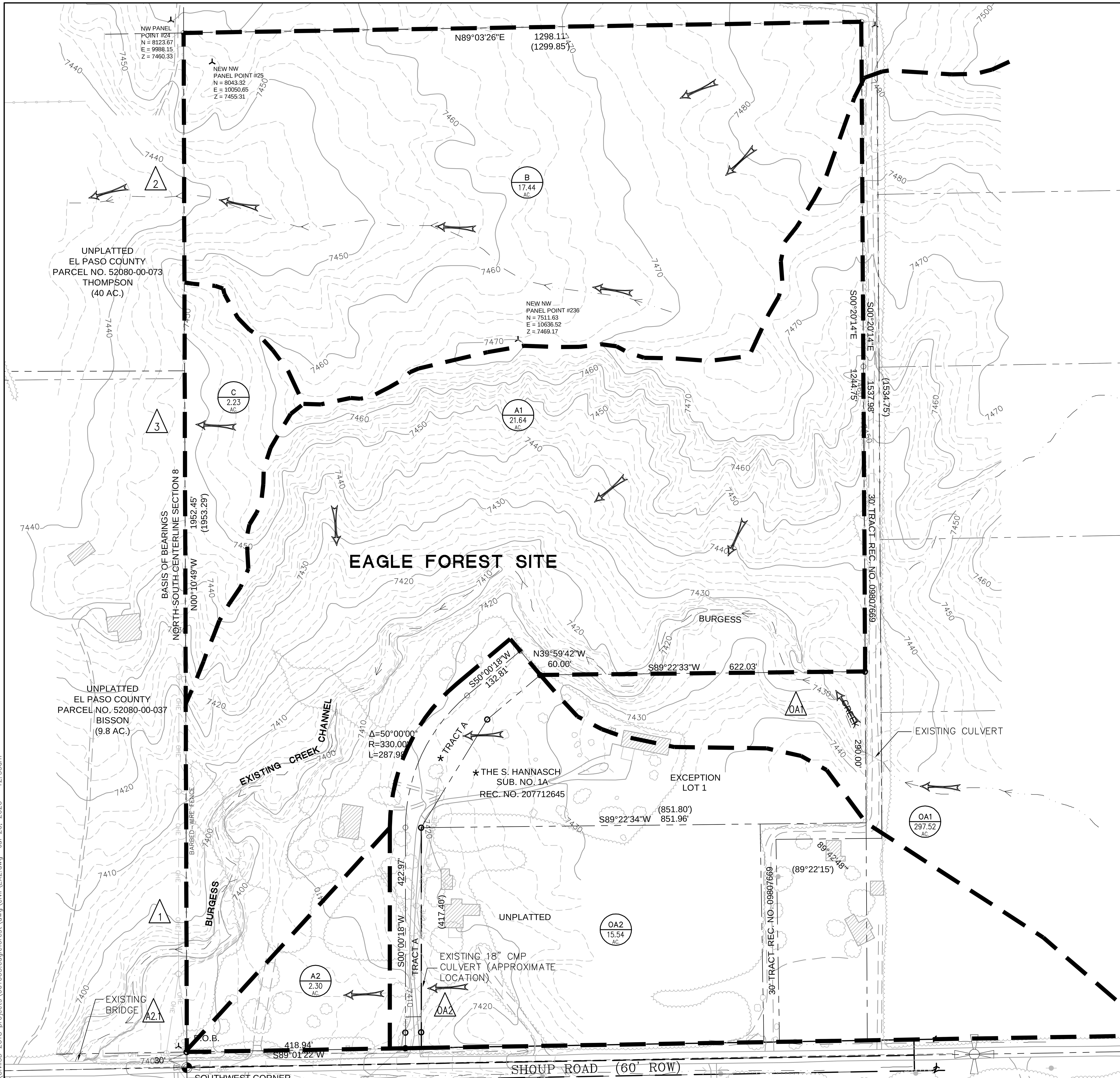
EAGLE FOREST SUBDIVISION

No.	REVISION	BY	DATE

MAJOR BASIN/ HISTORIC DRAINAGE PLAN

HORZ. SCALE:	1"=300'	DRAWN:	MSP
VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:	LWA	CHECKED:	JPS
CREATED:	1/13/05	LAST MODIFIED:	7/20/20
PROJECT NO:	061003	MODIFIED BY:	MSP
SHEET:	EX1		

C:\Civil3D 2018 projects\061003.eagleforest\dwg\civil\EX1.dwg Jul 20, 2020 - 12:32pm



LEGEND

- FILING LIMITS
- MAJOR BASIN BOUNDARY
- 6520 EXISTING CONTOUR
- DRAINAGE CHANNEL
- PROPOSED FLOW DIRECTION ARROW
- 1 DESIGN POINT
- A BASIN DESIGNATION
- 3 AC BASIN AREA (ACRES)

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
A2.1	6.4	30.9
1	67.7	287.1
2	3.1	22.9
3	0.6	4.5

JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO 80903
PH: 719-477-9429
FAX: 719-471-0766

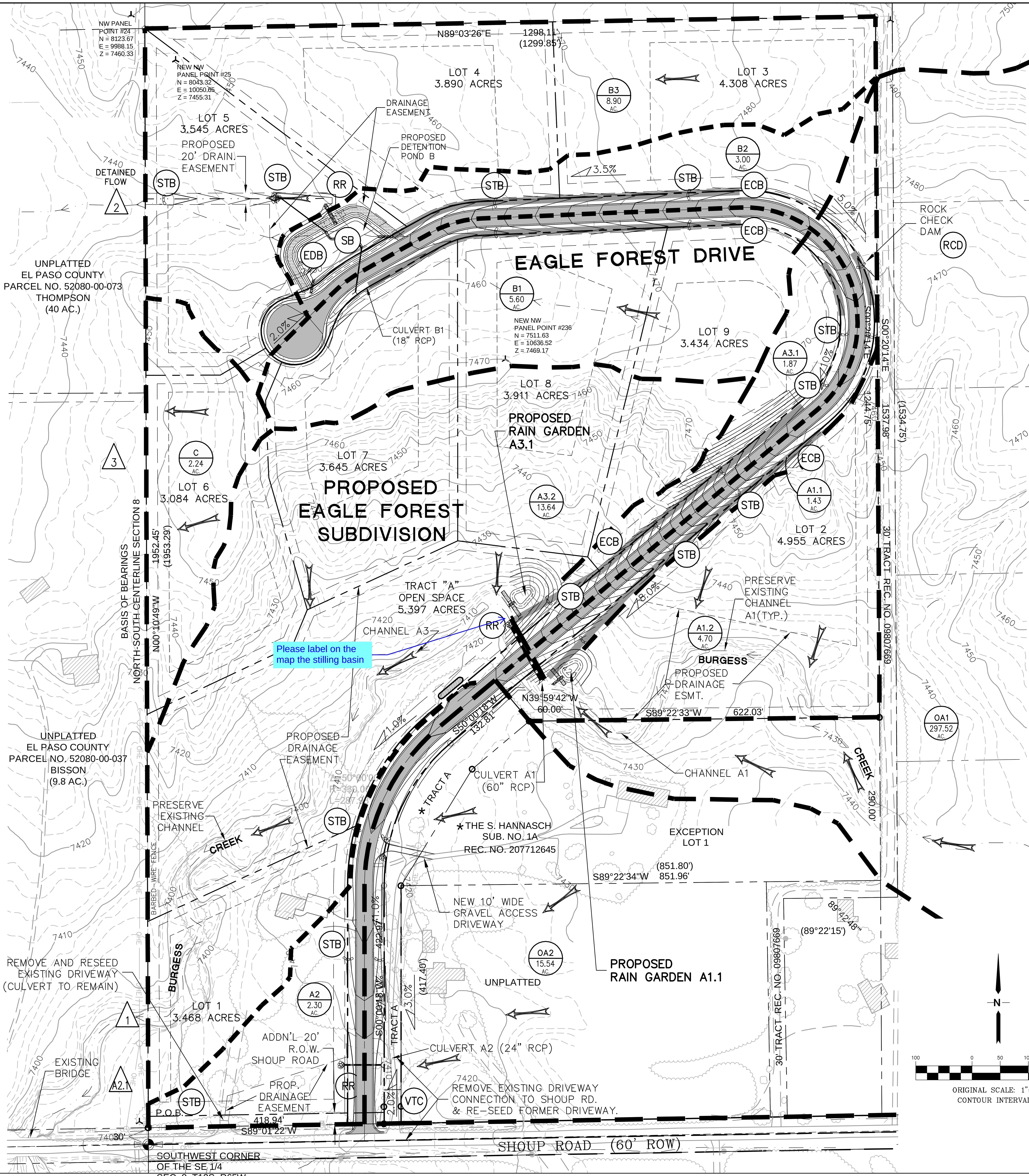
EAGLE FOREST SUBDIVISION

HISTORIC DRAINAGE PLAN

NO.	REVISION	BY	DATE

HORZ. SCALE:	1"=100'	DRAWN:	MSP
VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:	LWA	CHECKED:	JPS
CREATED:	1/13/05	LAST MODIFIED:	7/20/20
PROJECT NO:	061003	MODIFIED BY:	MSP
SHEET:	EX2		

C:\Civil3D 2018 projects\061003.eagleforest\dwg\Civil\EX2.dwg Jul 20, 2020 - 12:33pm



LEGEND

FILING LIMITS	
MAJOR BASIN BOUNDARY	
MINOR BASIN BOUNDARY	
6520	EXISTING CONTOUR
DRAINAGE CHANNEL	
PROPOSED FLOW DIRECTION ARROW	
PROPOSED CULVERT W/ FLARED END SECTIONS	
DESIGN POINT	1
BASIN DESIGNATION / BASIN AREA (ACRES)	A / 3 AC
RIPRAP	RR
VEHICLE TRACKING CONTROL PAD	VTC
STRAW BALE BARRIER	STB
SEDIMENT BASIN	SB
EXTENDED DETENTION BASIN	EDB
EROSION CONTROL BLANKET DITCH LINING (NAG C350 OR EQUAL)	ECB
ROCK CHECK DAM	RCD

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
A2.1	6.4	30.9
1	68.1	285.2
2(DEVELOPED)	6.0	28.7
2(DETAINED)	3.3	21.2
3	1.1	5.2

ORIGINAL SCALE: 1"=100'
CONTOUR INTERVAL=2'

JPS ENGINEERING
19 E. Willamette Ave.
Colorado Springs, CO 80903
PH: 719-477-9429
FAX: 719-471-0766

EAGLE FOREST SUBDIVISION

DEVELOPED DRAINAGE & EROSION CONTROL PLAN

HORZ. SCALE: 1"=100'	DRAWN: MSP
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: LWA	CHECKED: JPS
CREATED: 1/13/05	LAST MODIFIED: 12/28/20
PROJECT NO: 061003	MODIFIED BY: MSP
SHEET: D1	

C:\Civil3D 2018 projects\061003.eagleforest\dwg\civil\D1.dwg Dec 28, 2020 - 4:23pm