Preliminary & Final Drainage Report

for

Rex Road

through

Falcon Regional Park

MERIDIAN RANCH

A GOLF & RECREATIONAL COMMUNITY

EL PASO COUNTY, COLORADO

June 2023

Prepared For:

GTL DEVELOPMENT, INC.
P.O. Box 80036
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Prepared By:
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PCD Project No. CDR236

CERTIFICATIONS

Design 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 applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

COLORADO REGISTERED PROFESSIONAL ENGINEER
THOMAS A. KERBY
31429

Thomas A. Kerby, P.E. #31429

Owner/Developer's Statement:

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

______________________________ 6/5/2023

Raul Guzman, Vice President Date
GTL Development, Inc.
P.O. Box 80036
San Diego, CA 92138

El Paso County:

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

______________________________ __________

Joshua Palmer, P.E. Date
County Engineer / ECM Administrator

Rex Road
Preliminary/Final Drainage Report

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EXECUTIVE SUMMARY

The purpose of the following Preliminary/Final Drainage Report (PDR/FDR) is to present the changes to the drainage patterns as a result of constructing the extension of Rex Road through Falcon Regional Park from Meridian Ranch to Eastonville Road. Runoff quantities and proposed facilities have been calculated using the current City of Colorado Springs/El Paso County Drainage Criteria Manual (DCM) (1994 version) and portions of the City of Colorado Springs Drainage Criteria Manual, Volume 1 (DCM-1) ((2014 version) as amended by the El Paso County Engineering Criteria Manual (ECM).

This report based on the current version of the Meridian Ranch Sketch Plan amendment as adopted by the El Paso County Board of Commissioners on August 5, 2021. Hydrologic calculations follow method outlined in Chapter 6 of the 2014 version of the City of Colorado Springs Drainage Criteria Manual (COSDCM) as adopted by the El Paso County Board of County Commissioners by Resolution 15-042. Chapter 6 addresses the hydrologic calculation methods and includes an updated hydrograph to be used with storm drainage runoff. The Board adopted by the same resolution, Section 3.2.1 of Chapter 13 of the COSDCM referencing Full Spectrum Detention; the concept "provides better control of the full range of runoff rates that pass through detention facilities than the convention multi-stage concept. This section of the COSDCM identifies the necessity to provide full spectrum detention but does not prescribe a methodology to reach such the detention requirements. This report includes hydrologic models from HEC-HMS for the historic, interim and future conditions for the 2-yr, 5-yr, 10-yr, 25-yr, 50-yr, and 100-yr design storm frequencies. The interim and the future conditions include the existing detention facilities sized and modeled such that *"frequent and infrequent inflows are released at rates approximating undeveloped conditions."*

The Rex Road extension is approximately ¼ mile long between Meridian Ranch on the west and Eastonville Road on the east, is approximately 4.2 acres and is located within the Falcon Regional Park in Section 21, Township 12 South, Range 64 West of the 6th Principal Meridian. It is approximately 12 miles northeast of the city of Colorado Springs, 2.5 miles north of the unincorporated town of Falcon.

This segment of Rex Road is located within Gieck Ranch Drainage Basin. The Gieck Ranch Basin has been studied, but has not received final approval from El Paso County.

Based on the aforementioned design parameters the construction of the project will not adversely affect downstream properties.

INTRODUCTION

Purpose

The purpose of the following Preliminary/Final Drainage Report (PDR/FDR) is to present proposed changes to the drainage patterns as a result of the construction of Rex Road. The report outlines and compares the calculated post construction flows with those of allowable exiting runoff discharge.

Scope

The scope of this report includes:

- Location and description of the proposed development stating the proposed land use, density, acreage and adjacent features to the site.
- Calculations for design peak flows from all off-site tributary drainage areas.
- Calculations for design peak flows within the proposed project area for all drainage areas.
- Discussion of major drainage facilities required as a result of the development.
- Discussion and analysis of existing and proposed facilities.

Runoff quantities and proposed facilities have been calculated using the current City of Colorado Springs/El Paso County Drainage Criteria Manual (DCM) (1994 version) and those portions of the City of Colorado Springs Drainage Criteria Manual, Volume 1 (DCM-1) ((2014 version) adopted by Resolution 15-042 of the El Paso County Board of County Commissioners as amended by the El Paso County Engineering Criteria Manual (ECM).

Background

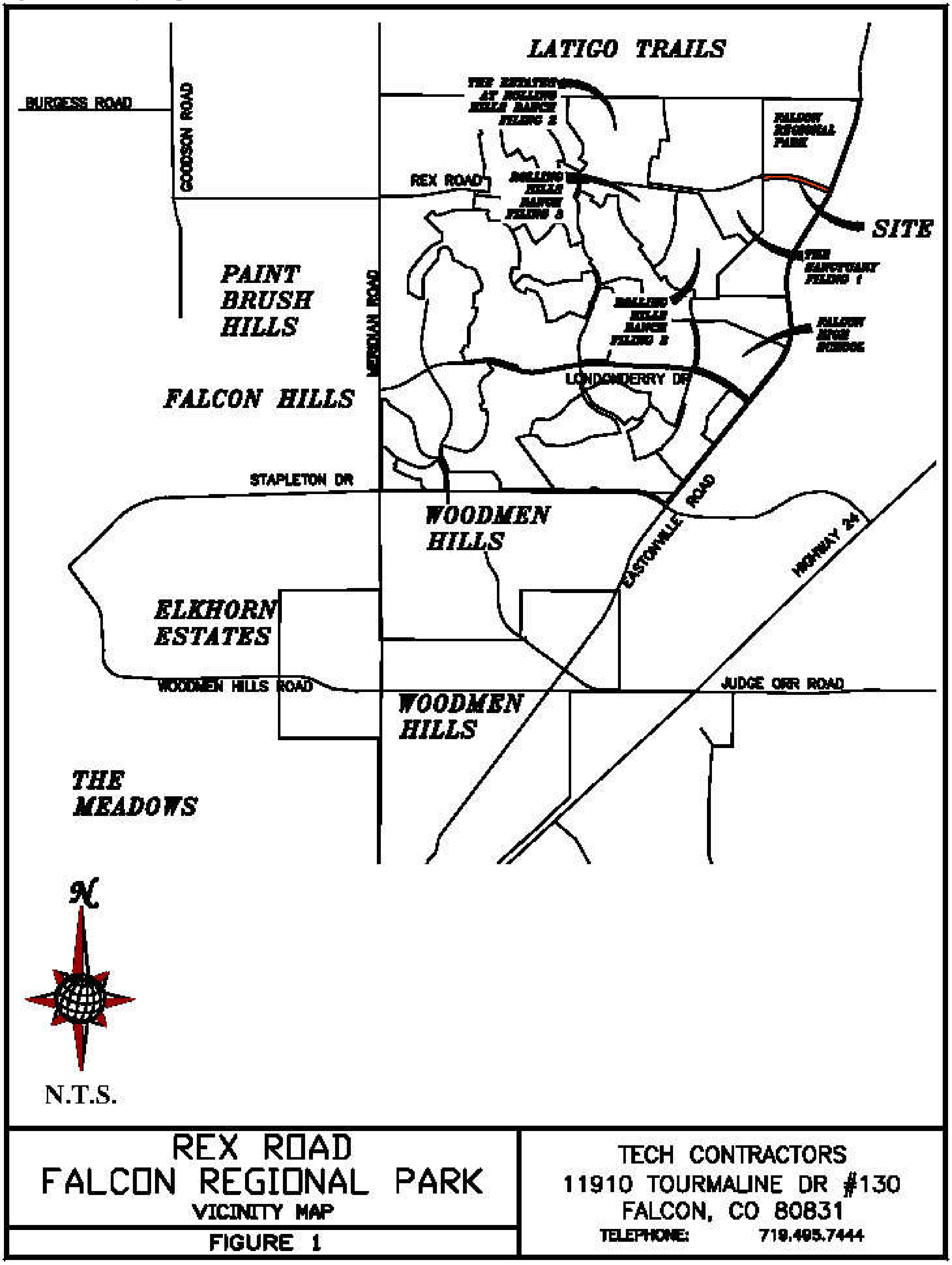
On November 16, 2000 the El Paso County Board of County Commissioners approved the rezoning of the Meridian Ranch project (PUD-00-010) from A-35 to PUD with several conditions. Condition number seven stated in part that "drainage plans shall release and/or retain at approximately eighty percent (80%) of historic rates." At the time of the initial approvals there were no drainage improvements downstream of the Meridian Ranch project and the existing natural channels were shallow and undefined.

The Sketch Plan Amendment (SKP-21-003) was processed and approved in 2021 by the El Paso County Board of County Commissioners by Resolution 21-332 for Meridian Ranch. The resolution eliminated the required restriction of 80% of historic peak flow rates mentioned above. The drainage patterns proposed with this project will cause peak flow rates to approximate the historic peak flow rates as per the current El Paso County stormwater requirements.

No development has occurred downstream of Eastonville Road, however the approved Meridian Ranch MDDP and this report indicate the Eastonville Road culvert crossing located downstream of this project does not provide enough capacity for the historic flow rates. It is anticipated that this culvert will be replaced with the Eastonville Road construction proposed by El Paso County.

Current calculations show the future design discharge flow rates across Eastonville Road to be below historic flow rates at full buildout for the full spectrum of design storms.

Figure 1: Vicinity Map



EXISTING CONDITIONS

General Location

The Rex Road extension project is approximately ¼ mile long located between Meridian Ranch on the west and Eastonville Road on the east, is approximately 4.2 acres and is located in Section 21, Township 12 South, Range 64 West of the 6th Principal Meridian. It is approximately 12 miles northeast of the city of Colorado Springs, 2.5 miles north of the unincorporated town of Falcon, and immediately north of the Woodmen Hills development.

Land Use

Historically, ranching dominated the area surrounding Meridian Ranch; however, currently urbanization has occurred in the general vicinity. Most notably, urbanization is occurring to the north with Latigo Trails, to the south and west the Meridian Ranch Subdivisions, and to the east in Grandview Reserve. The current and proposed land use surrounding the project is open space/ regional park. There are no existing utilities except buried electrical feed owned by Mountain View Electric.

A shallow swale traverses the site from northwest to southeast providing drainage for areas north of the project and carries the flow way from the site toward Eastonville Road.

Climate

Mild summers and winter, light precipitation; high evaporation and moderately high wind velocities characterize the climate of the study area. The average annual monthly temperature is 48.4 F with an average monthly low of 30.3 F in the winter and an average monthly high of 68.1 F in the summer. Two years in ten will have maximum temperature higher than 98 F and a minimum temperature lower than –16 F. Precipitation averages 15.73" annually, with 80% of this occurring during the months of April through September. The average annual Class A pan evaporation is 45 inches. (Soil Survey of El Paso County Area, Colorado).

Topography and Floodplains

The topography of the site is typical of a high desert, short prairie grass (approximately 60% vegetative cover) with relatively flat slopes generally ranging from 2% to 4%. The project site drains generally from the northwest to southeast and is tributary to the Black Squirrel Creek. There are no trees or brush located on the project site.

The Flood Insurance Rate Maps (FIRM No. 08041C0552G dated 12/07/2018) indicates that the project is outside of any designated flood plain. Please see Figure 2: The Sanctuary Federal Emergency Management Agency (FEMA) Floodplain Map.

Geology

The National Resources Conservation Service (NRCS) soil survey records indicate that the service area is predominately covered by soils classified in the Columbine (3.0 ac.) and Stapleton series (2.1 ac.). These series are categorized in the Hydrological Soil Groups A & B.

The Stapleton (83) sandy loam is a deep, non-calcareous, well-drained soil formed in alluvium derived from arkosic bedrock on uplands. Permeability of this soil is rapid. Available water

Figure 2: FEMA Floodplain Map

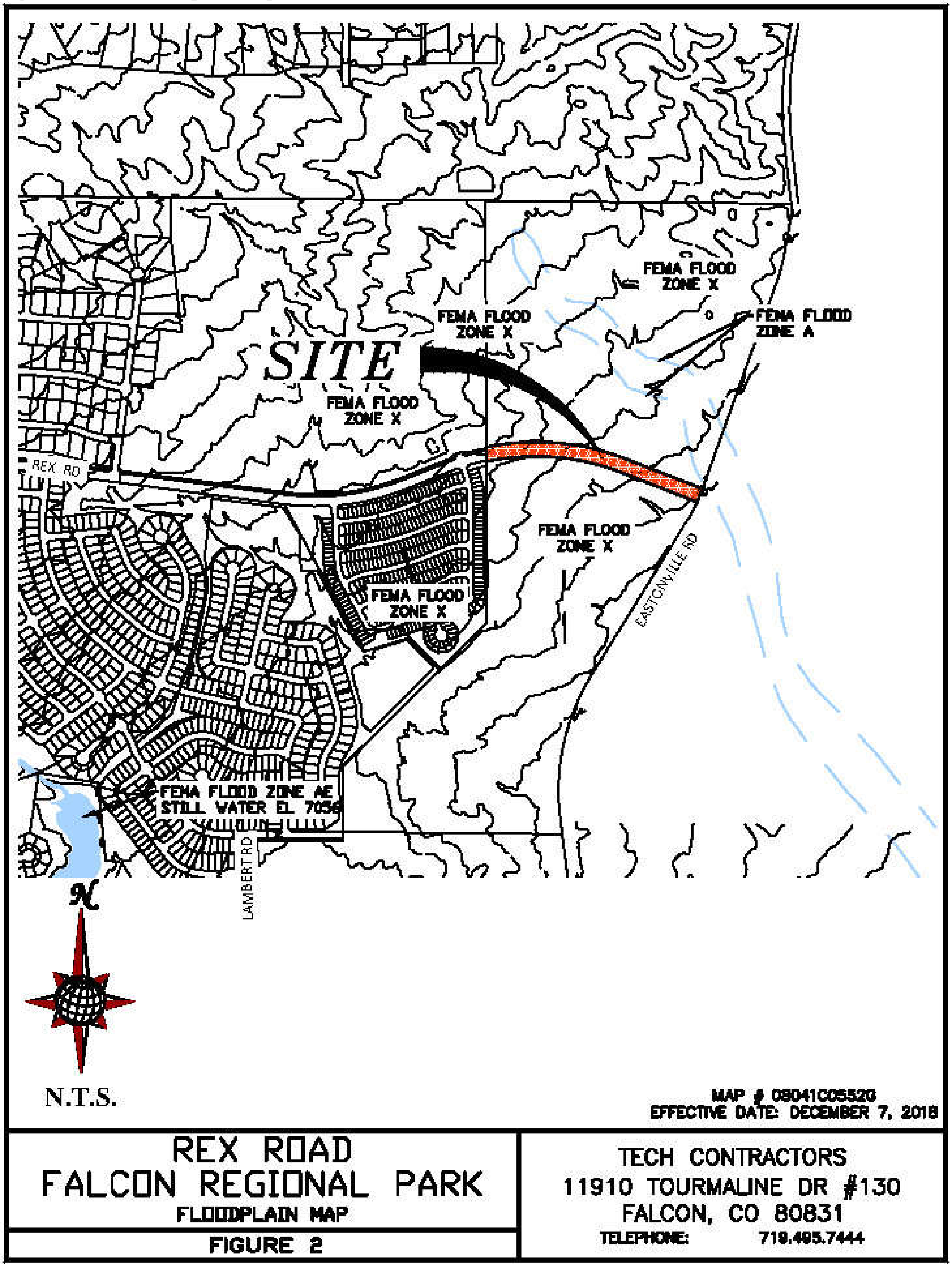
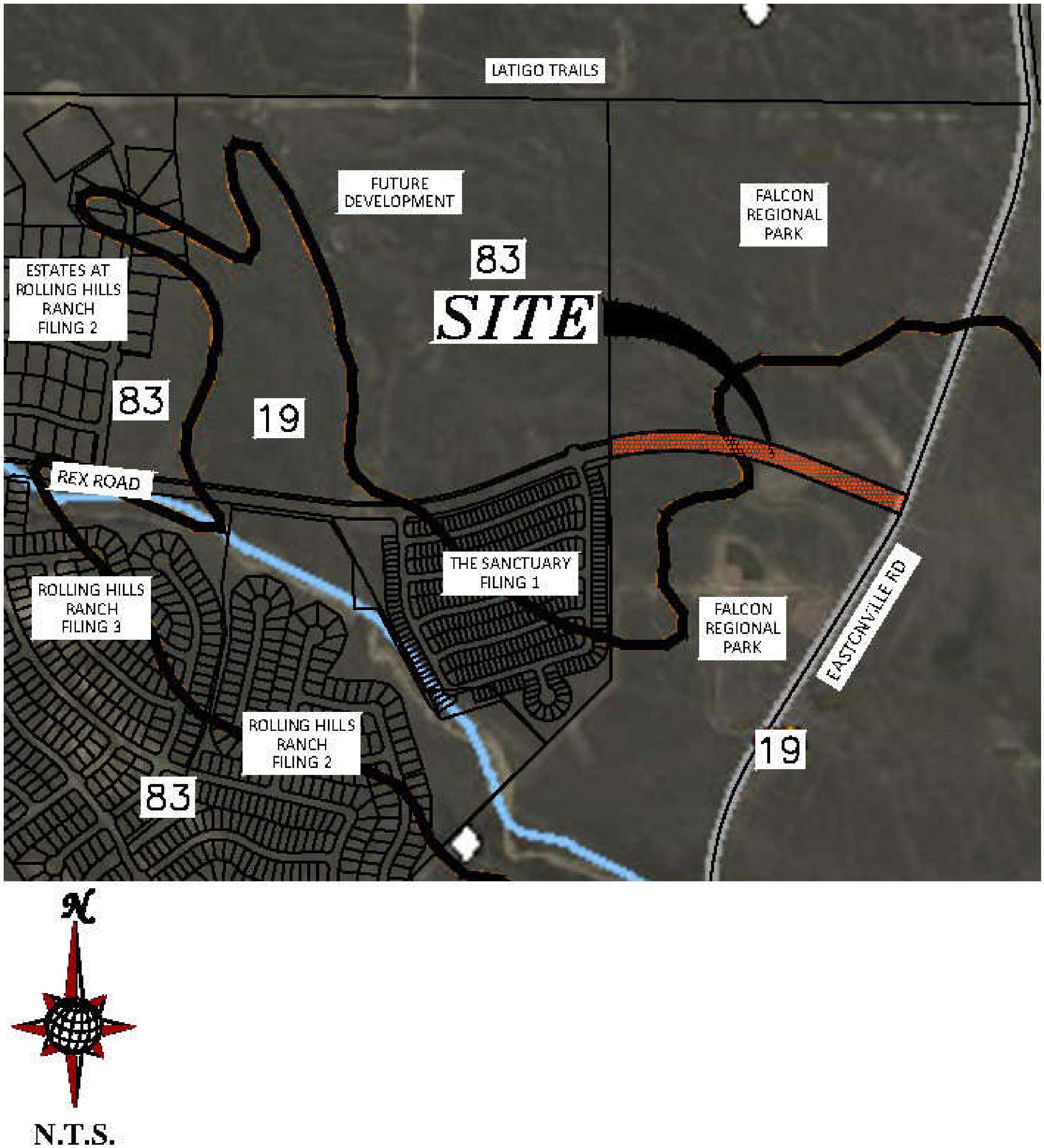


Figure 3: Soils Map



REX ROAD
FALCON REGIONAL PARK
SOILS MAP

FIGURE 3

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capacity is moderate, surface runoff is slow, and the hazard of erosion and soil blowing is moderate. The Stapleton series is categorized as a Hydrological Soil Group B.

This soil is used mainly for grazing livestock, for wildlife habitat and for home sites. The main limitation of this soil for urban development is a hazard of flooding in some areas.

This soil is suited to habitat for open land and rangeland wildlife. The main limitation of this soil for urban development is frost-action potential.

Typically, these soils are well-drained, gravelly sandy loams that form on alluvial terraces and fans and exhibit high permeability and low available water capacity with depth to bedrock greater than 6 feet.

The Columbine (19) gravelly sandy loam is a deep, well-drained to excessively drained soil formed in coarse textured material on alluvial terraces, fans and flood plains. Permeability of this soil is very rapid. Available water capacity is low to moderate, surface runoff is slow, and the hazard of erosion is slight to moderate. The Columbine series is categorized as a Hydrological Soil Group A.

This soil is used mainly for grazing livestock, for wildlife habitat and for home sites. The main limitation of this soil for urban development is a hazard of flooding in some areas.

Note: (#) indicates Soil Conservation Survey soil classification number. See Figure 3 the Sanctuary Filing 1 – Soils Map.

Natural Hazards Analysis

Natural hazards analysis indicates that no unusual surface or subsurface hazards are located near the vicinity. However, because the soils are cohesionless, sloughing of steep banks during drilling and/or excavation could occur. By citing improvements in a manner that provides an opportunity to lay the banks of excavations back at a 1:1 slope during construction, the problems associated with sloughing soils can be minimized.

DRAINAGE BASINS AND SUB-BASINS

The site is near the top of the Gieck Ranch Drainage Basin and accepts flow from areas north of the extension of Rex Road within undeveloped areas of Meridian Ranch and portions of the Latigo development.

Two different scenarios were analyzed for the drainage conditions for the project.

The first scenario analyzes the historic conditions for the area. This condition has project site and tributary area in the pre-development state; where the tributary and downstream areas were modeled in its undeveloped, undisturbed condition, alternatively called the historic condition.

The second scenario is the proposed conditions scenario and it consists of the current existing conditions for the tributary areas whether developed or undeveloped/historic with the addition of the Rex Road extension in the proposed developed condition. The current existing conditions assume all approved projects tributary to the project are at full buildout. This condition was analyzed to ensure that the historic flow rates are approximated at the culverts crossing Eastonville Road.

The future final scenario has not been included with this report as the future design of the remainder of Rex Road is to be designed by others. No design specifics have been made available for the future intersection of Rex Road and Eastonville Road. The future build out conditions for the areas tributary and downstream of the project could not be modeled accurately to ensure the storm drain peak flow rate and design at the Eastonville Rd crossing locations downstream of this project approximate the peak historic flow rates.

DRAINAGE DESIGN CRITERIA

SCS Hydrograph Procedure

The US Army Corp of Engineers HEC-HMS computer program was used to model the Soil Conservation Service (SCS) Hydrograph procedure to determine final design parameters for the major drainage facilities within the project. Onsite basin areas were calculated using aerial topography of the site and approved final design data. Times of concentration were estimated using the SCS procedures described in the DCM. Based upon the hydrologic soil type, the natural conditions found in the basins and the runoff curve numbers (CN) chart from Table 6-10 of the City of Colorado Springs DCM for Antecedent Runoff Condition II (ARC II), the following CN values were used for the given conditions.

Table 1: SCS Runoff Curve Numbers

Condition	CN*
Residential Lots (5 acre)	63
Residential Lots (2.5 acre)	66
Residential Lots (1 acre)	68
Residential Lots (1/2 acre)	70
Residential Lots (1/3 acre)	72
Residential Lots (1/4 acre)	75
Residential Lots (1/5 acre)	78
Residential Lots (1/6 acre)	80

School	80
Parks/Open Space	62
Commercial	85
Roadways	98
Graded	67
Golf Course	62
Latigo Undeveloped	65
Undeveloped	61

*Curve Numbers were interpolated and based on amount of impervious area per lot. The 24 hour storm precipitation values were selected from the NOAA Atlas 14, Volume 8, Version 2 for the Meridian Ranch location (Latitude 38.9783°, Longitude -104.5842°, Elevation 7054 ft). These numbers along with SCS information were used as input to the U.S. Army Corp of Engineers HEC-HMS computer model to determine design runoffs. See the table for all the design storm events in Appendix A. These numbers along with SCS information were used as input to the U.S. Army Corp of Engineers HEC-HMS computer model to determine design runoffs.

Full Spectrum Design

No detention facilities are proposed with this project. Areas tributary that are located within Meridian Ranch have been graded such that the runoff is conveyed away from and around the Falcon Regional Park. Water quality for the proposed roadway improvements will be achieved by directing the surface flow from the roadway platform to existing natural swales south of Rex Rd. and directed toward a proposed bioretention basin.

DRAINAGE CALCULATIONS

SCS General Overview

The project is located within the Gieck Ranch Drainage Basin; storm water runoff will be conveyed overland across the Regional Park natural swales or carried by proposed curb and gutter in a southeasterly direction towards existing Eastonville Road.

The bulk of historic overland flows from within Meridian Ranch have been directed away from the Falcon Regional Park to be kept within Meridian Ranch and conveyed to the existing Pond G detention facility. See approved preliminary and final drainage reports associated with the Rolling Hills Ranch Filings 1-3 (SF1923, SF2020, SF2116) and the Sanctuary Filing 1 (SF2220) final plats and the Rolling Hills Ranch North Grading (EGP2202) for more information regarding drainage within Meridian Ranch. The remaining mostly undeveloped flows from Latigo Trails, undeveloped Meridian Ranch Open Space and the Falcon Regional Park will continue within the natural grass lined swales approximately matching the historic flows for the full spectrum of design storms.

Figure 4: Rex Road SCS Calculations – Historic Conditions Map and Figure 5: Rex Road SCS Calculations – Proposed Conditions Map depict the historic and proposed general drainage patterns through the Regional Park across and under Rex Road toward Eastonville Road..

The purpose of this report is to show that the construction of Rex Road will not adversely impact the existing drainage facilities adjacent to and downstream of the proposed Rex Road construction.

SCS Calculations

Historic Drainage - SCS Calculation Method

Following is a tabulation of the surface drainage characteristics under Existing Conditions using the SCS calculation method. Please refer to Figure 4 – Rex Road SCS Calculations - Historic Basin Map.

Table 2: Historic Drainage Basins – SCS

HISTORIC SCS (Full Spectrum)						
HYDROLOGIC ELEMENT	Drainage Area (SQ. MI.)	Peak Discharge Q100 (CFS)	Peak Discharge Q50 (CFS)	Peak Discharge Q10 (CFS)	Peak Discharge Q5 (CFS)	Peak Discharge Q2 (CFS)
HG14	0.2297	79	52	12	4.7	0.8
HG13	0.1053	38	25	5.8	2.2	0.4
G14	0.1053	38	25	5.8	2.2	0.4
G14-G16	0.1053	37	25	5.8	2.2	0.4
G16	0.3350	116	77	18	6.8	1.2

The project site drains generally from the northwest to southeast with relatively flat slopes generally ranging from 2% to 4%.

Proposed Drainage - SCS Calculation Method

Following is a tabulation of the surface drainage characteristics for the proposed conditions using the SCS calculation method. Please refer to Figure 5 – Rex Road SCS Calculations – Proposed Basins Map

Table 3: Future Drainage Basins-SCS

PROPOSED SCS (Full Spectrum)						
HYDROLOGIC ELEMENT	Drainage Area (SQ. MI.)	Peak Discharge Q100 (CFS)	Peak Discharge Q50 (CFS)	Peak Discharge Q10 (CFS)	Peak Discharge Q5 (CFS)	Peak Discharge Q2 (CFS)
OS09b	0.0435	22	14	3.2	1.1	0.2
OS09b-G14	0.0435	22	14	3.2	1.1	0.2
FG34	0.0275	20	13	3.3	1.3	0.2
G14	0.0710	38	25	5.5	2.0	0.3
G14-G15	0.0710	37	24	5.5	2.0	0.3
FG35	0.0292	25	18	5.5	2.4	0.5
G15	0.1002	55	36	8.0	3.0	0.6
G15-G16	0.1002	54	35	8.0	3.0	0.6
FG37	0.0754	46	31	7.3	2.7	0.4
FG36	0.0295	19	13	3.9	1.8	0.4
G15a	0.0295	19	13	3.9	1.8	0.4
G15a-G16	0.0295	19	13	3.8	1.7	0.4
G16	0.2051	114	74	16	6.5	1.2

Rational Calculations

The Rational Hydrologic Calculation Method was used to estimate the total runoff from the 5-year and the 100-year design storm and thus establish the storm drainage system design for facilities with less than 100 acres if tributary area. Using the rational calculation methodology outlined in the Hydrology Section (Ch 6) of the COSDCM coupled with the El Paso County EPCDCM an effective drainage design for the Rex Road construction has been designed. The storm drainage facilities have been designed such that the minor storm will be conveyed such that the street flow does not overtop the curbs. The culvert undercrossing has been designed such that the major storm will be safely conveyed downstream under Rex Road.

The site is located within the Gieck Ranch Drainage Basin. The storm drain runoff will be collected by natural swales and conveyed southeasterly toward Eastonville Road and away from the project without damaging adjacent property.

Rational Narrative

The following is a detailed narrative of the proposed storm drainage runoff tributary to Rex Road (see Figure 6 for more information). These storm drainage analysis meets the requirements as found in the El Paso County Engineering Criteria Manual I.7.1.C.5. (ECM) for storm water quality and discharge into Waters of the State. Discharge points are located on the south side of Rex Road (DP15 & DP15a).

- Basin OS9b (28 acres, Q_5= 5.0 CFS, Q_{100} = 34 CFS) contains off-site area north of Meridian Ranch within the future Latigo Trails subdivision entering Meridian Ranch via existing natural swale at Design Point 1. The surface runoff is collected into natural drainage swales and ultimately directed southerly through Meridian Ranch Basin FG34 to DP G14.

- Basin FG34 (18 acres, Q_5= 4.7 CFS, Q_{100} = 25 CFS) contains open space area within the future Rolling Hills Ranch North subdivision entering the Falcon Regional Park via a natural swale at Design Point G14. The surface runoff is collected into natural drainage swales and ultimately directed southerly to the Falcon Regional Park. The flow (Q_5= 7.5 CFS, Q_{100} = 46 CFS) is conveyed downstream via a natural swale to a proposed culvert at Rex Road (DP G15.1).

- Basin FG35a (14 acres, Q_5= 4.5 CFS, Q_{100} = 23 CFS) contains area within the Falcon Regional Park north of Rex Road. The surface runoff will sheet flow toward natural swales and is directed toward a proposed 36" RCP culvert under Rex Road located at DP G15.1. The total flow at the culvert (Q_5= 8.0 CFS, Q_{100} = 47 CFS) is conveyed downstream via a 36" RCP where the culvert flow is combined with runoff from Basin FG35b at Inlet I01.

- Basin FG35b (4.9 acres, Q_5= 6.3 CFS, Q_{100} = 17 CFS) contains area north of Rex Rd and portions of Rex Road east of Meridian Ranch and west of the above mentioned 36" RCP culvert crossing. The surface runoff will sheet flow off the surrounding areas onto Rex Road and the flow will be directed to a proposed flow-by inlet (Inlet I01) and combined with the flow in the 36" RCP culvert. Most of the flow is captured (Q_5= 5.2 CFS, Q_{100} = 12 CFS) with the remaining flow (Q_5= 1.2 CFS, Q_{100} = 5.3 CFS) continuing downstream to Design Point G15a. The combined flow in the 30" RCP (Q_5= 4.9 CFS, Q_{100} = 23 CFS) from Basin FG36a will continue downstream along a natural channel through Basin FG37.

- Basin FG36a (18 acres, Q_5= 5.3 CFS, Q_{100} = 26 CFS) contains Regional Park area north of Rex Road within the Falcon Regional Park west of Eastonville Road. The surface runoff flows to a natural swale toward a proposed 30" RCP culvert near the intersection of Rex Rd with Eastonville Rd. The culvert flow is conveyed downstream to DP15a.

- Basin FG36c (2.8 acres, Q_5= 3.3 CFS, Q_{100} = 8.0 CFS) contains area north of Rex Road within the Falcon Regional Park west of Eastonville Road. The surface runoff sheet flows onto Rex Rd. The surface runoff is combined with the by-pass flow from Inlet I01 and is carried eastward toward the intersection of Rex Rd with Eastonville Rd. Near the intersection the flow (Q_5= 4.2 CFS, Q_{100} = 12 CFS) is directed southerly via a down drain to DP15a where it is combined with the culvert flow from FG36a. The total flow (Q_5= 8.0 CFS, Q_{100} = 32 CFS) is directed to DP16a.

- Basin FG37 (48 acres, Q_5= 10 CFS, Q_{100} = 62 CFS) contains area within the Falcon Regional Park south of Rex Rd. The surface flow from the area combines with the runoff from the Rex Rd culvert crossings and is directed to the Eastonville Rd culvert crossing located at DP G16 (Q_5= 15 CFS, Q_{100} = 78 CFS).

DETENTION POND

There are no existing or proposed detention ponds associated with this project. Water quality is achieved through the benefit of runoff reduction through portions of the adjacent swales and the construction of a bioretention pond near the southeast corner of the intersection of Rex Rd with Eastonville Rd.

DRAINAGE FEES

The proposed project falls in the Gieck Ranch Drainage Basin and there are no drainage or bridge fees associated with the Gieck Ranch Drainage Basin and this is not a final plat.

The following is the imperviousness calculation:

	Acres	Assumed Imperviousness	Impervious Acres
Open Space	0.0	3%	0.0
Right-of-way	4.2	90%	4.6
Residential Lots	0.0	65%	0.0
Total	4.2		3.8=90% imperv.

GIECK RANCH FEES:

Drainage Fees: There are no drainage fees for this basin.

Bridge Fees: There are no bridge fees for this basin.

CONCLUSION

The rational and SCS based hydrologic calculation methods were used to estimate the historic and developed runoff values to determine the impact of this extension of Rex Road on surrounding property. The resulting calculations were used to estimate the hydraulic impact on the existing natural drainage swales and proposed facilities.. Based on the aforementioned design parameters the extension of Rex Road will not adversely affect downstream properties as the resultant developed flow rates for the various design storms fall below the historic flow rates of the same storms.

Below is a comparison of various flow rates at key design points:

MERIDIAN RANCH DISCHARGE KEY DESIGN POINTS							
Proposed Conditions SCS Calculations		Peak Discharge Q100 (CFS)	Peak Discharge Q50 (CFS)	Peak Discharge Q10 (CFS)	Peak Discharge Q5 (CFS)	Peak Discharge Q2 (CFS)
G14 - DISCHARGE POINT TO REGIONAL PARK (G07 - HISTORIC)	Historic	38	25	5.8	2.2	0.4
	Proposed	38	25	5.5	2.0	0.3
	% of Historic	100%	100%	95%	89%	85%
G16 - EASTONVILLE RD[1] DOWNSTREAM OF REX RD	Historic	116	77	18	6.8	1.2
	Proposed	114	74	16	6.5	1.2
	% of Historic	98%	97%	89%	95%	99%

[1] Flow rate at Eastonville Rd. listed for reference only

EROSION CONTROL DESIGN

General Concept

Historically, erosion on this property has been held to a minimum by a variety of natural features and agricultural practices including:

- Substantial prairie grass growth
- Construction of drainage arresting berms
- Construction of multiple stock ponds along drainage courses

During construction, best management practices (BMP) for erosion control will be employed based on El Paso County Criteria. BMP's will be utilized as deemed necessary by the contractor and/or engineer and are not limited to the measures shown on the construction drawing set. The contractor shall minimize the amount of area disturbed during all construction activities.

In general the following shall be applied in developing the sequence of major activities:

- Install down-slope and side-slope perimeter BMP's before the land disturbing activity occurs.
- Do not disturb an area until it is necessary for the construction activity to proceed
- Cover or stabilize as soon as possible.
- Time the construction activities to reduce the impacts from seasonal climatic changes or weather events.
- The construction of filtration BMP's should wait until the end of the construction project when upstream drainage areas have been stabilized.
- Do not remove the temporary perimeter controls until after all upstream areas are stabilized.

Four Step Process

The following four step process is recommended for selecting structural BMP's in developing urban areas:

Step 1: Quantify Runoff Reduction

The intent of this approach is to avoid the direct connection of impervious areas to the storm drain and instead, guide runoff from pavement and roofs to vegetated areas such as grass buffers and grass swales in a manner that maintains sheet flow conditions. The soil type in the vicinity of this project is conducive to infiltration.

This project is located within the Falcon Regional Park with minimal hardscape surfaces proposed. The project will include a standard right-of-way, half-width pavement section and sidewalk along the south side. Run-off from the street will be directed to adjacent grass lined swales and buffers to carry the stormwater downstream. The grass lined swales will reduce the need for larger water quality basins and provide some form of runoff reduction.

Step 2: Stabilize Drainageways

The existing natural drainage swales traversing the area and located adjacent to the project will remain primarily in its natural state with a wide flat bottom and gentle slope reducing the velocity of the concentrated flow traveling along the drainageway.

Step 3: Provide Water Quality Capture Volume (WQCV)

Bioretention is proposed near the southeast terminus of the project providing the necessary WQCV for the project minus the credits from runoff reduction.

Step 4: Consider Need for Industrial and Commercial BMP's

This project is neither industrial nor commercial and therefore this section does not apply.

See Appendix D for more information.

Detention Pond

There is no proposed detention pond associated with this project.

Silt Fence and/or Straw Wattles

Straw Wattles or silt fence will be placed along downstream limits of disturbed areas. This will prevent suspended sediment from leaving the site during infrastructure construction. Silt fencing is to remain in place until vegetation is reestablished.

Straw Wattles and/or Erosion Bales

Straw wattles or erosion bales will be placed ten (10) feet from the upstream end of all culverts during construction to prevent culverts from filling with sediment. Erosion wattles/bales will remain in place until vegetation is reestablished. Erosion checks will be used in disturbed drainage swales where the slopes are greater than 1 percent in order to reduce flow velocities until vegetation is reestablished.

Miscellaneous

Best erosion control practices will be utilized as deemed necessary by the Contractor or Engineer and are not limited to the measures described above.

REFERENCES

1. "City of Colorado Springs/El Paso County Drainage Criteria Manual" September 1987, Revised November 1991, Revised October 1994.

2. Chapter 6, Hydrology and Chapter 11, Storage, Section 3.2.1 of the "City of Colorado Springs Drainage Criteria Manual" May 2014.

3. "Volume 2, El Paso County/City of Colorado Springs Drainage Criteria Manual-Stormwater Quality Policies, Procedures and Best Management Practices" November 1, 2002.

4. Flood Insurance Rate Study for El Paso County, Colorado and Incorporated Areas. Federal Emergency Management Agency, Revised March 17, 1997.

5. Soils Survey of El Paso County area, Natural Resources Conservation Services of Colorado.

6. Master Development Drainage Plan Meridian Ranch. August 2000. Prepared by URS Corp.

7. Revision to Master Development Drainage Plan Meridian Ranch. July 2021. Prepared by Tech Contractors.

8. Master Development Drainage Plan Latigo Trails. October 2001. Prepared by URS Corp.

9. Final Drainage Report for The Sanctuary Filing 1 at Meridian Ranch. August 2022. Prepared by Tech Contractors.

Appendices

Appendix A - HEC-HMS Data

Input Data

Rex Road - Regional Park

BASIN	AREA (acre)	AREA (mi^2)	CURVE NO.	LAG TIME (min)
HISTORIC				
HG13	67	0.1053	61.0	43.0
HG14	147	0.2297	61.0	45.1
PROPOSED				
OS09b	28	0.0435	61.0	25.1
FG34	18	0.0275	62.7	16.8
FG35	19	0.0292	65.3	15.0
FG36	19	0.0295	65.1	25.8
FG37	48	0.0754	62.1	21.0

COMPOSITE 'C' FACTORS

PROJECT:	**Rex Road - Regional Park**					Date	5/16/2023	
BASIN DESIGNATION	AREA (AC.) UNDEV 61	5 DU/AC 78	STREETS 98	OPEN SPACE PARKS/GC 62	TOTAL	AREA (MI^2)	COMPOSITE 'C' FACTOR	PERCENT IMPERV.
HISTORIC								
HG13	67				67	0.1053	**61.0**	**0.0%**
HG14	147				147	0.2297	**61.0**	**0.0%**
						0.3350	**Composite**	**0.0%**
TOTALS	214	0	0	0	214			
PROPOSED								
OS09b	28				28	0.0435	**61.0**	**0.0%**
FG34	16	1.8			18	0.0275	**62.7**	**4.4%**
FG35	14	1.6	1.4	1.2	19	0.0292	**65.3**	**11.3%**
FG36	16		2.1	0.5	19	0.0295	**65.1**	**11.2%**
FG37	15		0.5	33	48	0.0754	**62.1**	**2.4%**
						0.2051	**Composite:**	**4.7%**
	89	3	4	34	131			

LAG TIMES

SCS Calculations

PROJECT: **Rex Road - Regional Park** DATE: 6/2/2023

LAG TIMES															
SUBBASIN DATA			INITIAL/OVERLAND TIME (T_i)						TRAVEL TIME (T_t)					TOTAL	FINAL
BASIN DESIGNATION	P_2	AREA (SQ MI)	LENGTH (FT)	ΔH	SLOPE %	OVERLAND CONVEYANCE TYPE	n	T_i (Min.)*	LENGTH (FT)	ΔH	TRAVEL CONVEYANCE TYPE	VEL. (FPS)	T_t (Min.)**	T_i+T_t (Min.)	T_{lag} (min)
HISTORIC															
HG13	1.88	0.105	745	27.0	3.6%	GP	0.15	50.2	3225	90	G	2.5	21.5	71.7	**43.0**
HG14	1.88	0.230	550	14.0	2.5%	GP	0.15	45.4	3650	68	G	2.0	29.7	75.1	**45.1**
PROPOSED															
OS09b	1.88	0.071	495	30.0	6.1%	GP	0.15	29.5	1725	42	G	2.3	12.3	41.8	**25.1**
FG34	1.88	0.028	200	12.0	6.0%	GP	0.15	14.3	2045	56	G	2.5	13.7	28.1	**16.8**
FG35	1.88	0.029	165	7.0	4.2%	GP	0.15	14.1	1450	32	G	2.2	10.8	25.0	**15.0**
FG36	1.88	0.030	305	7.0	2.3%	GP	0.15	29.5	1770	38	G	2.2	13.4	42.9	**25.8**
FG37	1.88	0.075	305	15.0	4.9%	GP	0.15	21.8	1780	40	G	2.2	13.2	35.0	**21.0**

TYPE OF SURFACE		n
SMOOTH SURFACES (conc, asph, gravel, bare soil, etc)	S	0.0110
FALLOW (no cover)	F	0.0500
CULTIVATED SOILS (<20% cover)	CL	0.0600
CULTIVATED SOILS (>20% cover)	CG	0.1700
GRASS (Short prairie grass)	GP	0.1500
GRASS (Dense grass)	GD	0.2400
GRASS (Bermuda grass)	GB	0.4100
RANGE (Natural)	R	0.1300
WOODS (Light Underbrush)	WL	0.4000
WOODS (Dense Underbrush)	WD	0.8000

Notes:

* $T_i = 0.42 (n \bullet L)^{0.8} / (P_2)^{0.5} \bullet S^{0.4}$

** $T_t = L/60 \bullet V$ (min)

TYPE OF SURFACE	
HEAVY MEADOW	H
TILLAGE/FIELD	T
RIPRAP (not buried)	R
SHORT PASTURE AND LAW	L
NEARLY BARE GROUND	B
GRASSED WATERWAY	G
NATURAL SANDY CHANNE	N
PAVED AREAS	P

NOAA Atlas 14, Volume 8, Version 2
Location name: Peyton, Colorado, USA*
Latitude: 38.9783°, Longitude: -104.5842°
Elevation: 7054.14 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.239 (0.190-0.301)	0.291 (0.232-0.367)	0.381 (0.302-0.482)	0.460 (0.363-0.585)	0.576 (0.442-0.764)	0.670 (0.501-0.899)	0.770 (0.556-1.06)	0.875 (0.606-1.23)	1.02 (0.680-1.48)	1.14 (0.737-1.66)
10-min	0.349 (0.278-0.441)	0.426 (0.339-0.538)	0.558 (0.443-0.706)	0.674 (0.532-0.857)	0.843 (0.647-1.12)	0.982 (0.734-1.32)	1.13 (0.814-1.55)	1.28 (0.888-1.80)	1.50 (0.996-2.16)	1.67 (1.08-2.44)
15-min	0.426 (0.340-0.538)	0.519 (0.413-0.656)	0.680 (0.540-0.861)	0.822 (0.648-1.04)	1.03 (0.789-1.36)	1.20 (0.895-1.61)	1.37 (0.993-1.89)	1.56 (1.08-2.20)	1.82 (1.22-2.64)	2.03 (1.31-2.97)
30-min	0.608 (0.485-0.768)	0.741 (0.590-0.936)	0.969 (0.769-1.23)	1.17 (0.923-1.49)	1.46 (1.12-1.94)	1.70 (1.27-2.28)	1.95 (1.41-2.68)	2.21 (1.53-3.12)	2.58 (1.72-3.73)	2.87 (1.86-4.20)
60-min	0.778 (0.620-0.982)	0.934 (0.744-1.18)	1.21 (0.962-1.54)	1.47 (1.16-1.86)	1.84 (1.42-2.46)	2.16 (1.62-2.91)	2.50 (1.81-3.44)	2.87 (1.99-4.05)	3.38 (2.26-4.91)	3.80 (2.46-5.56)
2-hr	0.948 (0.762-1.19)	1.13 (0.905-1.41)	1.46 (1.16-1.83)	1.76 (1.40-2.22)	2.23 (1.73-2.96)	2.62 (1.99-3.51)	3.05 (2.23-4.18)	3.52 (2.47-4.95)	4.19 (2.82-6.04)	4.73 (3.09-6.87)
3-hr	1.04 (0.839-1.29)	1.22 (0.986-1.52)	1.57 (1.26-1.96)	1.90 (1.51-2.38)	2.41 (1.90-3.21)	2.86 (2.18-3.83)	3.35 (2.47-4.59)	3.90 (2.75-5.47)	4.68 (3.18-6.75)	5.33 (3.50-7.71)
6-hr	1.21 (0.980-1.49)	1.40 (1.14-1.73)	1.78 (1.44-2.21)	2.16 (1.74-2.68)	2.76 (2.19-3.65)	3.29 (2.53-4.38)	3.88 (2.88-5.28)	4.53 (3.23-6.34)	5.49 (3.76-7.88)	6.29 (4.17-9.04)
12-hr	1.39 (1.14-1.70)	1.62 (1.33-1.98)	2.06 (1.68-2.53)	2.48 (2.02-3.06)	3.16 (2.53-4.14)	3.76 (2.92-4.96)	4.42 (3.31-5.97)	5.15 (3.70-7.14)	6.22 (4.30-8.85)	7.10 (4.75-10.1)
24-hr	1.61 (1.33-1.95)	1.88 (1.55-2.29)	2.39 (1.97-2.92)	2.88 (2.35-3.52)	3.63 (2.91-4.69)	4.27 (3.34-5.58)	4.98 (3.75-6.66)	5.75 (4.17-7.90)	6.87 (4.78-9.70)	7.79 (5.25-11.1)
2-day	1.86 (1.55-2.24)	2.19 (1.83-2.64)	2.79 (2.31-3.36)	3.33 (2.75-4.04)	4.15 (3.35-5.30)	4.85 (3.81-6.25)	5.59 (4.25-7.39)	6.40 (4.67-8.70)	7.55 (5.30-10.6)	8.49 (5.77-12.0)
3-day	2.04 (1.71-2.45)	2.41 (2.01-2.88)	3.05 (2.54-3.66)	3.63 (3.01-4.38)	4.51 (3.65-5.71)	5.24 (4.14-6.72)	6.03 (4.59-7.92)	6.87 (5.03-9.29)	8.07 (5.69-11.2)	9.04 (6.18-12.7)
4-day	2.20 (1.85-2.62)	2.58 (2.16-3.08)	3.25 (2.72-3.89)	3.86 (3.21-4.63)	4.77 (3.87-6.01)	5.53 (4.38-7.06)	6.34 (4.85-8.31)	7.22 (5.31-9.73)	8.46 (5.98-11.7)	9.46 (6.50-13.2)
7-day	2.60 (2.20-3.08)	3.00 (2.54-3.56)	3.71 (3.13-4.41)	4.36 (3.65-5.20)	5.33 (4.36-6.67)	6.14 (4.89-7.78)	7.00 (5.40-9.11)	7.93 (5.87-10.6)	9.26 (6.59-12.8)	10.3 (7.14-14.4)
10-day	2.96 (2.51-3.48)	3.39 (2.88-4.00)	4.16 (3.52-4.92)	4.85 (4.08-5.76)	5.88 (4.82-7.31)	6.73 (5.38-8.48)	7.63 (5.91-9.88)	8.61 (6.39-11.5)	9.97 (7.13-13.7)	11.1 (7.70-15.4)
20-day	3.95 (3.38-4.61)	4.55 (3.89-5.32)	5.57 (4.75-6.52)	6.44 (5.46-7.58)	7.68 (6.32-9.39)	8.67 (6.97-10.8)	9.69 (7.54-12.4)	10.8 (8.04-14.1)	12.2 (8.79-16.6)	13.3 (9.36-18.4)
30-day	4.75 (4.09-5.51)	5.49 (4.72-6.38)	6.70 (5.74-7.81)	7.72 (6.58-9.04)	9.12 (7.52-11.1)	10.2 (8.24-12.6)	11.3 (8.83-14.3)	12.4 (9.32-16.2)	13.9 (10.1-18.7)	15.0 (10.6-20.6)
45-day	5.73 (4.96-6.62)	6.62 (5.72-7.65)	8.05 (6.93-9.33)	9.21 (7.89-10.7)	10.8 (8.91-12.9)	12.0 (9.68-14.6)	13.1 (10.3-16.5)	14.3 (10.7-18.5)	15.8 (11.4-21.1)	16.9 (12.0-23.0)
60-day	6.56 (5.70-7.55)	7.55 (6.55-8.69)	9.12 (7.88-10.5)	10.4 (8.92-12.0)	12.1 (9.98-14.4)	13.3 (10.8-16.1)	14.5 (11.4-18.1)	15.6 (11.8-20.2)	17.1 (12.5-22.8)	18.2 (12.9-24.8)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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HISTORIC CHARTS

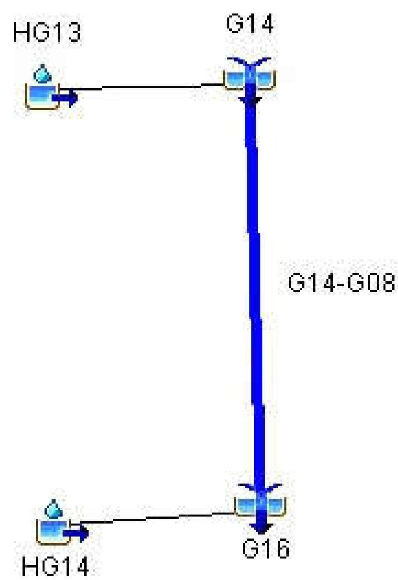
HISTORIC SCS (100-YEAR)				
HYDROLOGIC ELEMENT	DRAINAGE AREA (SQ. MI.)	DISCHARGE PEAK Q100 (CFS)	TIME OF PEAK	TOTAL VOLUME Q100 (AC. FT.)
HG14	0.2297	79	01Jul2015, 12:42	16
HG13	0.1053	38	01Jul2015, 12:42	7.4
G14	0.1053	38	01Jul2015, 12:42	7.4
G14-G16	0.1053	37	01Jul2015, 12:48	7.3
G16	0.3350	116	01Jul2015, 12:48	23

HISTORIC SCS (50-YEAR)				
HYDROLOGIC ELEMENT	DRAINAGE AREA (SQ. MI.)	DISCHARGE PEAK Q50 (CFS)	TIME OF PEAK	TOTAL VOLUME Q50 (AC. FT.)
HG14	0.2297	52	01Jul2015, 12:48	11
HG13	0.1053	25	01Jul2015, 12:42	5.2
G14	0.1053	25	01Jul2015, 12:42	5.2
G14-G16	0.1053	25	01Jul2015, 12:48	5.1
G16	0.3350	77	01Jul2015, 12:48	16

HISTORIC SCS (10-YEAR)				
HYDROLOGIC ELEMENT	DRAINAGE AREA (SQ. MI.)	DISCHARGE PEAK Q10 (CFS)	TIME OF PEAK	TOTAL VOLUME Q10 (AC. FT.)
HG14	0.2297	12	01Jul2015, 12:54	3.7
HG13	0.1053	5.8	01Jul2015, 12:54	1.7
G14	0.1053	5.8	01Jul2015, 12:54	1.7
G14-G16	0.1053	5.8	01Jul2015, 13:00	1.7
G16	0.3350	18	01Jul2015, 13:00	5.4

Highlighted green rows reference key design points (Typical all charts this section)

HISTORIC CONDITIONS



HISTORIC SCS (5-YEAR)				
HYDROLOGIC ELEMENT	DRAINAGE AREA (SQ. MI.)	DISCHARGE PEAK Q5 (CFS)	TIME OF PEAK	TOTAL VOLUME Q5 (AC. FT.)
HG14	0.2297	4.7	01Jul2015, 13:06	1.9
HG13	0.1053	2.2	01Jul2015, 13:00	0.9
G14	0.1053	2.2	01Jul2015, 13:00	0.9
G14-G16	0.1053	2.2	01Jul2015, 13:18	0.9
G16	0.3350	6.8	01Jul2015, 13:12	2.8

HISTORIC SCS (2-YEAR)				
HYDROLOGIC ELEMENT	DRAINAGE AREA (SQ. MI.)	DISCHARGE PEAK Q2 (CFS)	TIME OF PEAK	TOTAL VOLUME Q2 (AC. FT.)
HG14	0.2297	0.8	01Jul2015, 14:18	0.6
HG13	0.1053	0.4	01Jul2015, 14:12	0.3
G14	0.1053	0.4	01Jul2015, 14:12	0.3
G14-G16	0.1053	0.4	01Jul2015, 14:36	0.3
G16	0.3350	1.2	01Jul2015, 14:24	0.8

Highlighted green rows reference key design points (Typical all charts this section)

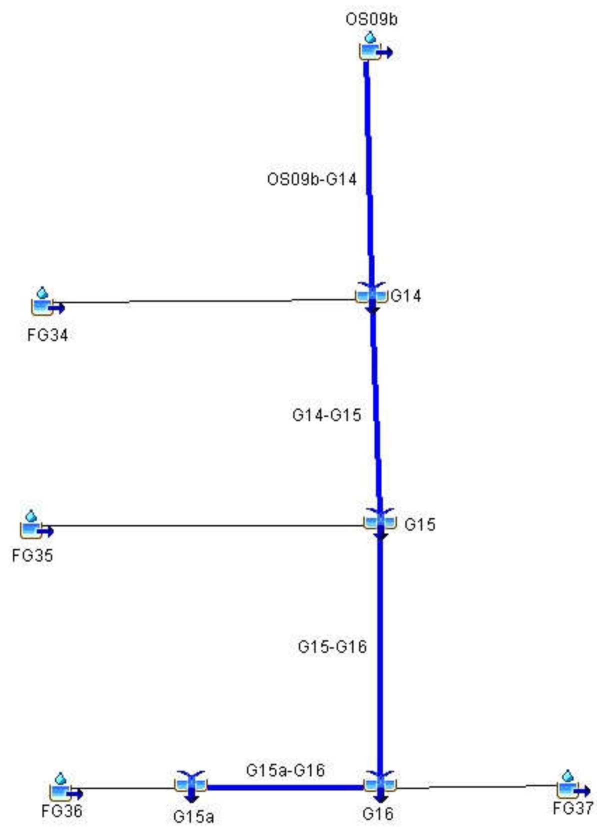
FUTURE CHARTHS

PROPOSED SCS (100-YEAR)				
HYDROLOGIC ELEMENT	DRAINAGE AREA (SQ. MI.)	PEAK DISCHARGE Q100 (CFS)	TIME OF PEAK	TOTAL VOLUME Q100 (AC. FT.)
OS09b	0.0435	22	01Jul2015, 12:18	3.1
OS09b-G14	0.0435	22	01Jul2015, 12:24	3.1
FG34	0.0275	20	01Jul2015, 12:12	2.1
G14	0.0710	38	01Jul2015, 12:18	5.2
G14-G15	0.0710	37	01Jul2015, 12:24	5.1
FG35	0.0292	25	01Jul2015, 12:12	2.5
G15	0.1002	55	01Jul2015, 12:18	7.7
G15-G16	0.1002	54	01Jul2015, 12:24	7.5
FG37	0.0754	46	01Jul2015, 12:18	5.6
FG36	0.0295	19	01Jul2015, 12:18	2.5
G15a	0.0295	19	01Jul2015, 12:18	2.5
G15a-G16	0.0295	19	01Jul2015, 12:24	2.5
G16	0.2051	114	01Jul2015, 12:24	16

PROPOSED SCS (50-YEAR)				
HYDROLOGIC ELEMENT	DRAINAGE AREA (SQ. MI.)	PEAK DISCHARGE Q50 (CFS)	TIME OF PEAK	TOTAL VOLUME Q50 (AC. FT.)
OS09b	0.0435	14	01Jul2015, 12:24	2.2
OS09b-G14	0.0435	14	01Jul2015, 12:24	2.1
FG34	0.0275	13	01Jul2015, 12:12	1.5
G14	0.0710	25	01Jul2015, 12:18	3.7
G14-G15	0.0710	24	01Jul2015, 12:24	3.6
FG35	0.0292	18	01Jul2015, 12:12	1.9
G15	0.1002	36	01Jul2015, 12:18	5.5
G15-G16	0.1002	35	01Jul2015, 12:30	5.4
FG37	0.0754	31	01Jul2015, 12:18	4.0
FG36	0.0295	13	01Jul2015, 12:24	1.8
G15a	0.0295	13	01Jul2015, 12:24	1.8
G15a-G16	0.0295	13	01Jul2015, 12:30	1.8
G16	0.2051	74	01Jul2015, 12:24	11

Highlighted green rows reference key design points (Typical all charts this section)

GIECK FUTURE CONDITIONS



PROPOSED SCS (10-YEAR)				
HYDROLOGIC ELEMENT	DRAINAGE AREA (SQ. MI.)	PEAK DISCHARGE Q10 (CFS)	TIME OF PEAK	TOTAL VOLUME Q10 (AC. FT.)
OS09b	0.1313	11.6	01Jul2015, 12:18	2.2
OS09b-G14	0.1313	11.6	01Jul2015, 12:18	2.2
FG34	0.1313	11.4	01Jul2015, 12:24	2.1
G14	0.0578	5.6	01Jul2015, 12:12	1.0
G14-G15	0.0578	5.5	01Jul2015, 12:18	1.0
FG35	0.0538	7.0	01Jul2015, 12:36	1.4
G15	0.0538	7.0	01Jul2015, 12:36	1.4
G15-G16	0.1116	11.0	01Jul2015, 12:24	2.3
FG37	0.1116	10.9	01Jul2015, 12:30	2.3
FG36	0.0391	6.4	01Jul2015, 12:12	0.9
G15a	0.2820	27.2	01Jul2015, 12:24	5.4
G15a-G16	0.2820	27.1	01Jul2015, 12:30	5.3
G16	0.2820	27	01Jul2015, 12:30	5.3

Highlighted green rows reference key design points (Typical all charts this section)

PROPOSED SCS (5-YEAR)				
HYDROLOGIC ELEMENT	DRAINAGE AREA (SQ. MI.)	PEAK DISCHARGE Q5 (CFS)	TIME OF PEAK	TOTAL VOLUME Q5 (AC. FT.)
OS09b	0.0435	1.1	01Jul2015, 12:36	0.4
OS09b-G14	0.0435	1.1	01Jul2015, 12:42	0.4
FG34	0.0275	1.3	01Jul2015, 12:18	0.3
G14	0.0710	2.0	01Jul2015, 12:36	0.7
G14-G15	0.0710	2.0	01Jul2015, 12:54	0.6
FG35	0.0292	2.4	01Jul2015, 12:12	0.4
G15	0.1002	3.0	01Jul2015, 12:48	1.0
G15-G16	0.1002	3.0	01Jul2015, 13:06	1.0
FG37	0.0754	2.7	01Jul2015, 12:24	0.7
FG36	0.0295	1.8	01Jul2015, 12:30	0.4
G15a	0.0295	1.8	01Jul2015, 12:30	0.4
G15a-G16	0.0295	1.7	01Jul2015, 12:36	0.4
G16	0.2051	6.5	01Jul2015, 12:36	2.1

PROPOSED SCS (2-YEAR)				
HYDROLOGIC ELEMENT	DRAINAGE AREA (SQ. MI.)	PEAK DISCHARGE Q2 (CFS)	TIME OF PEAK	TOTAL VOLUME Q2 (AC. FT.)
OS09b	0.0435	0.2	01Jul2015, 13:42	0.1
OS09b-G14	0.0435	0.2	01Jul2015, 14:00	0.1
FG34	0.0275	0.2	01Jul2015, 13:00	0.1
G14	0.0710	0.3	01Jul2015, 13:36	0.2
G14-G15	0.0710	0.3	01Jul2015, 14:06	0.2
FG35	0.0292	0.5	01Jul2015, 12:24	0.2
G15	0.1002	0.6	01Jul2015, 13:48	0.4
G15-G16	0.1002	0.6	01Jul2015, 14:24	0.3
FG37	0.0754	0.4	01Jul2015, 13:12	0.2
FG36	0.0295	0.4	01Jul2015, 12:48	0.2
G15a	0.0295	0.4	01Jul2015, 12:48	0.2
G15a-G16	0.0295	0.4	01Jul2015, 13:00	0.2
G16	0.2051	1.2	01Jul2015, 13:00	0.7

Highlighted green rows reference key design points (Typical all charts this section)

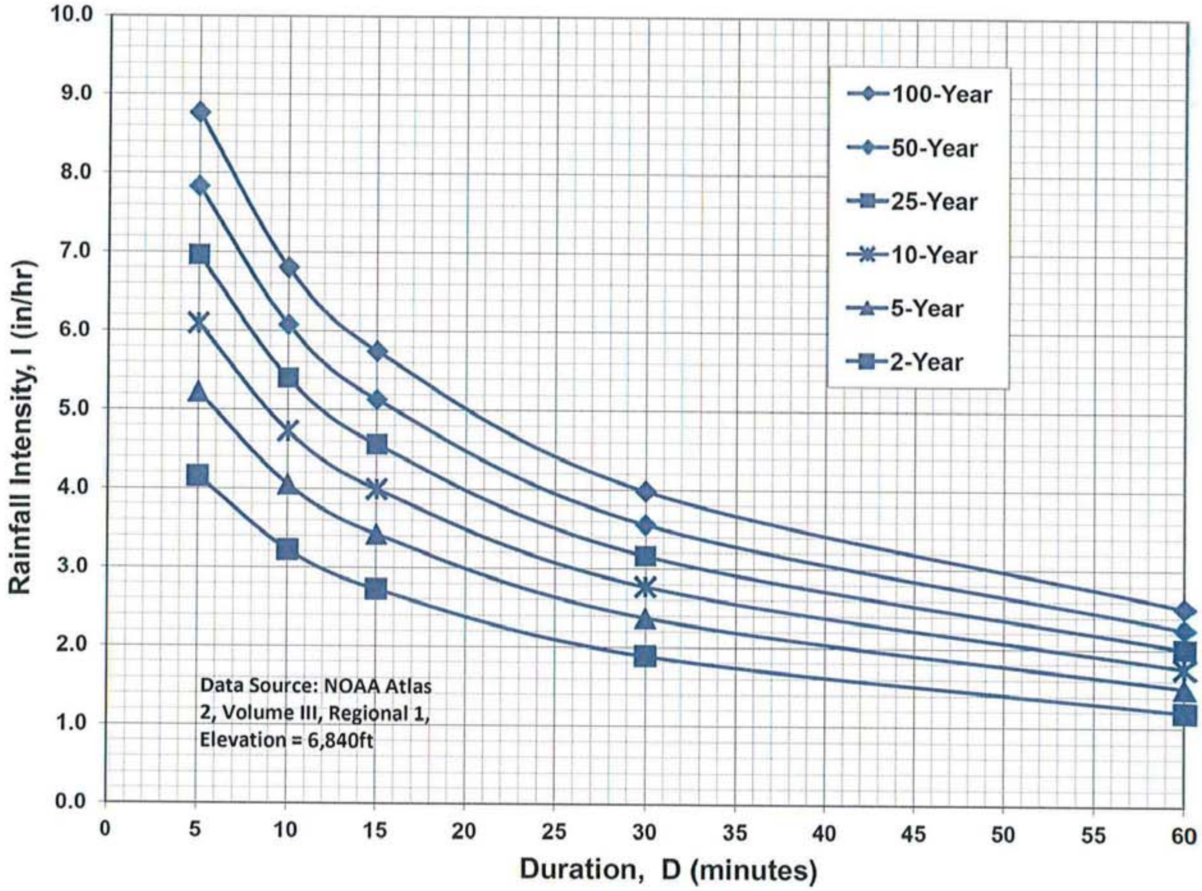
Appendix B – Rational Calculations

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

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.

COMPOSITE 'C' FACTORS

PROJECT: **Rex Road - Regional Park** 6/2/2023

BASIN DESIGNATION	AREA (AC.)						COMPOSITE FACTOR			Percent Impervious
	UNDEV	5 DU/AC	GRAVEL	STREETS	OPEN SPACE PARKS/GC LAWNS	TOTAL	2-year	5-year	100-year	
PROPOSED										
OS09b	28					28	**0.03**	**0.09**	**0.36**	**0.0%**
FG34	16	1.8				18	**0.06**	**0.12**	**0.38**	**4.4%**
FG35a	11	1.6			0.7	14	**0.07**	**0.13**	**0.38**	**5.2%**
FG35b	3.0			1.4	0.5	4.9	**0.27**	**0.33**	**0.53**	**28.0%**
FG36a	16		0.3	0.8		18	**0.08**	**0.13**	**0.39**	**5.9%**
FG36c	1.3			1.0	0.5	2.8	**0.34**	**0.40**	**0.58**	**35.4%**
FG37	48			0.2		48	**0.03**	**0.09**	**0.36**	**0.5%**
TOTAL	124	3.4	0.3	3.4	1.7	133	**0.06**	**0.12**	**0.38**	**3.9%**

TIME OF CONCENTRATION

PROJECT: **Rex Road - Regional Park** DATE: 6/2/2023

SUBBASIN DATA			INIT./OVERLAND TIME (T_i)				TRAVEL TIME (T_t)							TOTAL
BASIN DESIGNATION	C_5	AREA (AC)	LENGTH (FT)	ΔH	SLOPE %	Ti (Min.)*	LENGTH (FT)	ΔH	SLOPE %	CONVEYANCE TYPE	CONVEYANCE COEF.	VEL. (FPS)	Tt (Min.)**	Ti+Tt (Min.)
OS09b	0.09	28	495	29.0	5.9%	22.9	1725	41	2.4%	B	10	1.5	18.6	41.5
FG34	0.12	18	200	12.0	6.0%	14.0	2045	56	2.7%	B	10	1.7	20.6	34.6
FG35a	0.13	14	165	7.0	4.2%	14.1	1305	31	2.4%	B	10	1.5	14.1	28.3
FG35b	0.33	4.9	125	8.0	6.4%	8.5	770	27	3.5%	P	20	3.7	3.4	11.9
FG36a	0.13	18	305	7.0	2.3%	23.4	1690	41	2.4%	G	15	2.3	12.1	35.5
FG36c	0.40	2.8	270	7.5	2.8%	15.0	1275	30	2.4%	P	20	3.1	6.9	21.9
FG37	0.09	48	305	15.0	4.9%	18.9	1780	40	2.2%	B	10	1.5	19.8	38.7

Notes:

$$* T_i = \frac{0.395\,(1.1 - C_5)\,L^{0.5}}{S^{0.33}}$$

$$V = C_V\, S_W^{0.5}$$

$$** T_t = L \times V$$

TYPE OF SURFACE		C_V
HEAVY MEADOW	H	2.5
TILLAGE/FIELD	T	5
RIPRAP (not buried)	R	6.5
SHORT PASTURE AND LAWN	L	7
NEARLY BARE GROUND	B	10
GRASSED WATERWAY	G	15
PAVED AREAS	P	20

STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)
SURFACE ROUTING

PROJECT: **Rex Road - Regional Park** Date: 6/2/2023

DESIGN POINT	BASIN	DIRECT RUNOFF AREA (AC)	Tc (Min.)	I (in./ hr.) (2 YR)	I (in./ hr.) (5 YR)	I (in./ hr.) (100 YR)	COEFF. (2 YR)	COEFF. (5 YR)	COEFF. (100 YR)	CA (2 YR)	CA (5 YR)	CA (100 YR)	Q (cfs) (2 YR)	Q (cfs) (5 YR)	Q (cfs) (100 YR)	TOTAL RUNOFF Sum Tc (min.)	I (in./ hr.) (2 YR)	I (in./ hr.) (5 YR)	I (in./ hr.) (100 YR)	CA (2 YR)	CA (5 YR)	CA (100 YR)	Q (cfs) (2 YR)	Q (cfs) (5 YR)	Q (cfs) (100 YR)	OVERLAND TRAVEL TIME DESTINATION DP	CONVEYANCE TYPE	COEFFICIENT Cv	SLOPE %	VEL. (FPS)	LENGTH (FT)	TRAVEL TIME Tt
PROPOSED																																
DP1	OS09b	28	41.5	1.60	1.99	3.35	0.03	0.09	0.36	0.83	2.50	10.0	1.3	5.0	34								**1.3**	**5.0**	**34**	G14	B	10.0	2.16%	1.5	950	10.8
G14	FG34	18	34.6	1.82	2.27	3.80	0.06	0.12	0.38	1.05	2.06	6.65	1.9	4.7	25	52.3	1.33	1.65	2.76	1.89	4.56	16.7	**2.5**	**7.5**	**46**	G15.1	B	10.0	2.28%	1.5	1360	15.0
G15.1	FG35a	14	28.3	2.06	2.57	4.32	0.07	0.13	0.38	0.91	1.76	5.27	1.9	4.5	23	67.3	1.03	1.27	2.13	2.80	6.32	21.9	**2.9**	**8.0**	**47**	I01						
I01	FG35b	4.9	11.9	3.09	3.87	6.49	0.27	0.33	0.53	1.35	1.64	2.63	4.2	6.3	17								**4.2**	**6.3**	**17**	G15a	P	20.0	1.38%	2.3	60	0.4
G15a1	FG36a	18	35.5	1.79	2.23	3.74	0.08	0.13	0.39	1.36	2.37	6.91	2.4	5.3	26								**2.4**	**5.3**	**26**	G15a	P	20.0	1.00%	2.0	85	0.7
G15a	FG36c	2.8	21.9	2.36	2.95	4.96	0.34	0.40	0.58	0.95	1.12	1.62	2.2	3.3	8.0	21.9	2.36	2.95	4.96	1.11	1.42	2.43	**2.6**	**4.2**	**12**							
G15a																36.2	1.76	2.20	3.69	2.47	3.79	9.34	**4.4**	**8.3**	**34**	G16a	G	15.0	2.02%	2.1	420	3.3
G15																67.5	1.02	1.26	2.12	3.98	7.66	23.7	**4.1**	**9.7**	**50**	G16a	G	15.0	2.25%	2.3	1150	8.5
G16a																76.1	0.88	1.09	1.82	6.45	11.4	33.1	**5.7**	**12**	**60**	G16a	G	15.0	0.91%	1.4	715	8.3
G16	FG37	48	38.7	1.68	2.10	3.52	0.03	0.09	0.36	1.65	4.54	17.51	2.8	10	62	84.4	0.76	0.93	1.56	8.11	16.0	50.6	**6.1**	**15**	**79**							

STORM DRAINAGE SYSTEM DESIGN
INLET CALCULATIONS

PROJECT: **Rex Road - Regional Park** Date: 12/22/2022

DP	BASIN	Inlet size L(i)	Proposed or Existing	INLET TYPE	CROSS SLOPE	STREET SLOPE	T_c	Q_{Total} Q_2 (cfs)	Q_{Total} Q_5 (cfs)	Q_{Total} Q_{100} (cfs)	$Q_{Capture}$ Q_5 (cfs)	$Q_{Capture}$ Q_{100} (cfs)	$Q_{Capture}$ $CA_{eqv.}$ (5-yr)	$Q_{Capture}$ $CA_{eqv.}$ (100-yr)	$Q_{Flow-by}$ Q_5 (cfs)	$Q_{Flow-by}$ Q_{100} (cfs)	$Q_{Flow-by}$ $CA_{eqv.}$ (5-yr)	$Q_{Flow-by}$ $CA_{eqv.}$ (100-yr)	DEPTH (max) Q_5 (ft)	DEPTH (max) Q_{100} (ft)	SPREAD Q_5 (ft)	SPREAD Q_{100} (ft)
I01	FG35b	20	PROP	FLOW-BY	2.0%	1.0%	11.9	4.2	6.3	17	5.2	12	1.34	1.82	1.2	5.3	0.30	0.81	0.37	0.50	14.4	20.9

STORM DRAINAGE SYSTEM DESIGN
HYDRAULICS

PROJECT: **Rex Road - Regional Park** Date: 6/2/2023

Label	Upstrm Node	Dnstrm Node	Intlet CA (acres)	Inlet Tc (min)	Inlet Flow (ft³/s)	System CA (acres)	System Flow Time (min)	System Intensity (in/hr)	Length (ft)	Section Size (in)	Slope (%)	Capacity (Full Flow) (ft³/s)	System Flow (ft³/s)	Velocity (Ave) (ft/s)	Elevation Ground (Upstrm) (ft)	Hydraulic Grade Line (Upstrm) (ft)	Invert (Upstrm) (ft)	Elevation Ground (Dnstrm) (ft)	Hydraulic Grade Line (Dnstrm) (ft)	Invert (Dnstrm) (ft)
P01	G15.1	I01	21.93	67.3	47	21.93	67.3	2.13	80.5	36	1.20%	73	47	11	7035.22	7034.5	7032.22	7037.27	7033.6	7031.25
P02	I01	G15	1.82	11.9	12	23.75	67.4	2.12	60.3	36	1.18%	72	51	11	7037.27	7033.6	7031.25	7035.00	7032.5	7030.54

Appendix C – Culvert and Outlet Protection Design

RIP RAP PLUNGE POOL

Urban Drainage & Flood Control District Pipe Outlet Design

Low Tailwater Design ($y_t \le D/3$)

OUTLET # G15

Outlet Size (D) :	36	in.	Discharge (q):	50	CFS
Capacity (Q): (full flow)	95	CFS	Flow depth (d): (calculated)	20.9	in.

Q_{full} = 95 CFS

A_{full} = 7.1 SF

V_{full} = 13.4 FPS

q/Q_{full} = 0.53

$Q/D^{2.5}$ = 3.2

d/D 0.58 from HS-20a using q/Q_{full}

d/D 0.62 from HS-20b using $Q/D^{2.5}$

A' (A/A_{full}) 0.58 from HS-20a using smaller d/D from above

Flow Area ($a=A' \times A_{full}$) 4.1 SF

Outlet Velocity (V = q/a) 12.2 FPS

$P_d = (V^2 + gd)^{1/2}$ = 14

RIP-RAP SIZE: M from HS-20c * Chart shows Type L but Will use Type M

d_{50}= 12 in

$T=1.75xd_{50}$ 1.75 ft

Basin Length (L) 12.0 FT.

Basin Width (W) 12.0 FT.

Cutoff Wall Depth (B=D/2+T) 3.25 FT

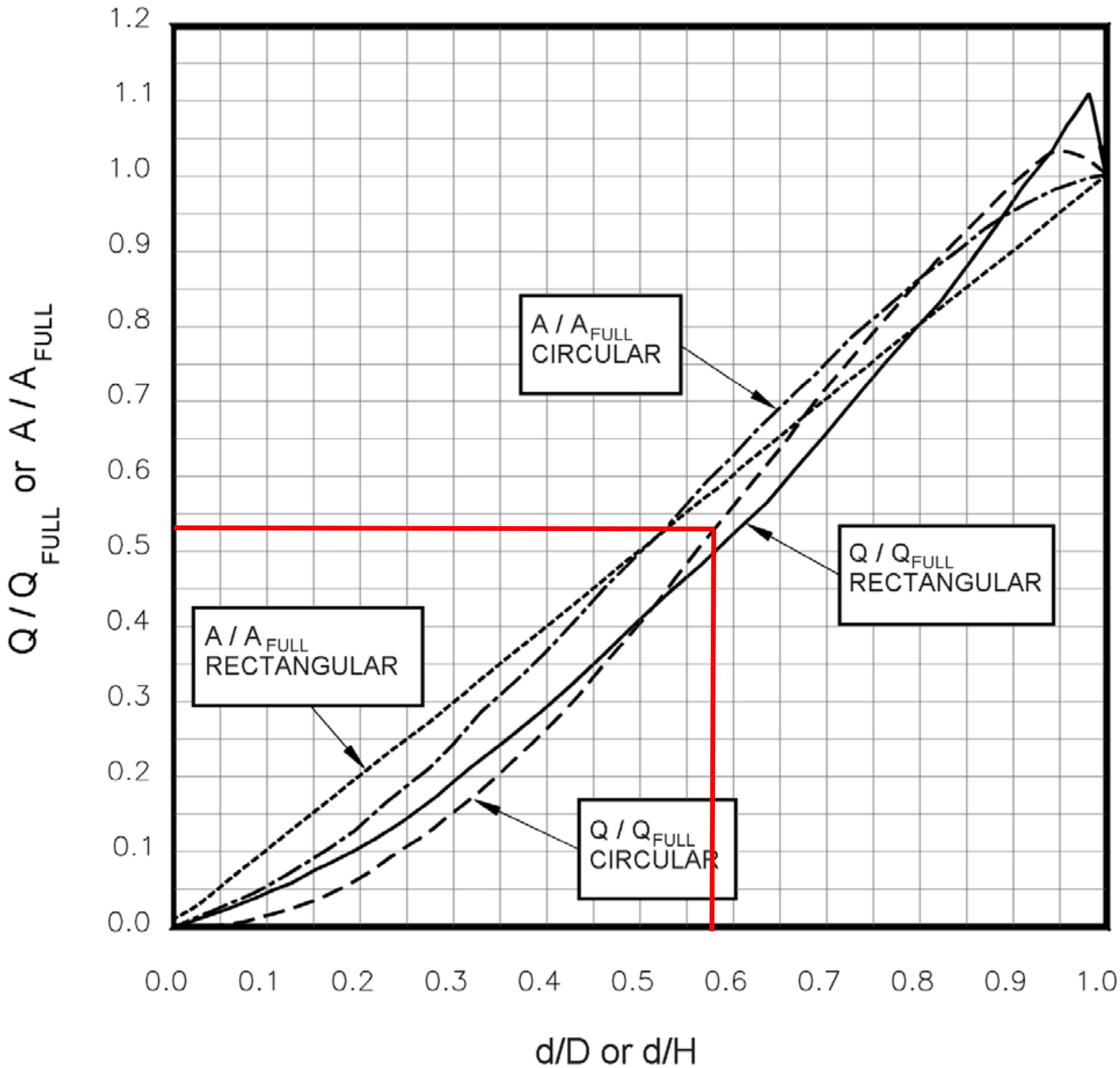


Figure HS-20a—Low Tailwater Riprap Basins for Storm Sewer Pipe Outlets—Discharge and Flow Area Relationships for Circular and Rectangular Pipes
(Ratios for Flow Based on Manning's *n* Varying With Depth)
(Stevens and Urbonas 1996)

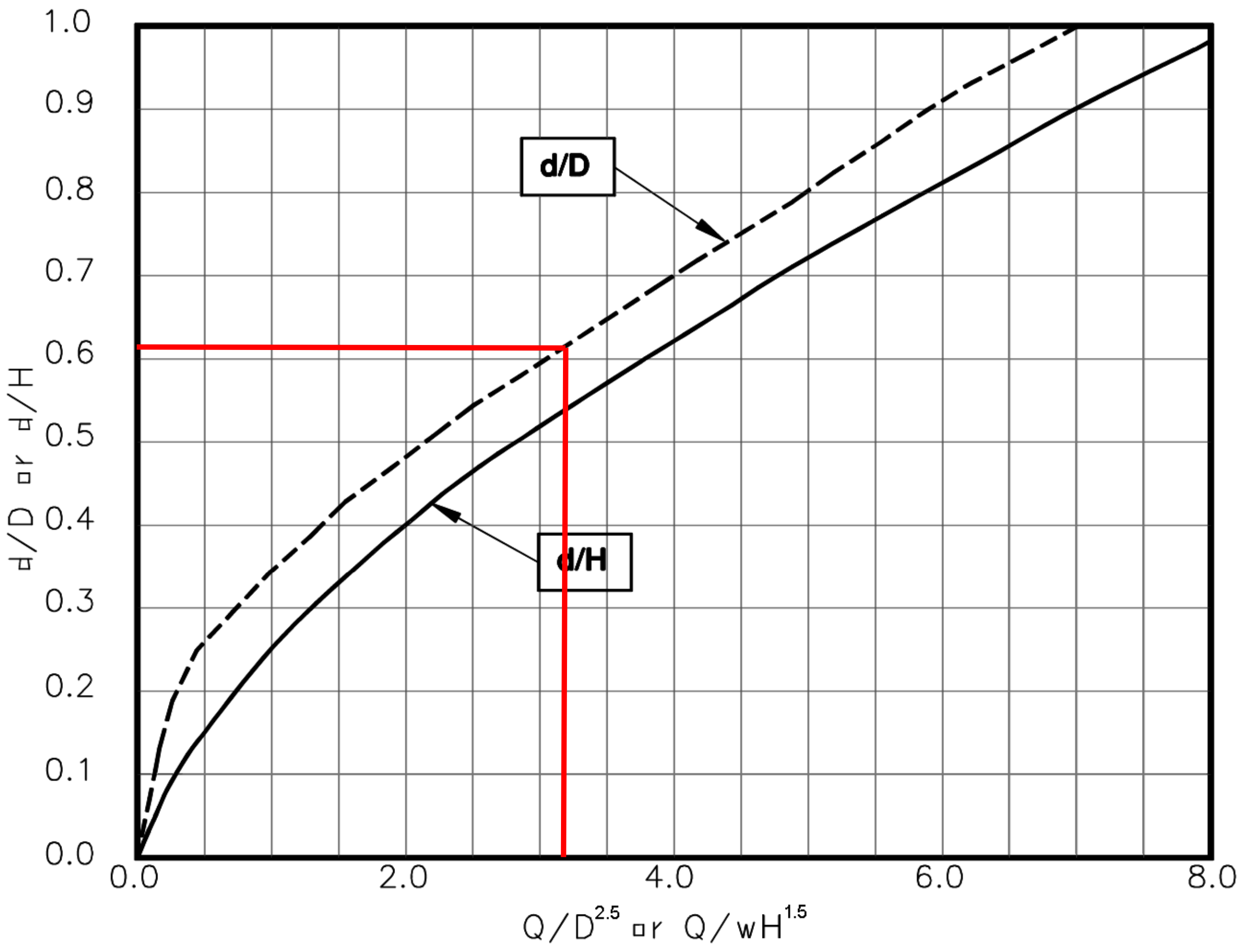


Figure HS-20b—Low Tailwater Riprap Basins for Storm Sewer Pipe Outlets—

Brink Depth for Horizontal Pipe Outlets

(Stevens and Urbonas 1996)

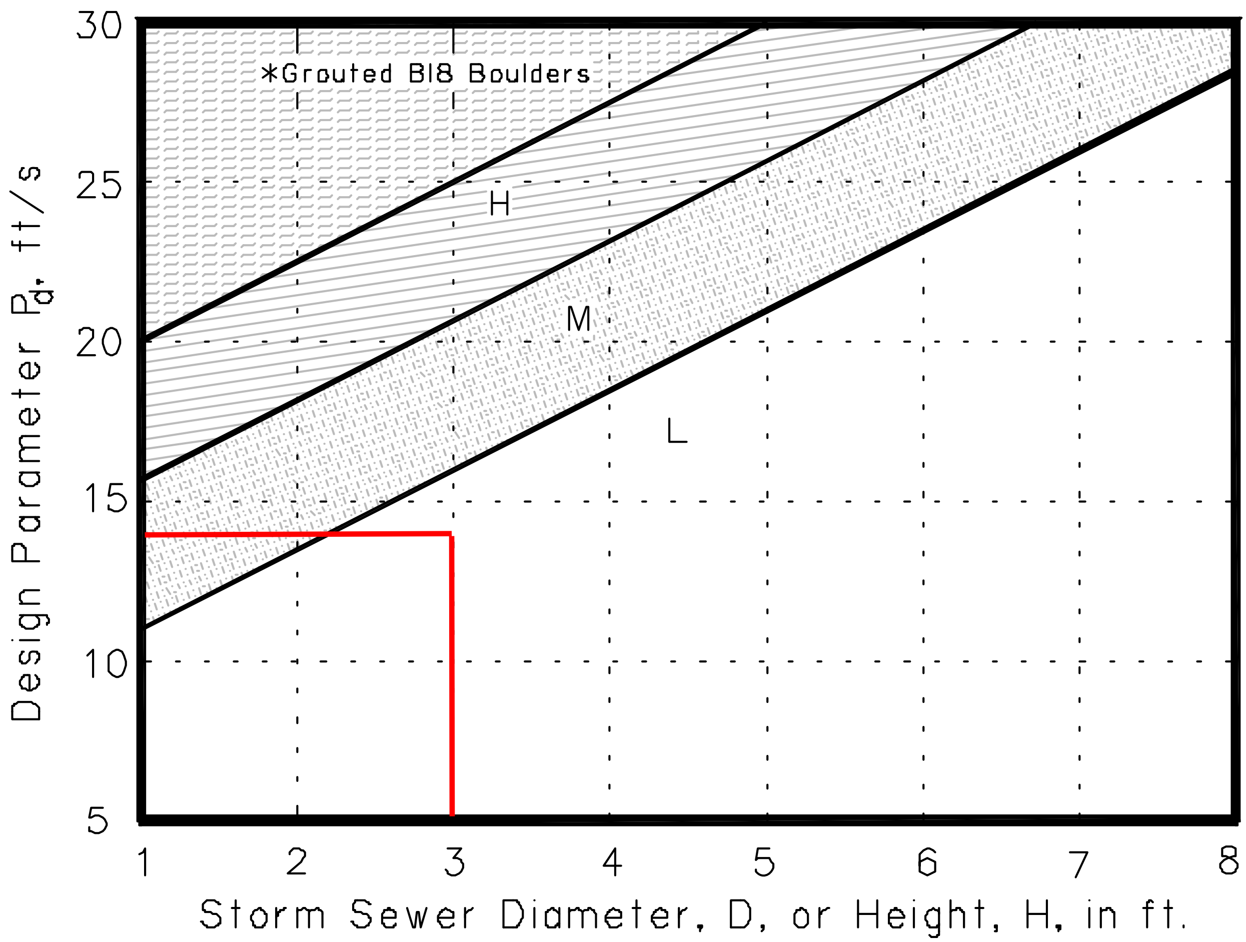


Figure HS-20c—Low Tailwater Riprap Basins for Storm Sewer Pipe Outlets—

Riprap Selection Chart for Low Tailwater Basin at Pipe Outlet

(Stevens and Urbonas 1996)

RIP RAP PLUNGE POOL

Urban Drainage & Flood Control District Pipe Outlet Design

Low Tailwater Design ($y_t \leq D/3$)

OUTLET # G15a

Outlet Size (D) :	24	in.	Discharge (q):	23	CFS
Capacity (Q): (full flow)	32	CFS	Flow depth (d): (calculated)	16.8	in.

Q_{full} = 32 CFS

A_{full} = 3.1 SF

V_{full} = 10.2 FPS

q/Q_{full} = 0.72

$Q/D^{2.5}$ = 4.1

d/D 0.81 from HS-20a using q/Q_{full}

d/D 0.70 from HS-20b using $Q/D^{2.5}$

A' (A/A_{full}) 0.70 from HS-20a using smaller d/D from above

Flow Area ($a=A' \times A_{full}$) 2.2 SF

Outlet Velocity (V = q/a) 10.5 FPS

$P_d = (V^2 + gd)^{1/2}$ = 12

RIP-RAP SIZE: M from HS-20c

d_{50}= 12 in

$T=1.75xd_{50}$ 1.75 ft

Basin Length (L) 8.0 FT.

Basin Width (W) 8.0 FT.

Cutoff Wall Depth (B=D/2+T) 2.75 FT

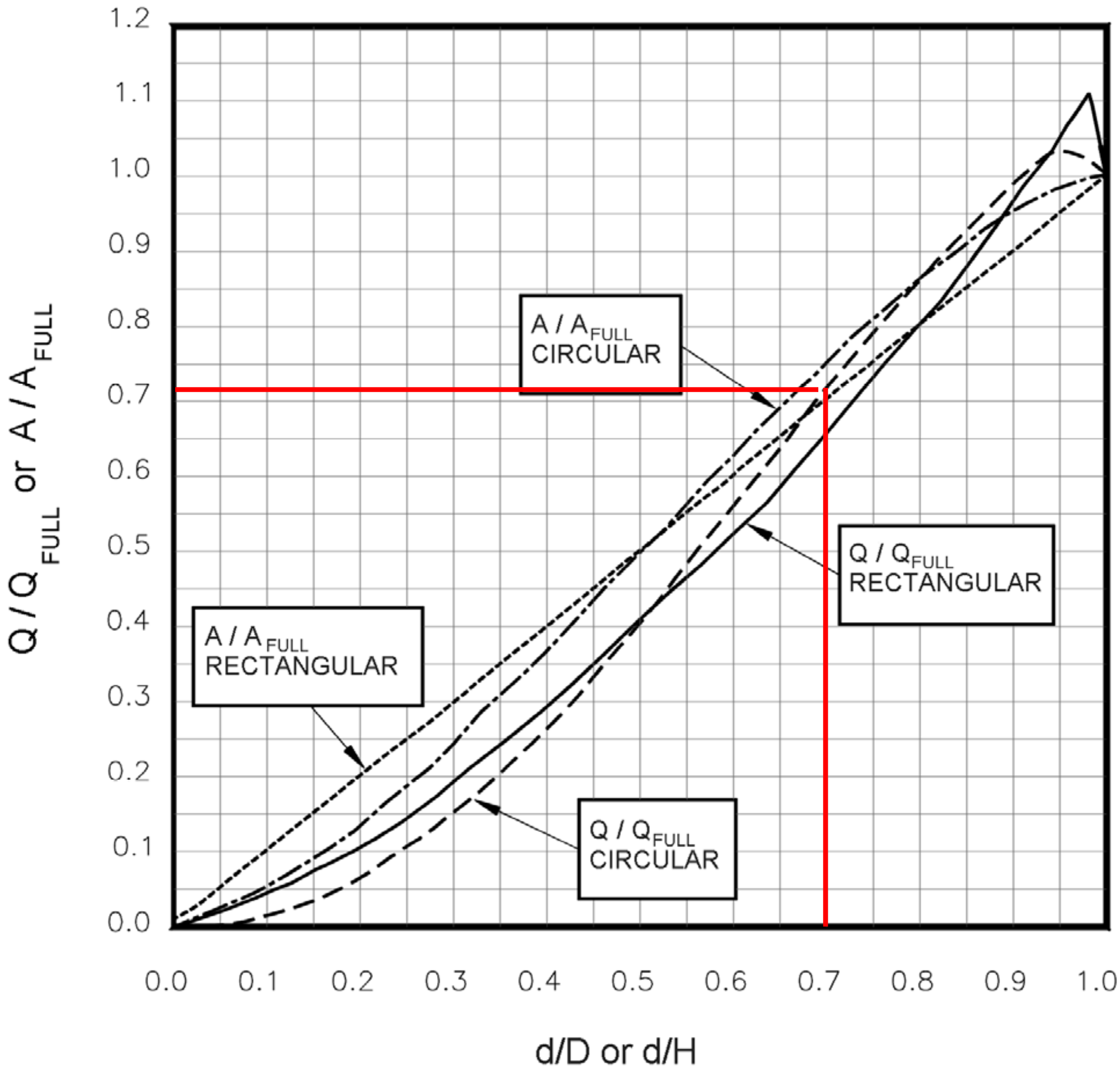


Figure HS-20a—Low Tailwater Riprap Basins for Storm Sewer Pipe Outlets—Discharge and Flow Area Relationships for Circular and Rectangular Pipes
(Ratios for Flow Based on Manning's *n* Varying With Depth)
(Stevens and Urbonas 1996)

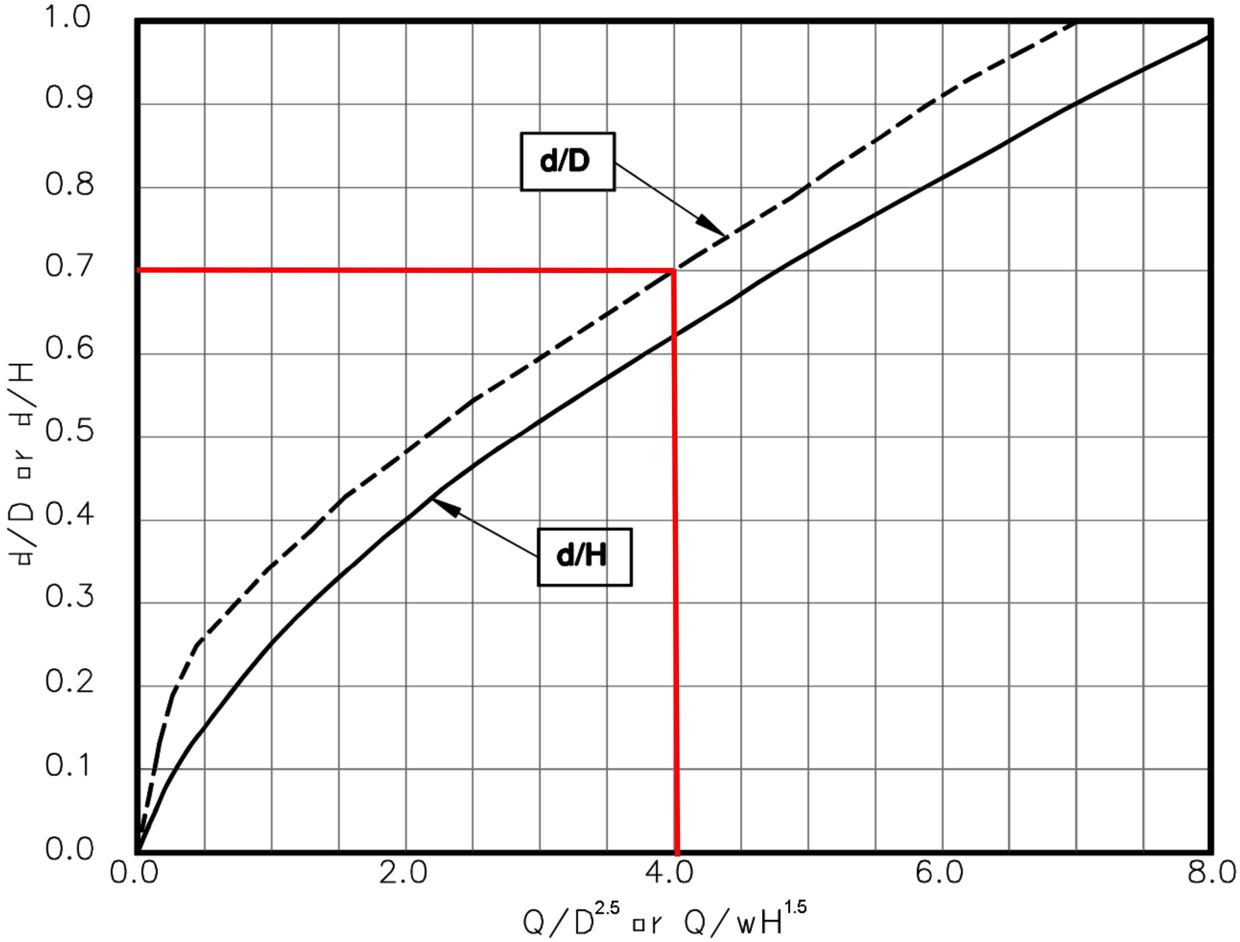


Figure HS-20b—Low Tailwater Riprap Basins for Storm Sewer Pipe Outlets—

Brink Depth for Horizontal Pipe Outlets

(Stevens and Urbonas 1996)

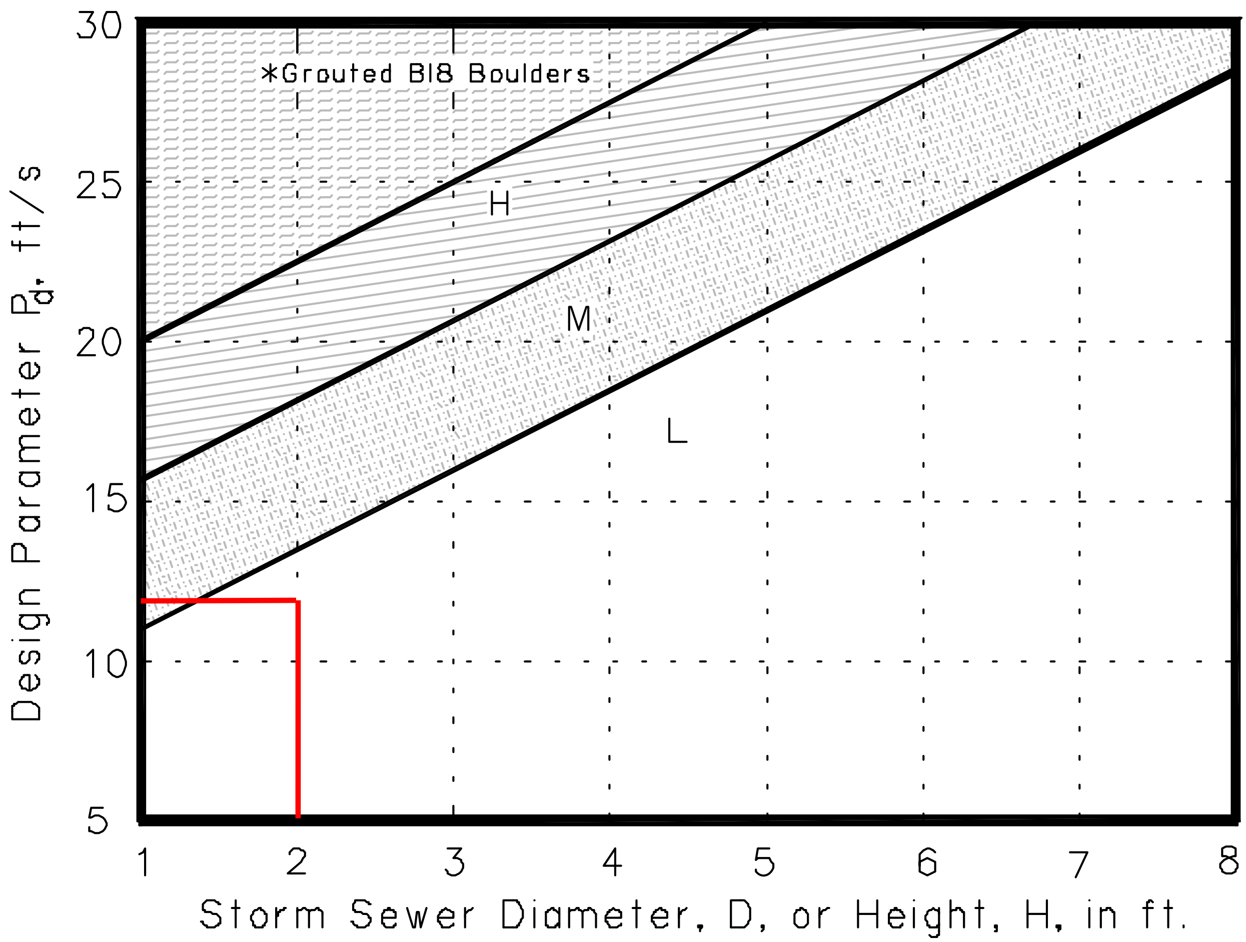


Figure HS-20c—Low Tailwater Riprap Basins for Storm Sewer Pipe Outlets—

Riprap Selection Chart for Low Tailwater Basin at Pipe Outlet

(Stevens and Urbonas 1996)

Appendix D – Water Quality Analysis

Appendix I Stormwater Quality Policy and Procedures-revisions

I.7. Post-Construction Stormwater Management

The Rex Road project will achieve water quality primarily with a Bioretention Basin located near the southwest corner of the future intersection of Rex Rd with Eastonville Road. The size of the basin was calculated to be approximately 915 cu. ft.

The furthest west drainage area (Exclusion Area), will not require water quality treatment by Section I.7.1.C.1 as outlined below. The area comprises approximately 1.4 ac. of impervious area tributary to a flow-by inlet (I01), the inlet captures approximately 2/3 of the flow equating to approximately 1 acre of tributary area downstream of the inlet into a natural channel. By the exception listed, up to 20%, not exceeding 1 acre can be released without water quality when the County has determined that it is not practicable to capture the runoff prior to control measures.

> **I.7.1.C.1 Water Quality Capture Volume (WQCV) Standard.**
>
> 100% of the applicable development site is captured, except the County may exclude up to 20 percent, not to exceed 1 acre of the applicable development site area when the County has determined that it is not practicable to capture runoff from portions of the site that will not drain towards control measures.

The second basin (UIA/RPA1) is the northern half of Rex Road with curb and gutter discharges into a wide flat-bottom channel to promote water quality. The runoff from the roadway platform will be conveyed through grass swale providing sufficient runoff reduction prior to combining with the remaining tributary flow.

The third basin (UIA/RPA2) is the northern half of Rex Road without curb and gutter discharges across a grass buffer providing sufficient runoff reduction prior to combining with the remaining tributary flow.

The fourth basin (UIA/RPA3) on the southern half of Rex Road is similar to the northern section without curb and gutter discharging across a grass buffer providing sufficient runoff reduction prior to combining with the remaining tributary flow.

The final area (Area 4) downstream of the exclusion area and upstream of UIA/RPA3 will require WQCV. A rain garden bioretention pond is proposed for this area. The calculation resulted in the basin geometry having a 1,620 SF flat bottom, 6” of depth for a volume of 915 CF. The basin will be placed near the southwest corner of the future intersection of Rex Rd and Eastonville Rd.

See the exhibit on the following page for impacted areas, calculations, and more information. See Fig. 7 for drainage flow patterns and general drainage areas for the areas in question.

Worksheet for North Rex Swale 32 FOOT

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030
Channel Slope	0.030 ft/ft
Left Side Slope	6.000 H:V
Right Side Slope	6.000 H:V
Bottom Width	32.00 ft
Discharge	18.00 cfs

Results

Normal Depth	2.3 in
Flow Area	6.4 ft²
Wetted Perimeter	34.4 ft
Hydraulic Radius	2.2 in
Top Width	34.32 ft
Critical Depth	2.5 in
Critical Slope	0.022 ft/ft
Velocity	2.80 ft/s
Velocity Head	0.12 ft
Specific Energy	0.32 ft
Froude Number	1.143
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.3 in
Critical Depth	2.5 in
Channel Slope	0.030 ft/ft
Critical Slope	0.022 ft/ft

Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018)

Designer:	**Thomas A Kerby, PE**
Company:	**Tech Contractors**
Date:	**June 7, 2023**
Project:	**Rex Road Extension at Falcon Regional Park**
Location:	**Falcon, CO**

SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth	0.60	inches
Depth of Average Runoff Producing Storm, d_6 =	0.43	inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	UIA:RPA	UIA:RPA	UIA:RPA									
Area ID	UIA/RPA1	UIA/RPA2	UIA/RPA3									
Downstream Design Point ID	G15a1	G15a1	G15a1									
Downstream BMP Type	None	None	None									
DCIA (ft^2)	--	--	--									
UIA (ft^2)	10,940	5,860	5,860									
RPA (ft^2)	3,520	1,740	1,740									
SPA (ft^2)	--	--	--									
HSG A (%)	0%	0%	0%									
HSG B (%)	100%	100%	100%									
HSG C/D (%)	0%	0%	0%									
Average Slope of RPA (ft/ft)	0.025	0.167	0.167									
UIA:RPA Interface Width (ft)	32.00	290.00	290.00									

CALCULATED RUNOFF RESULTS

Area ID	UIA/RPA1	UIA/RPA2	UIA/RPA3									
UIA:RPA Area (ft^2)	14,460	7,600	7,600									
L / W Ratio	14.12	0.09	0.09									
UIA / Area	0.7566	0.7711	0.7711									
Runoff (in)	0.09	0.14	0.14									
Runoff (ft^3)	114	91	91									
Runoff Reduction (ft^3)	342	153	153									

CALCULATED WQCV RESULTS

Area ID	UIA/RPA1	UIA/RPA2	UIA/RPA3									
WQCV (ft^3)	456	244	244									
WQCV Reduction (ft^3)	342	153	153									
WQCV Reduction (%)	75%	63%	63%									
Untreated WQCV (ft^3)	114	91	91									

CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

Downstream Design Point ID	G15a1											
DCIA (ft^2)	0											
UIA (ft^2)	22,660											
RPA (ft^2)	7,000											
SPA (ft^2)	0											
Total Area (ft^2)	29,660											
Total Impervious Area (ft^2)	22,660											
WQCV (ft^3)	944											
WQCV Reduction (ft^3)	648											
WQCV Reduction (%)	69%											
Untreated WQCV (ft^3)	296											

CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft^2)	29,660
Total Impervious Area (ft^2)	22,660
WQCV (ft^3)	944
WQCV Reduction (ft^3)	648
WQCV Reduction (%)	69%
Untreated WQCV (ft^3)	296

Design Procedure Form: Rain Garden (RG)

UD-BMP (Version 3.07, March 2018)

Designer: Thomas A Kerby, PE
Company: Tech Contractors
Date: June 7, 2023
Project: Rex Road Extension at Falcon Regional Park
Location: FALCON, CO

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 = 97.4 %
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i = 0.974
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 = 0.38 watershed inches
D) Contributing Watershed Area (including rain garden area)	Area = 19,540 sq ft
E) Water Quality Capture Volume (WQCV) Design Volume Vol = (WQCV / 12) * Area	V_{WQCV} = cu ft
F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = 0.60 in
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume	$V_{WQCV\ OTHER}$ = 858 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} = 6 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} = 381 sq ft
D) Actual Flat Surface Area	A_{Actual} = 1620 sq ft
E) Area at Design Depth (Top Surface Area)	A_{Top} = 2040 sq ft
F) Rain Garden Total Volume (V_T= ((A_{Top} + A_{Actual}) / 2) * Depth)	V_T= 915 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

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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 – HEC-RAS: Natural Drainage Course Hydraulics

The main natural drainage course was analyzed using HEC-RAS from the beginning of construction to the end of construction. The proposed swale has 4:1 side slopes and a 10 foot bottom width. A Mannings N-value of 0.35 was selected for the main channel flow with the overbank having a slightly higher value of 0.45 signifying weedy overgrowth. A Mannings N-value of 0.78 was used for the rip-rap areas.

Cross sections were created at the beginning, end, at grade breaks and the culvert crossing. Interpolated sections were added as needed. A normal depth was selected for the reach boundary conditions upstream and downstream. This could create an artificially high velocity at the beginning of the study zone and an artificially low velocity at the downstream end. The flow velocities were all below the 7-fps maximum desired for the blanket material as specified by the manufacturer.

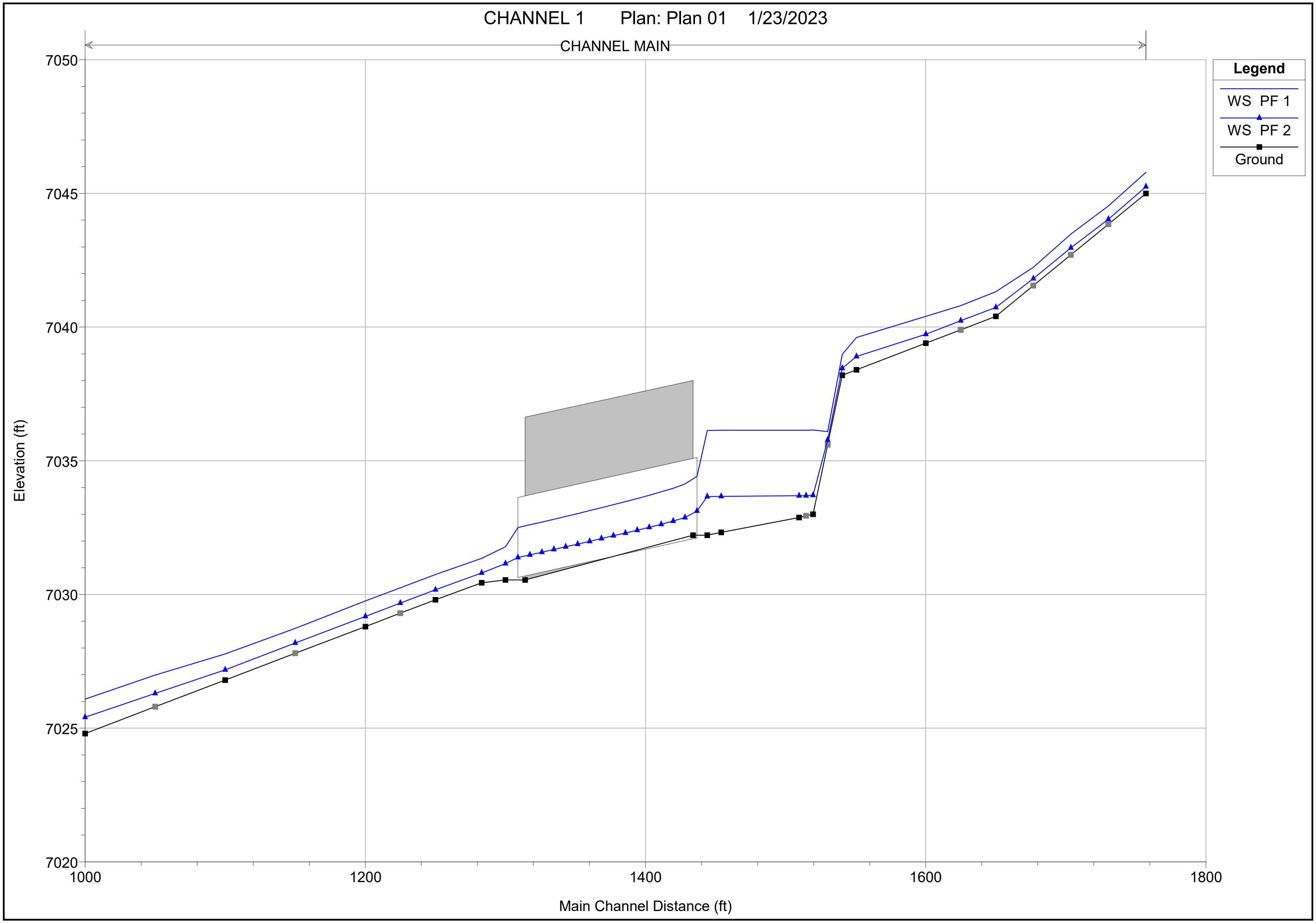
The Rational Calculation method was used for the channel and culvert analysis since the tributary area is less than 100-acres. Furthermore, the increase of flow was placed at the entrance to the culvert since HEC-RAS does not model the flow regime changes in the middle of a culvert. The flow regime change was modeled using the StormCAD software found in the Rational Calculation Appendix B.

See the charts, cross sections and profile below for more information.

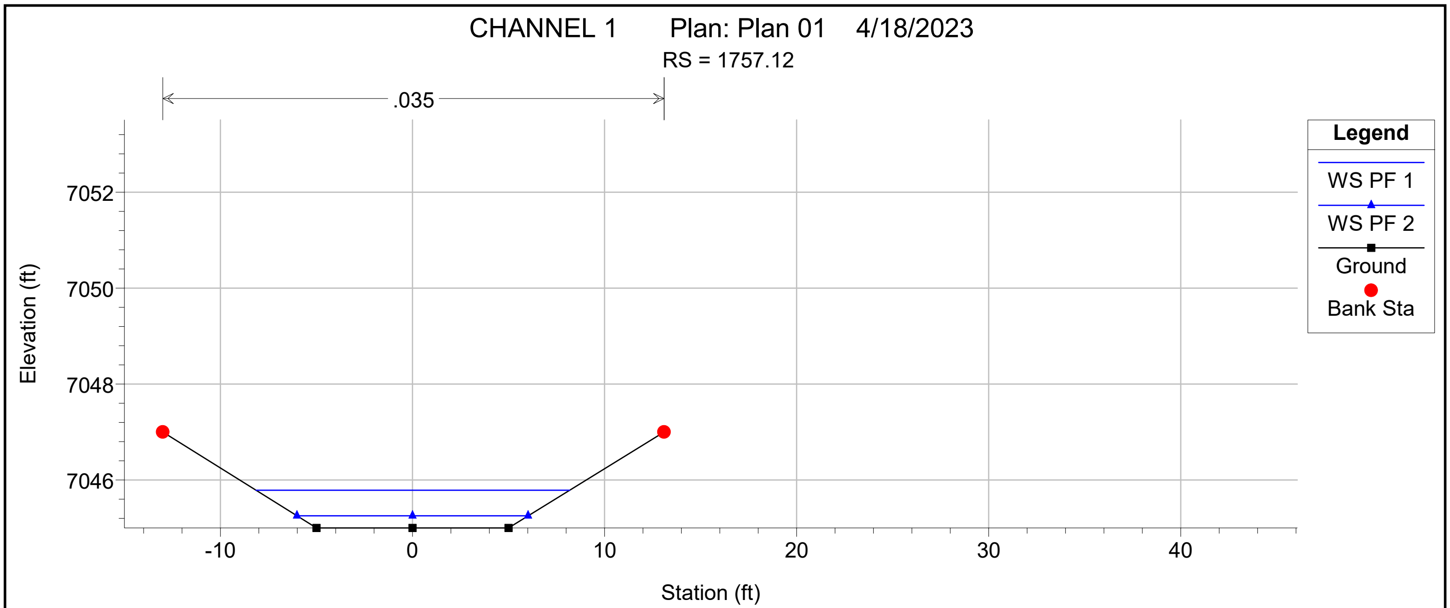
River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1757.12	Q_{100}	47	7045.0	7045.8	7045.8	7046.1	0.0212	4.5	10.4	16.3	1.0
1730.34*	Q_{100}	47	7043.9	7044.4	7044.6	7045.2	0.0746	6.9	6.8	14.5	1.8
1703.56*	Q_{100}	47	7042.7	7043.4	7043.5	7043.8	0.0346	5.4	8.8	15.6	1.3
1676.78*	Q_{100}	47	7041.6	7042.2	7042.3	7042.8	0.0538	6.2	7.6	15	1.5
1650	Q_{100}	47	7040.4	7041.1	7041.2	7041.6	0.0412	5.7	8.3	15.4	1.4
1625.00*	Q_{100}	47	7039.9	7040.7	7040.7	7041.0	0.0214	4.5	10.3	16.3	1.0
1600	Q_{100}	47	7039.4	7040.3	7040.2	7040.5	0.013	3.8	12.2	17.1	0.8
1550.5	Q_{100}	47	7038.4	7039.6		7039.7	0.0198	2.6	17.9	19.7	0.5
1540.5	Q_{100}	47	7038.2	7039.0	7039.0	7039.3	0.1072	4.6	10.3	16.3	1.0
1530.08*	Q_{100}	47	7035.6	7036.1	7036.4	7037.1	0.5528	8.0	5.9	13.8	2.2
1519.65	Q_{100}	47	7033.0	7036.1	7033.8	7036.2	0.0003	0.7	69.0	34.4	0.1
1514.65*	Q_{100}	47	7032.9	7036.1		7036.2	0.0001	0.8	70.8	34.7	0.1
1509.65	Q_{100}	47	7032.9	7036.1		7036.2	0.0001	0.8	72.6	35.1	0.1
1454	Q_{100}	47	7032.3	7036.1		7036.1	0.0001	0.5	96.5	40.3	0.0
1444	Q_{100}	50	7032.2	7036.1	7033.4	7036.1	0.0002	0.7	72.8	34.4	0.1
1436.75	Culvert	50									
1300	Q_{100}	50	7030.5	7031.8	7031.5	7032.0	0.0309	3.6	14.2	16.5	0.6
1283	Q_{100}	50	7030.4	7031.2	7031.2	7031.6	0.0176	4.6	11.1	16.5	0.9
1250	Q_{100}	50	7029.8	7030.6	7030.6	7030.9	0.0196	4.5	11.1	16.7	1.0
1225.00*	Q_{100}	50	7029.3	7030.1	7030.1	7030.4	0.0199	4.5	11.1	16.6	1.0
1200	Q_{100}	50	7028.8	7029.6	7029.6	7029.9	0.0199	4.5	11.1	16.6	1.0
1150.00*	Q_{100}	50	7027.8	7028.6	7028.6	7028.9	0.0204	4.6	11	16.6	1.0
1100	Q_{100}	50	7026.8	7027.6	7027.6	7027.9	0.0195	4.5	11.1	16.7	1.0
1050.00*	Q_{100}	50	7025.8	7026.9		7027.1	0.0137	4.0	12.4	16.7	0.8
1000	Q_{100}	50	7024.8	7026.0	7025.9	7026.3	0.0199	4.7	10.7	15.3	1.0

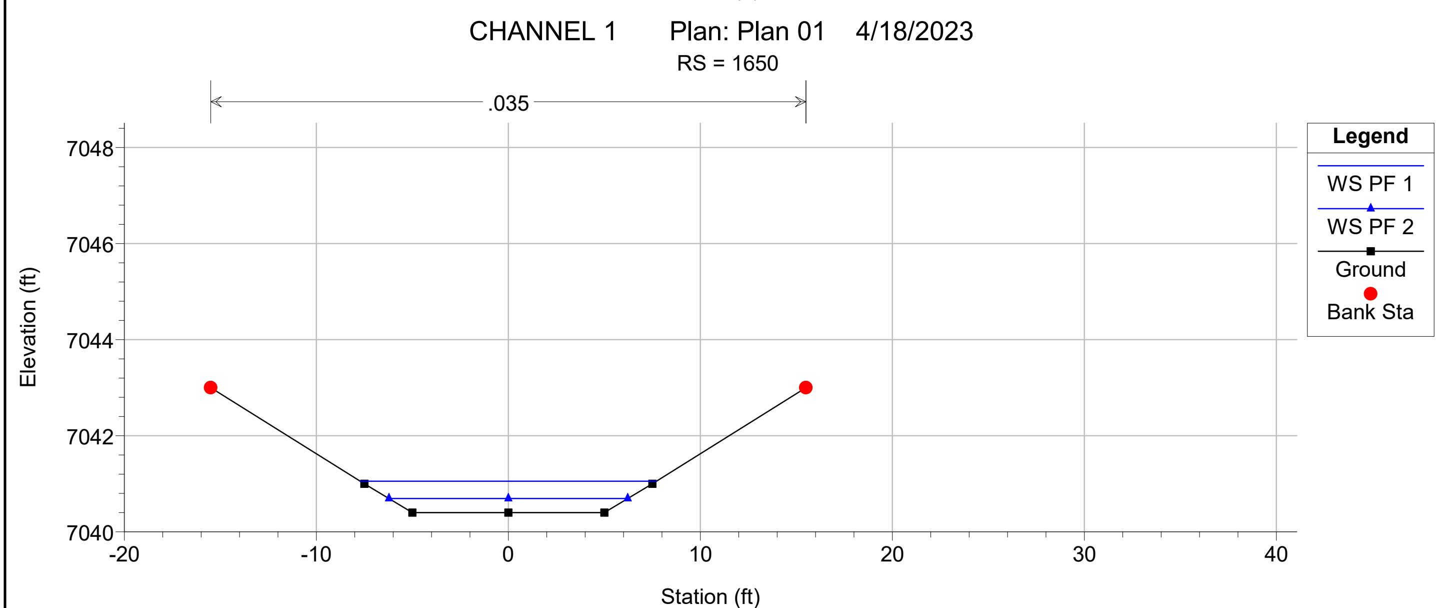
River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
1757.12	Q_5	8	7045.0	7045.3	7045.3	7045.4	0.0324	2.9	2.8	12.0	1.1
1730.34*	Q_5	8	7043.9	7044.1	7044.1	7044.3	0.0655	3.6	2.2	11.7	1.4
1703.56*	Q_5	8	7042.7	7042.9	7043.0	7043.1	0.0341	2.9	2.7	12.0	1.1
1676.78*	Q_5	8	7041.6	7041.8	7041.8	7042.0	0.0614	3.5	2.3	11.7	1.4
1650	Q_5	8	7040.4	7040.7	7040.7	7040.8	0.0196	2.4	3.3	12.4	0.8
1625.00*	Q_5	8	7039.9	7040.2		7040.3	0.0204	2.5	3.2	12.3	0.9
1600	Q_5	8	7039.4	7039.7		7039.8	0.0196	2.5	3.3	12.2	0.8
1550.5	Q_5	8	7038.4	7038.9		7038.9	0.0148	1.3	6.1	14.0	0.4
1540.5	Q_5	8	7038.2	7038.5	7038.5	7038.6	0.1441	2.8	2.9	12.1	1.0
1530.08*	Q_5	8	7035.6	7035.8	7035.9	7036.0	0.4879	4.1	2.0	11.4	1.7
1519.65	Q_5	8	7033.0	7033.7	7033.3	7033.7	0.0048	0.9	8.8	15.1	0.2
1514.65*	Q_5	8	7032.9	7033.7		7033.7	0.0007	0.8	9.6	15.4	0.2
1509.65	Q_5	8	7032.9	7033.7		7033.7	0.0006	0.8	10.4	15.8	0.2
1454	Q_5	8	7032.3	7033.7		7033.7	0.0003	0.4	21.3	20.6	0.1
1444	Q_5	10	7032.2	7033.7	7032.6	7033.7	0.0013	0.8	13.1	13.8	0.1
1436.75	Culvert	10									
1300	Q_5	10	7030.5	7031.1		7031.2	0.0229	1.8	5.5	11.5	0.5
1283	Q_5	10	7030.4	7030.8		7030.9	0.0174	2.5	4.0	13.5	0.8
1250	Q_5	10	7029.8	7030.1	7030.1	7030.2	0.0206	2.7	3.7	12.7	0.9
1225.00*	Q_5	10	7029.3	7029.6		7029.7	0.0189	2.6	3.8	12.7	0.8
1200	Q_5	10	7028.8	7029.1	7029.1	7029.2	0.0211	2.7	3.7	12.6	0.9
1150.00*	Q_5	10	7027.8	7028.1	7028.1	7028.2	0.0189	2.6	3.8	12.7	0.8
1100	Q_5	10	7026.8	7027.1	7027.1	7027.2	0.0214	2.7	3.7	12.6	0.9
1050.00*	Q_5	10	7025.8	7026.2	7026.2	7026.3	0.0151	2.6	3.8	10.7	0.8
1000	Q_5	10	7024.8	7025.3	7025.3	7025.5	0.0199	3.0	3.3	8.9	0.9

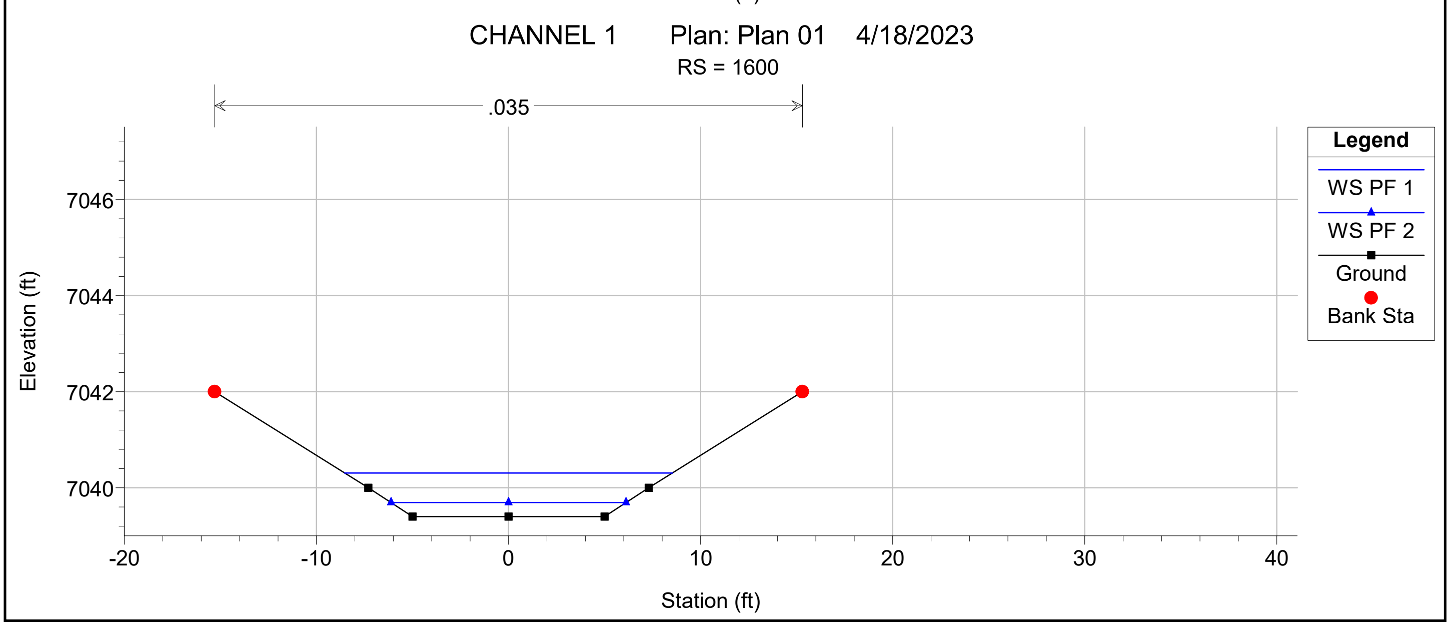
River Sta	Profile	Q Culv (cfs)		W.S. US. (ft)	Delta WS (ft)	E.G. US. (ft)	E.G. IC (ft)	E.G. OC (ft)	Culv Vel US (ft/s)	Culv Vel DS (ft/s)
1436.75	PF 1	50		7036.1	4.4	7036.1	7036.1	7036.1	8.6	10.8
Culvert #1	PF 2	10		7033.7	2.5	7033.7	7033.5	7033.7	4.8	7.2



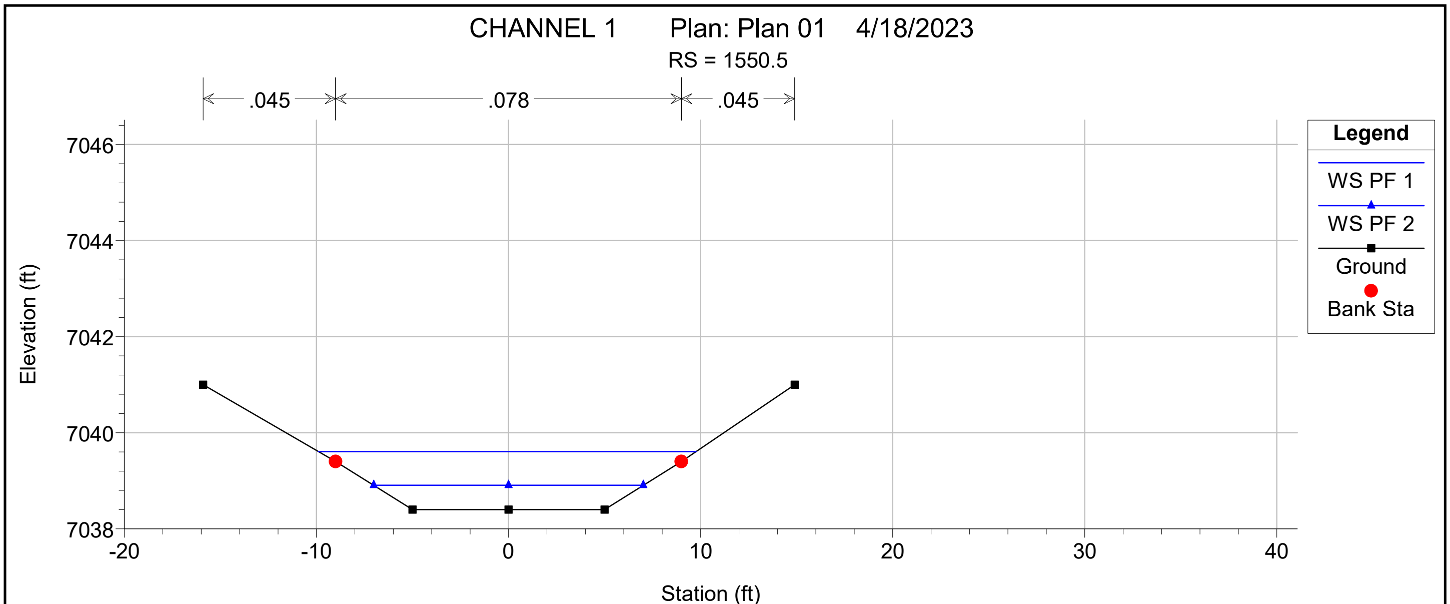
CHANNEL 1 Plan: Plan 01 1/23/2023
CHANNEL MAIN
Legend
WS PF 1
WS PF 2
Ground
Elevation (ft)
7050
7045
7040
7035
7030
7025
7020
1000
1200
1400
1600
1800
Main Channel Distance (ft)

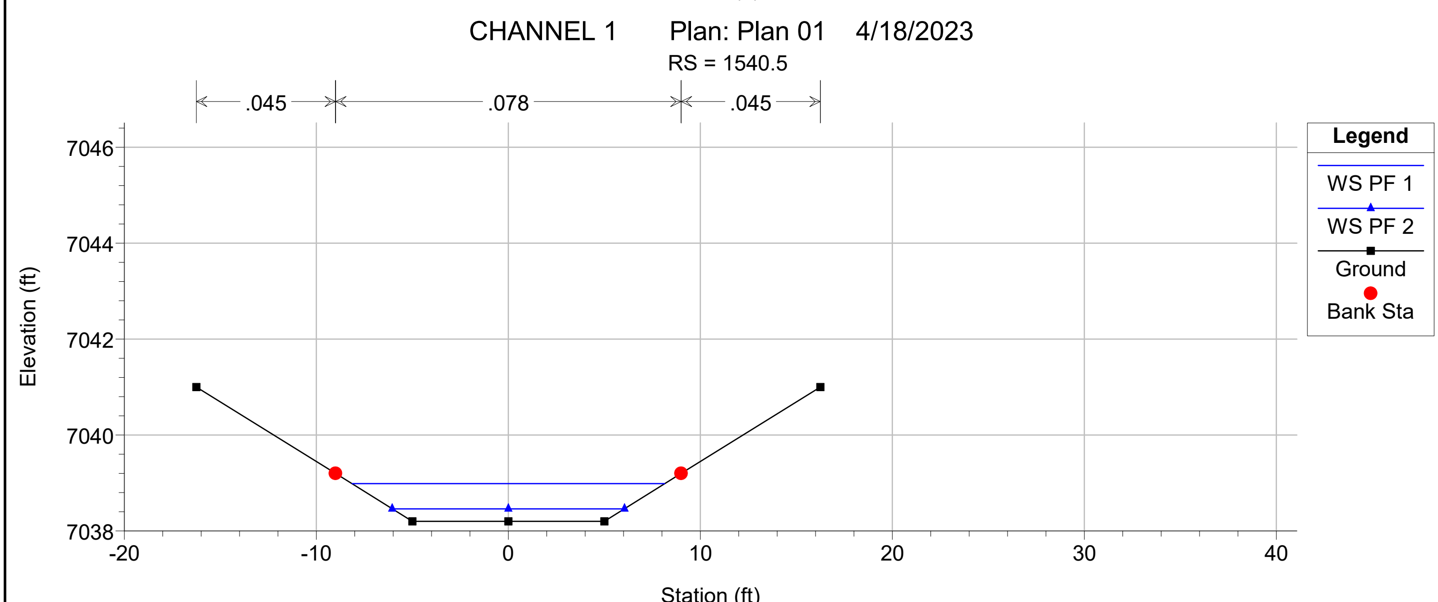


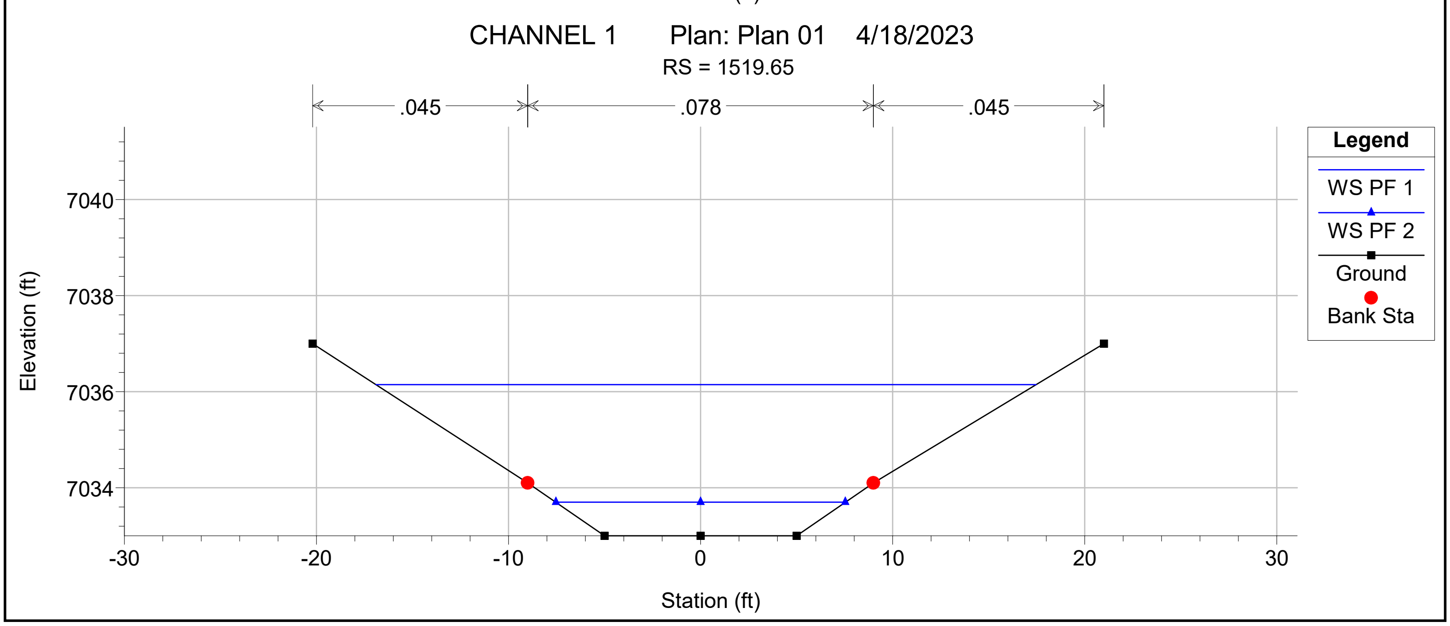




1 in Horiz. = 10 ft 1 in Vert. = 4 ft







1 in Horiz. = 10 ft 1 in Vert. = 4 ft

CHANNEL 1 Plan: Plan 01 4/18/2023

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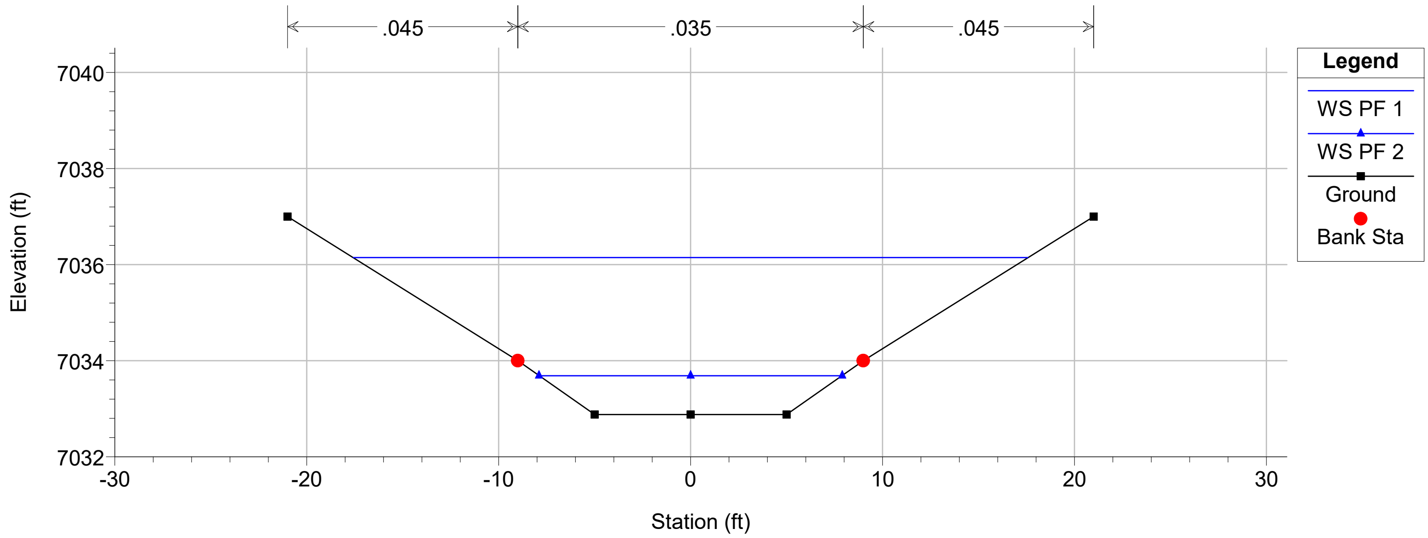

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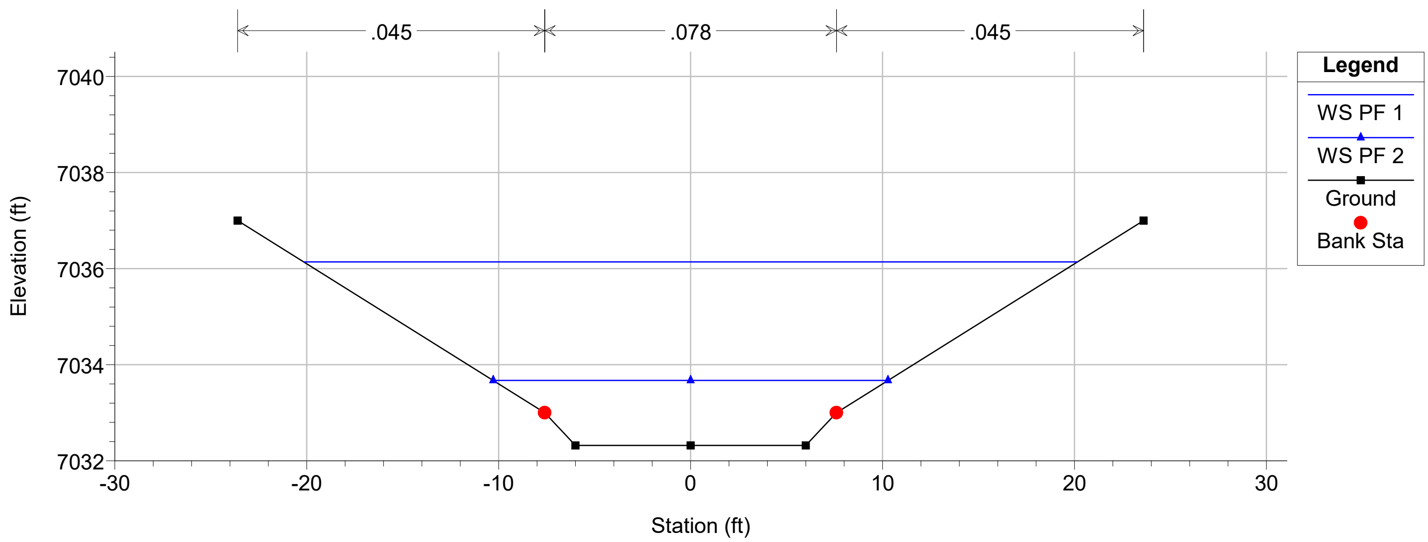

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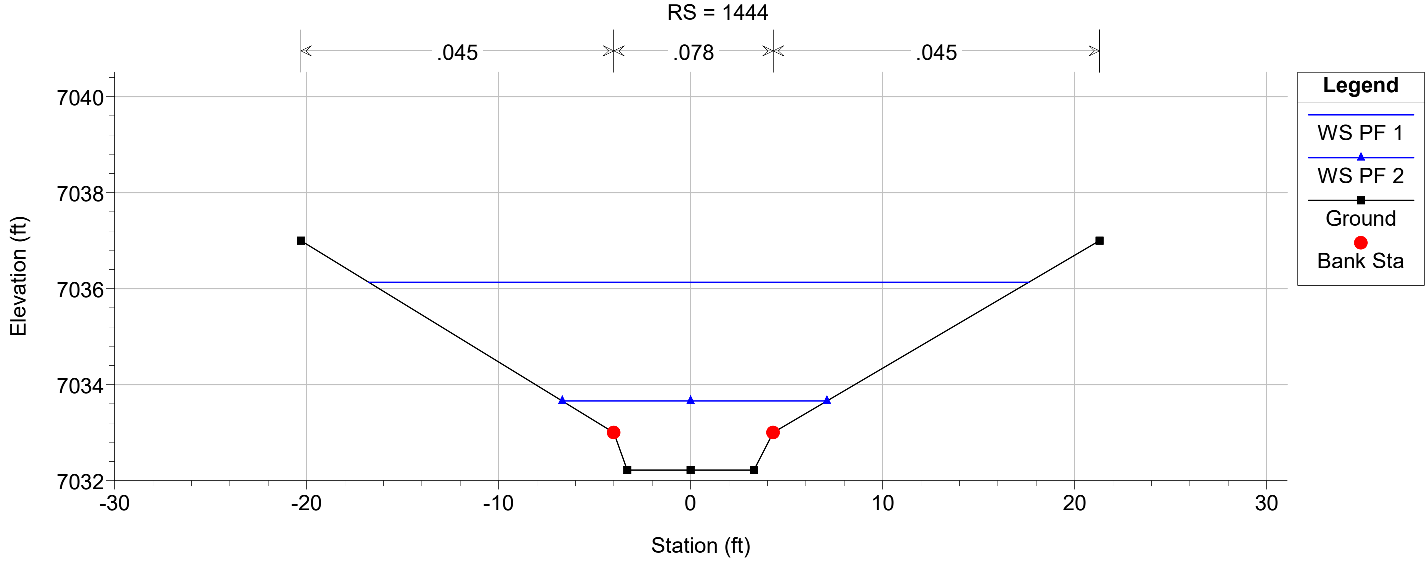

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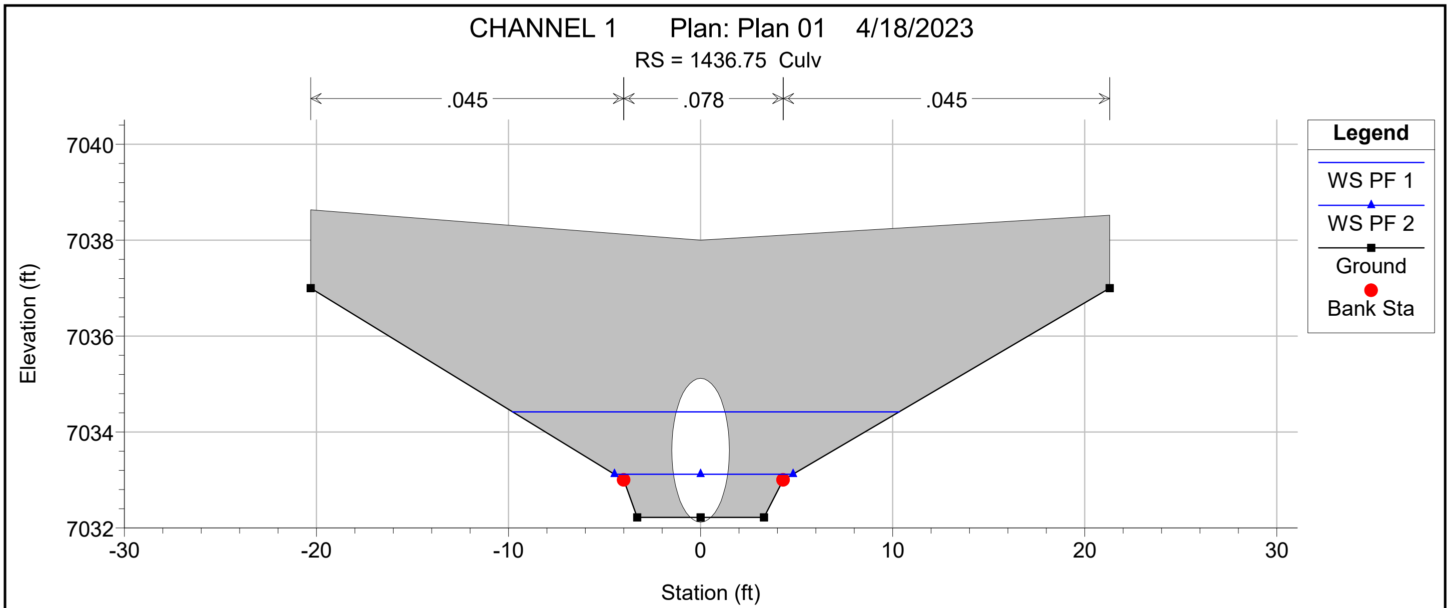

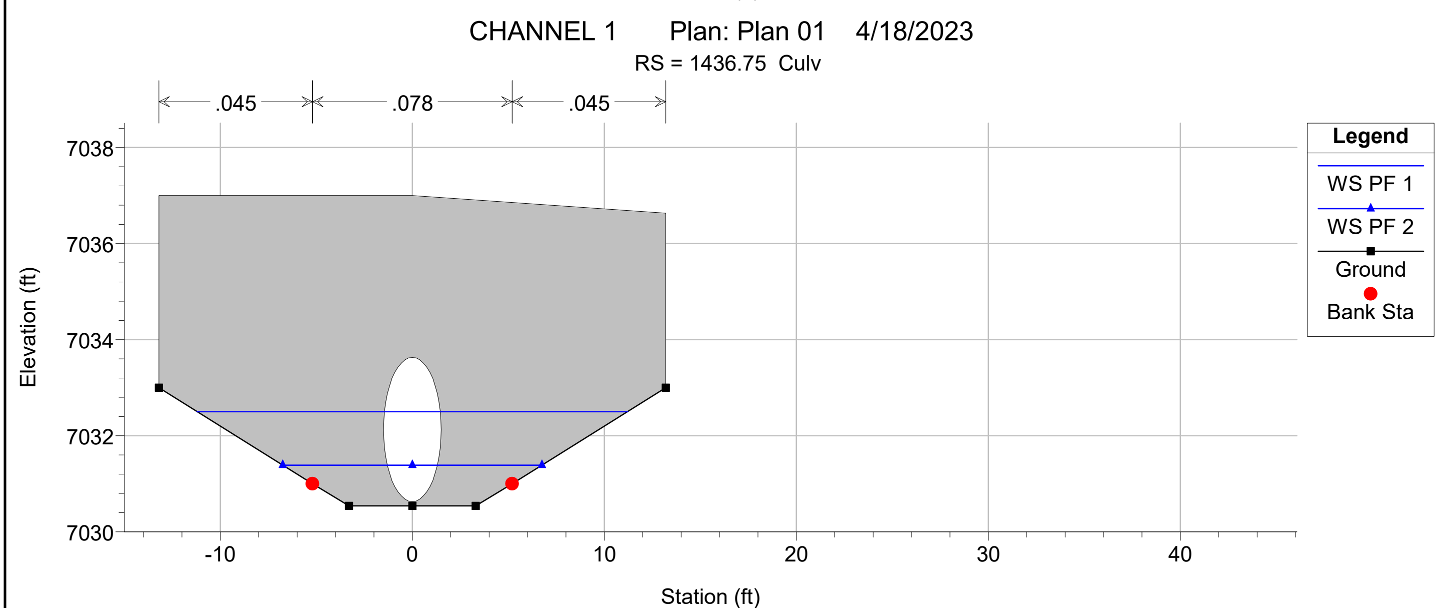

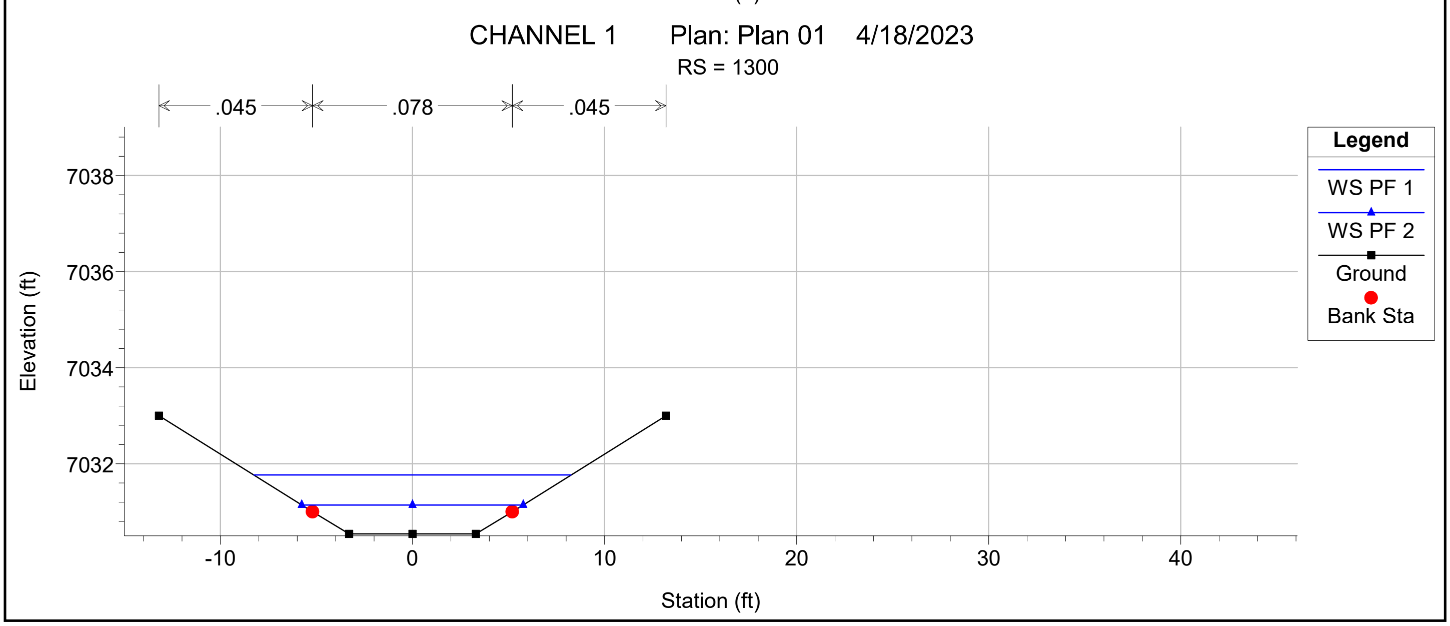

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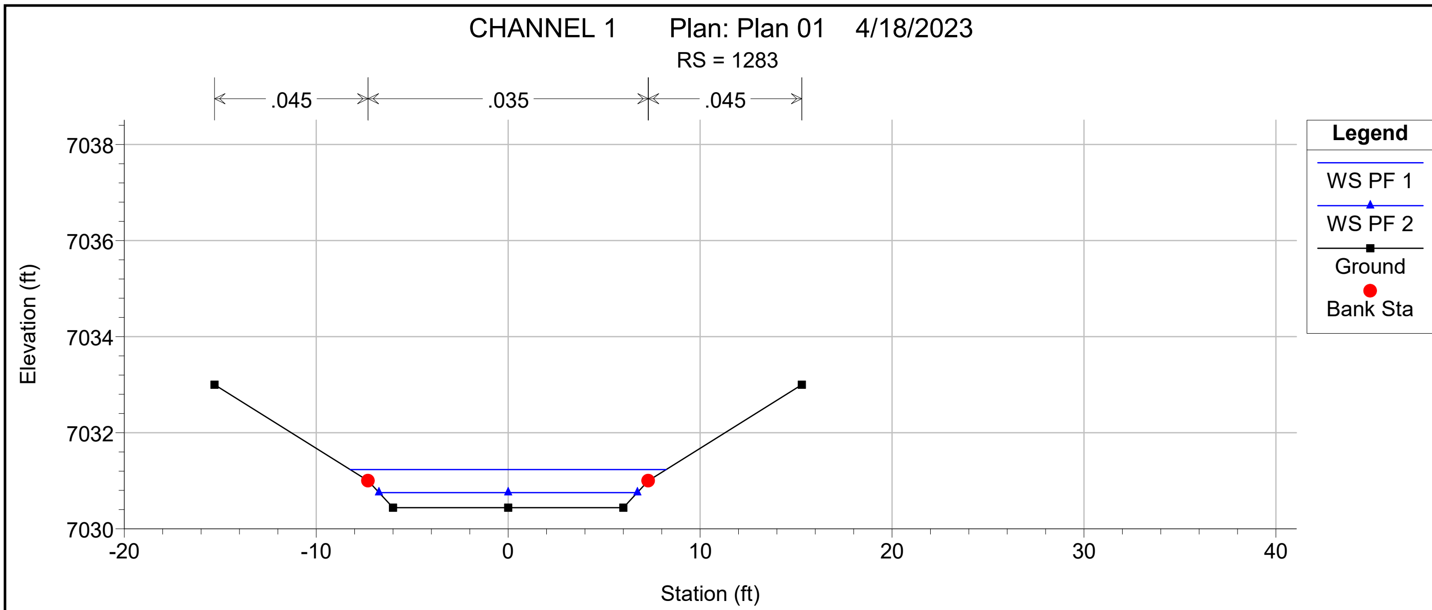

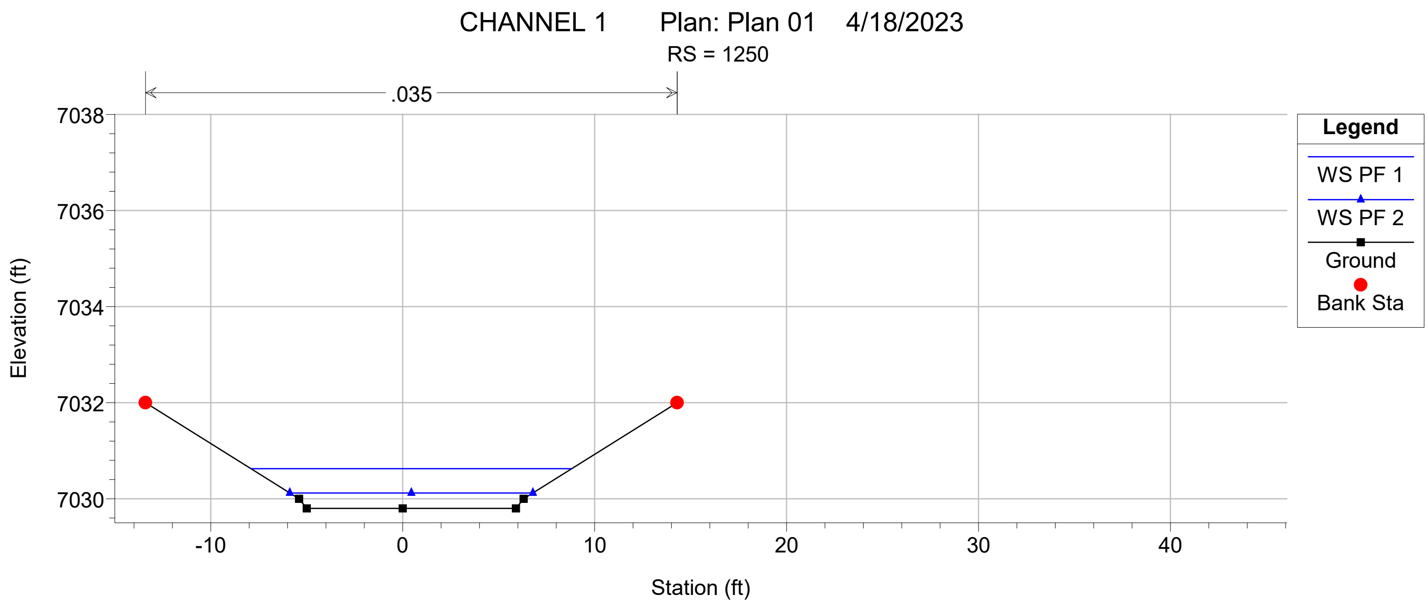

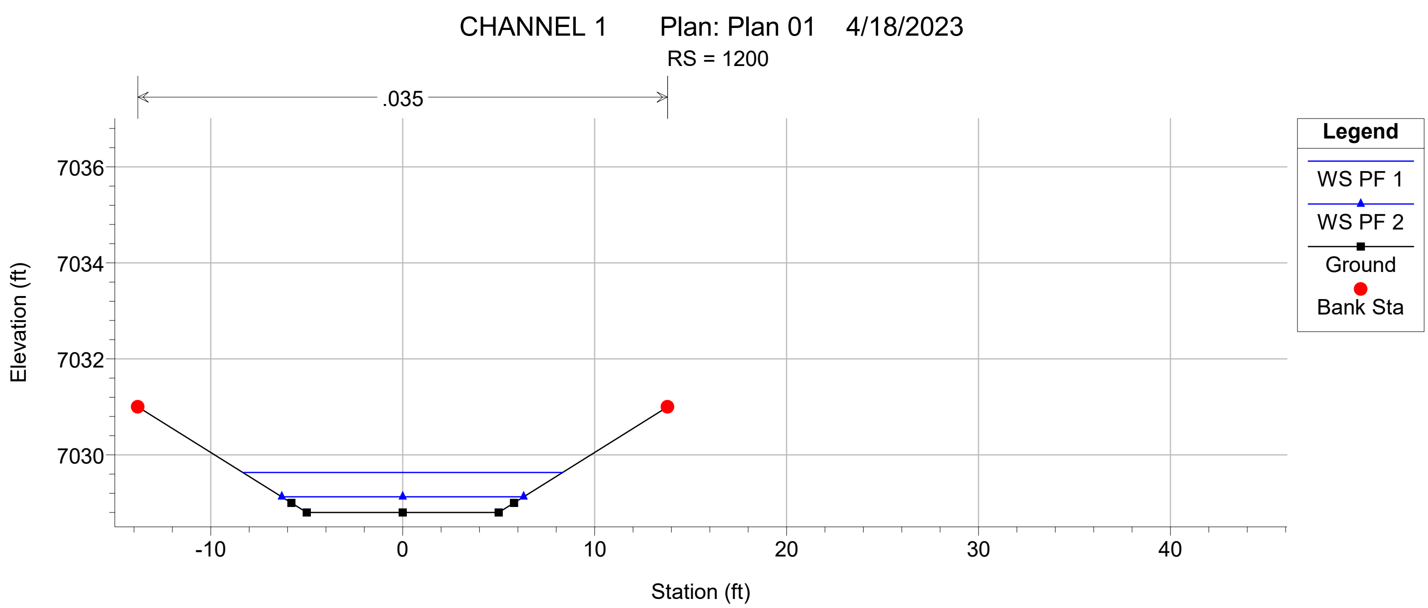

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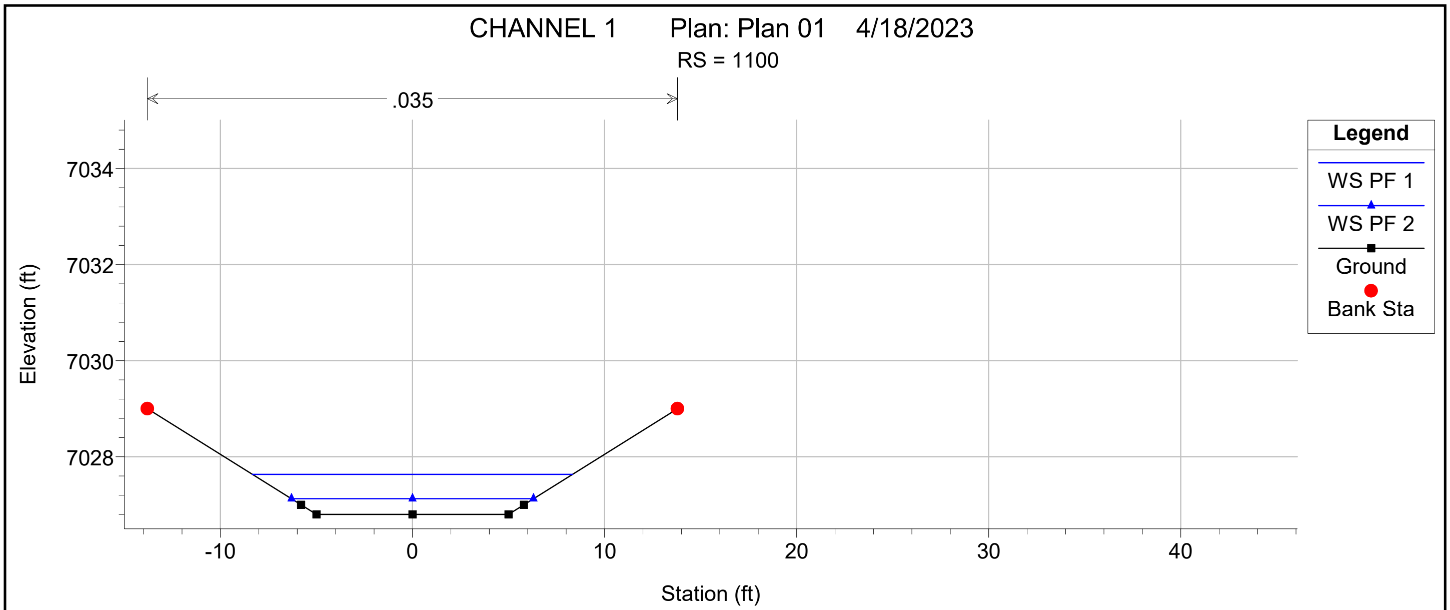
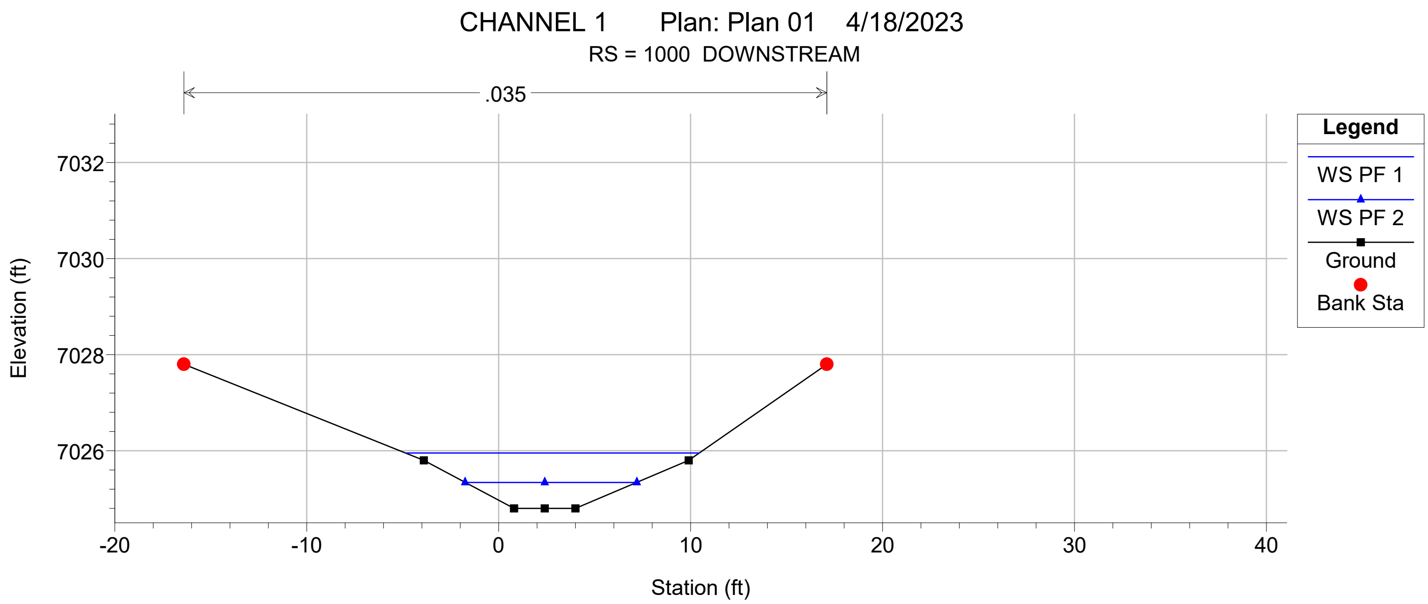




1 in Horiz. = 10 ft 1 in Vert. = 4 ft

Appendix F – Soil Resource Report

United States Department of Agriculture

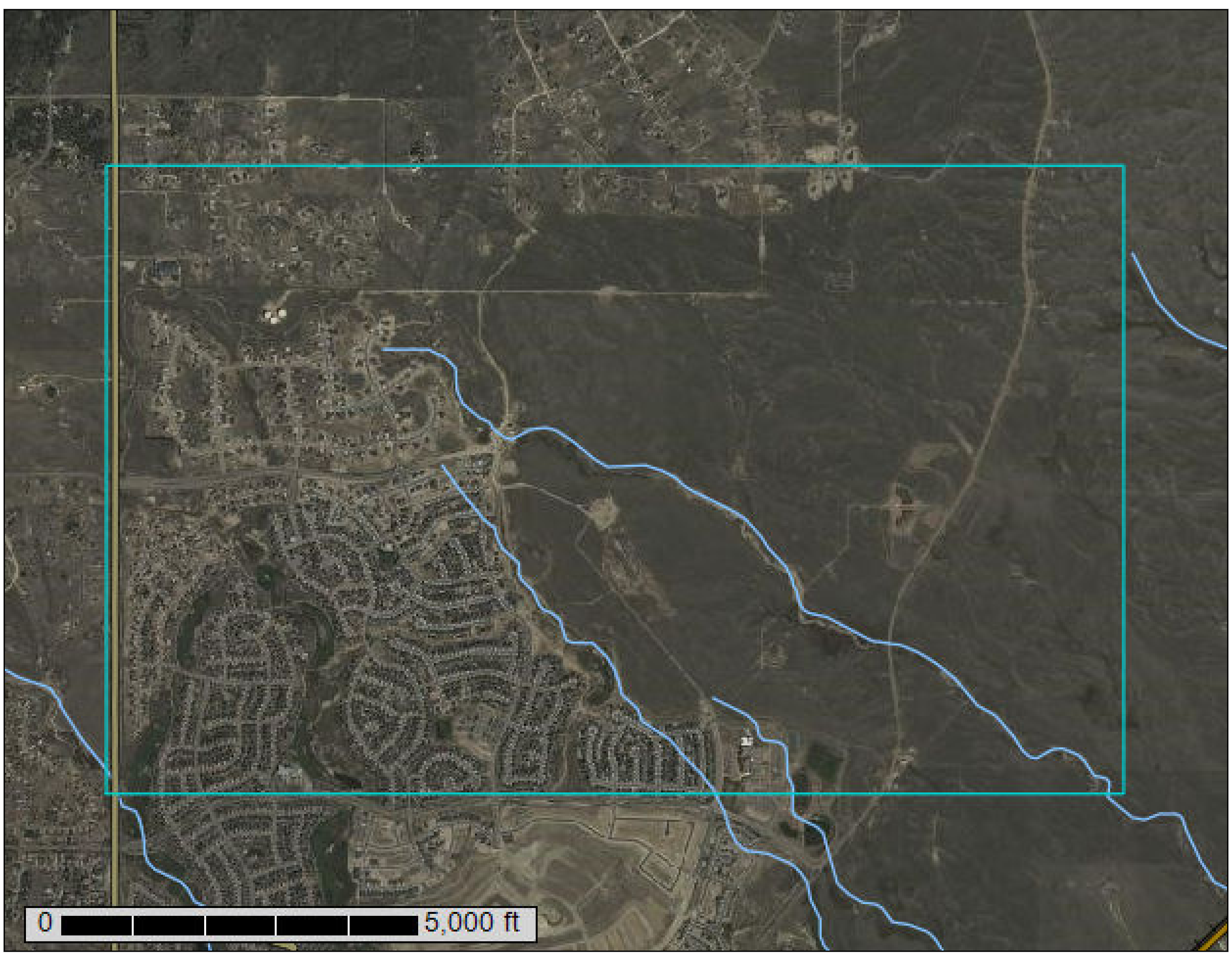
NRCS

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



March 10, 2022

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.

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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.

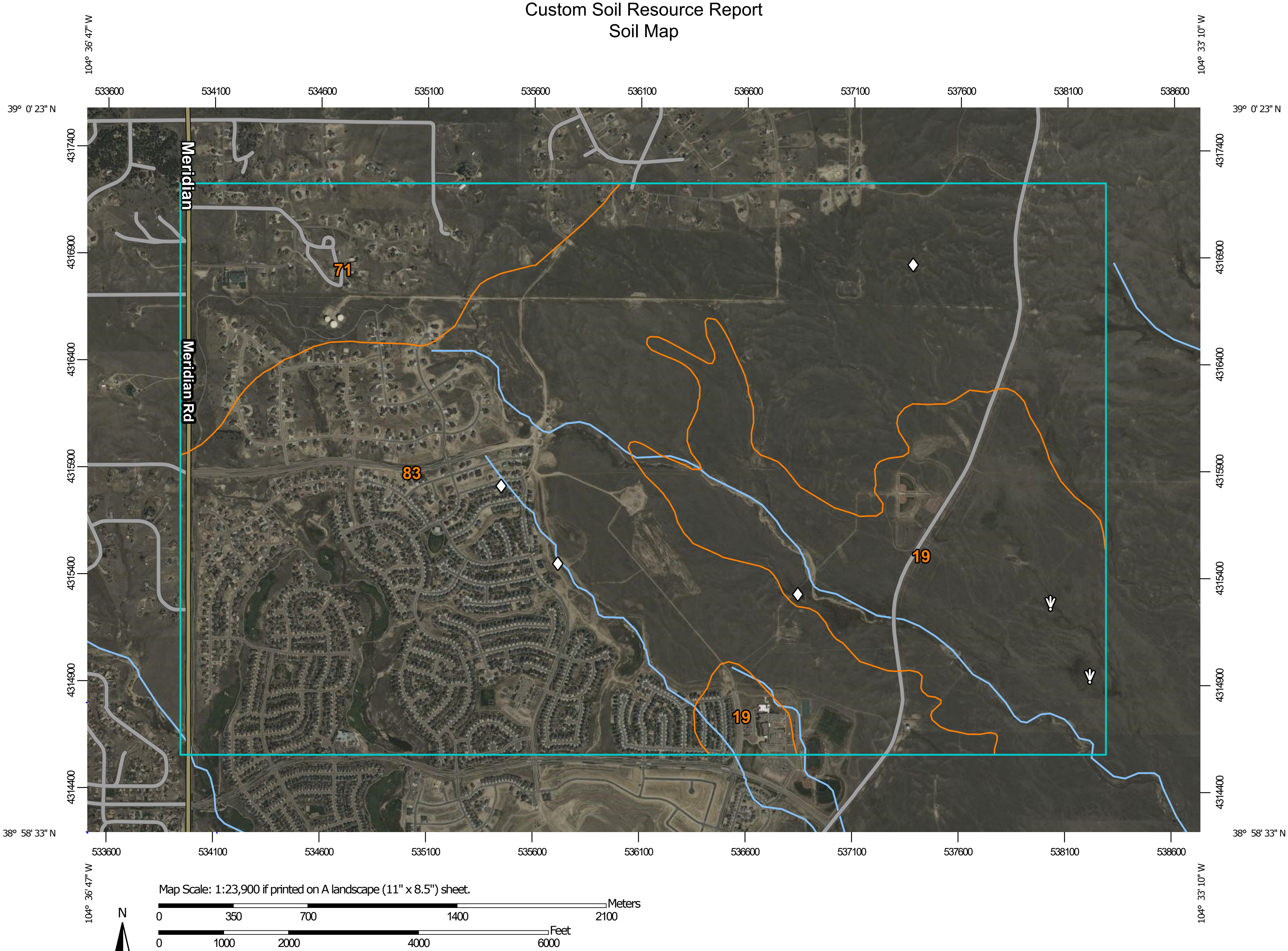
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree 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: 1:23,900 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 350, 700, 1400, 2100

Feet: 0, 1000, 2000, 4000, 6000

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.

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 19, Aug 31, 2021

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

Date(s) aerial images were photographed: Sep 11, 2018—Oct 20, 2018

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
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	575.5	20.0%
71	Pring coarse sandy loam, 3 to 8 percent slopes	339.8	11.8%
83	Stapleton sandy loam, 3 to 8 percent slopes	1,964.3	68.2%
Totals for Area of Interest		**2,879.9**	**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

19—Columbine gravelly sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 367p
Elevation: 6,500 to 7,300 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Columbine and similar soils: 97 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Columbine

Setting

Landform: Flood plains, fan terraces, fans
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 14 inches: gravelly sandy loam
C - 14 to 60 inches: very gravelly loamy sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.5 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: R049XY214CO - Gravelly Foothill
Hydric soil rating: No

Minor Components

Fluvaquentic haplaquolls

Percent of map unit: 1 percent
Landform: Swales
Hydric soil rating: Yes

Other soils

Percent of map unit: 1 percent
Hydric soil rating: No

Pleasant

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

71—Pring coarse sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 369k
Elevation: 6,800 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Pring

Setting

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

Typical profile

A - 0 to 14 inches: coarse sandy loam
C - 14 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well 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 supply, 0 to 60 inches: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: R048AY222CO - Loamy Park
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

83—Stapleton sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 369z
Elevation: 6,500 to 7,300 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Stapleton and similar soils: 97 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Stapleton

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

A - 0 to 11 inches: sandy loam
Bw - 11 to 17 inches: gravelly sandy loam
C - 17 to 60 inches: gravelly loamy sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well 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 supply, 0 to 60 inches: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: R049XY214CO - Gravelly Foothill
Hydric soil rating: No

Minor Components

Fluvaquentic haplaquolls

Percent of map unit: 1 percent
Landform: Swales
Hydric soil rating: Yes

Other soils

Percent of map unit: 1 percent
Hydric soil rating: No

Pleasant

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

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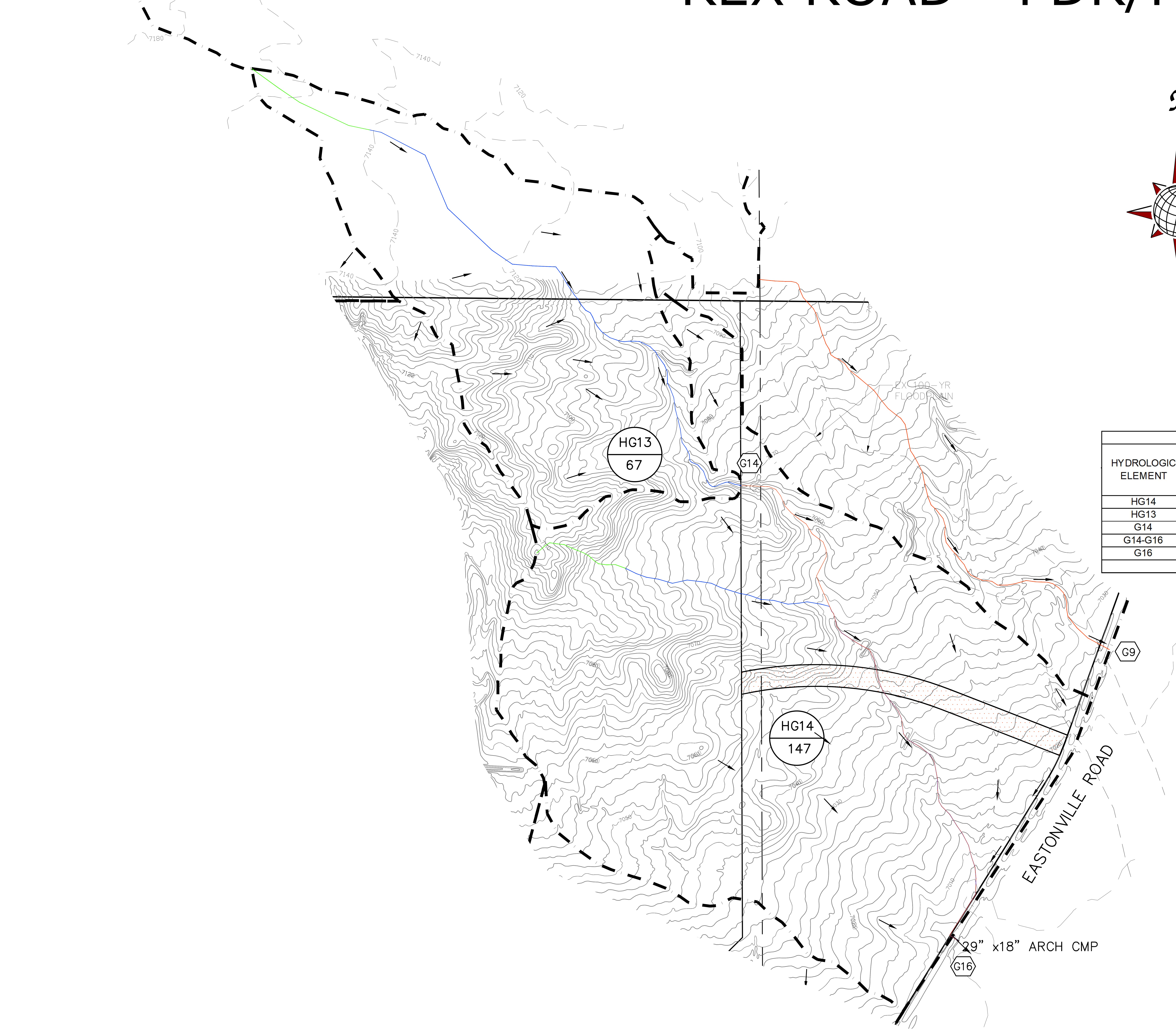
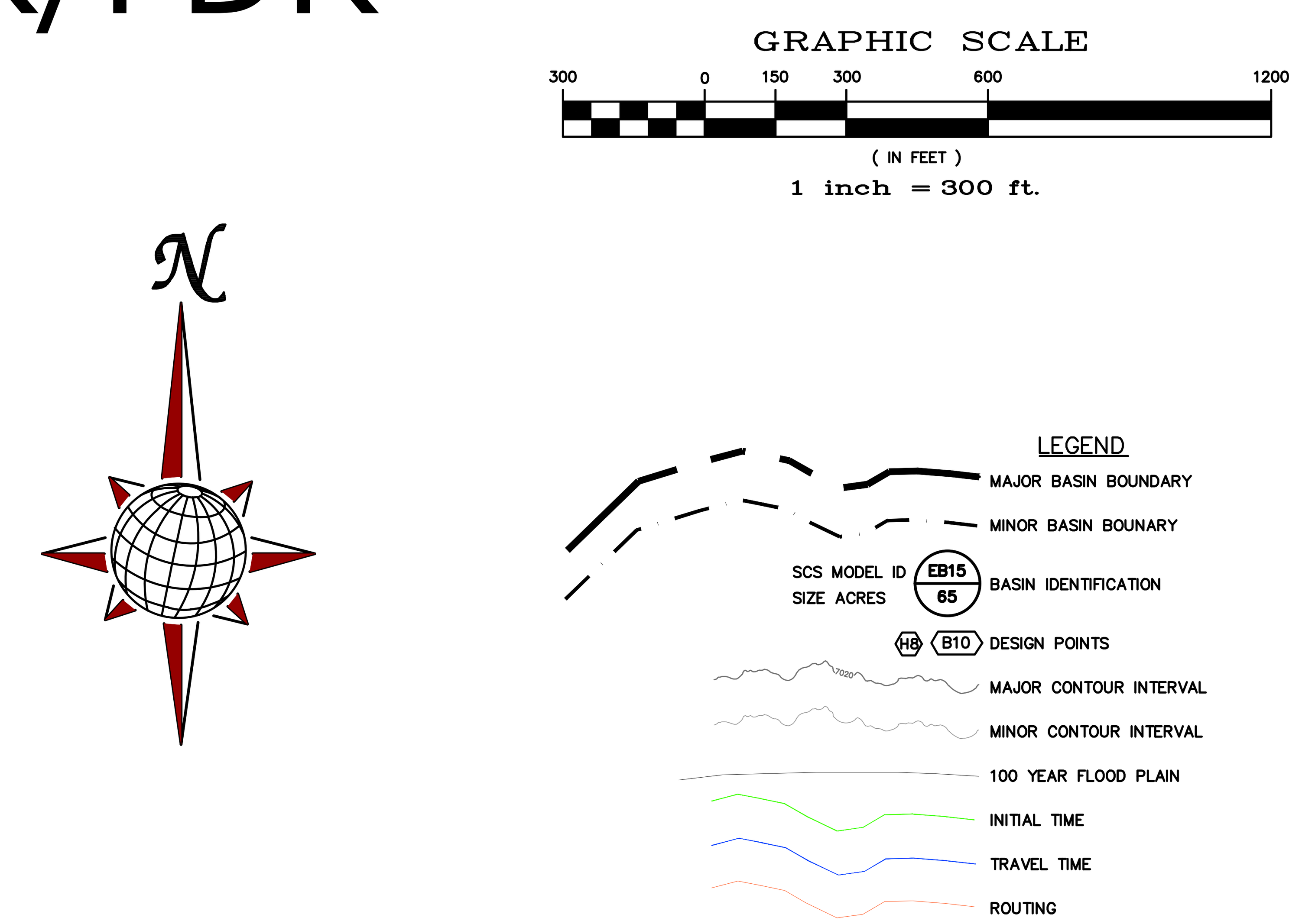
Appendix G – Drainage Maps

REX ROAD - PDR/FDR





HISTORIC SCS (Full Spectrum)						
HYDROLOGIC ELEMENT	DRAINAGE AREA (SQ. MI.)	PEAK DISCHARGE Q100 (CFS)	PEAK DISCHARGE Q50 (CFS)	PEAK DISCHARGE Q10 (CFS)	PEAK DISCHARGE Q5 (CFS)	PEAK DISCHARGE Q2 (CFS)
HG14	0.2297	79	52	12	4.7	0.8
HG13	0.1053	38	25	5.8	2.2	0.4
G14	0.1053	38	25	5.8	2.2	0.4
G14-G16	0.1053	37	25	5.8	2.2	0.4
G16	0.3350	116	77	18	6.8	1.2

HISTORIC CONDITIONS - SCS MAP

FIGURE 4

No.	Revisions	Date	Init.	Appr.	Date
-					
-					
-					
-					

TECH CONTRACTORS
11910 TOURMALINE DR #130
FALCON, CO 80831
TELEPHONE: 719.495.7444

MERIDIAN RANCH

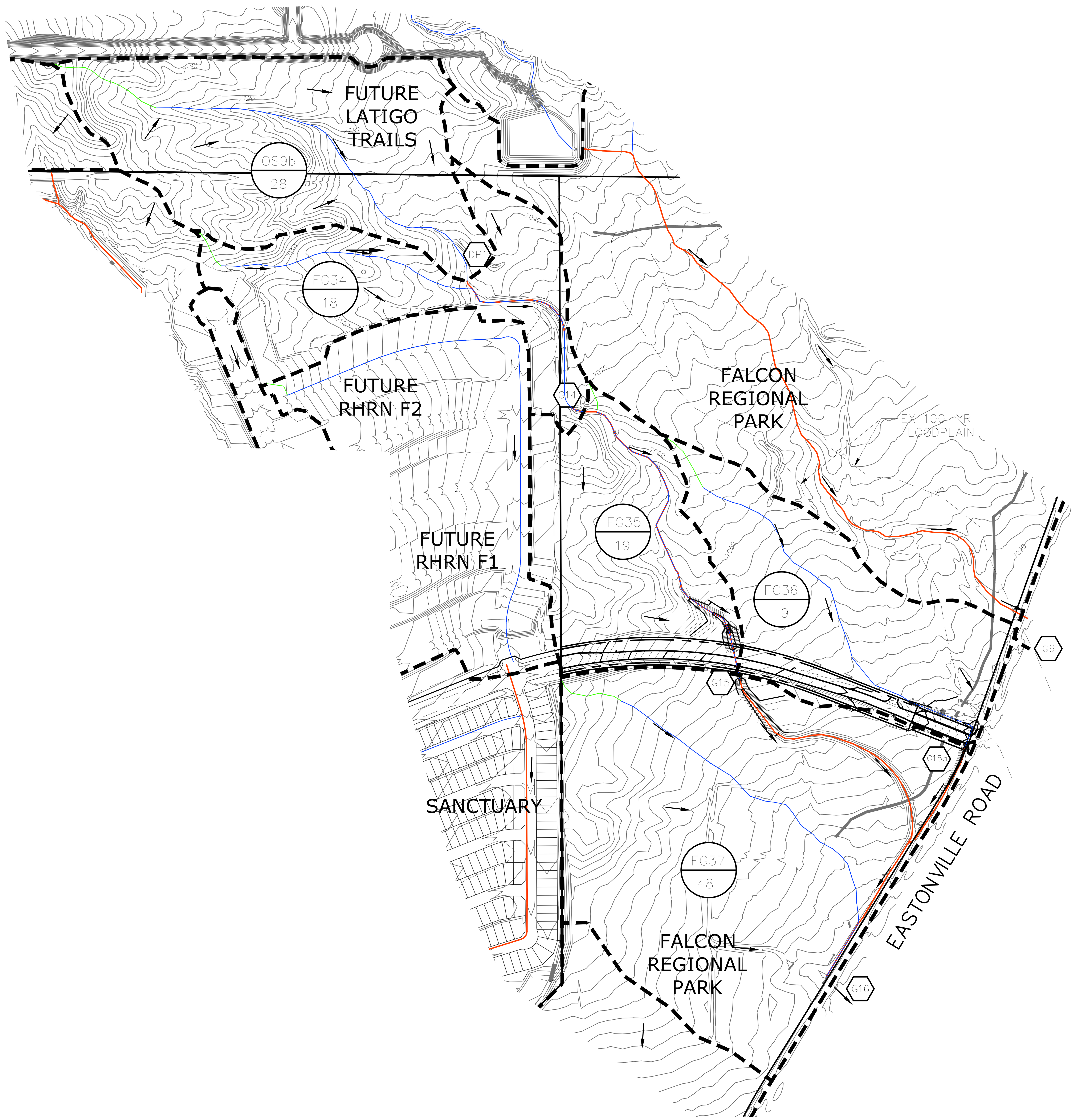
HISTORIC CONDITIONS - SCS MAP
REX ROAD
PDR - FDR

Drawn by TAK
Checked by RG
Date FEB 2023

Scale AS SHOWN

- of -

REX ROAD - PDR/FDR



LEGEND

- MAJOR BASIN BOUNDARY
- MINOR BASIN BOUNDARY
- SCS MODEL ID / SIZE ACRES — BASIN IDENTIFICATION
- DESIGN POINT
- MAJOR CONTOUR INTERVAL
- MINOR CONTOUR INTERVAL
- 100 YEAR FLOOD PLAIN
- INITIAL TIME
- OVERLAND TIME
- ROUTING

GRAPHIC SCALE

300 0 150 300 600 1200

(IN FEET)
1 inch = 300 ft.

PROPOSED SCS (Full Spectrum)						
HYDROLOGIC ELEMENT	DRAINAGE AREA (SQ. MI.)	PEAK DISCHARGE Q100 (CFS)	PEAK DISCHARGE Q50 (CFS)	PEAK DISCHARGE Q10 (CFS)	PEAK DISCHARGE Q5 (CFS)	PEAK DISCHARGE Q2 (CFS)
OS09b	0.0435	22	14	3.2	1.1	0.2
OS09b-G14	0.0435	22	14	3.2	1.1	0.2
FG34	0.0275	20	13	3.3	1.3	0.2
G14	0.0710	38	25	5.5	2.0	0.3
G14-G15	0.0710	37	24	5.5	2.0	0.3
FG35	0.0292	25	18	5.5	2.4	0.5
G15	0.1002	55	36	8.0	3.0	0.6
G15-G16	0.1002	54	35	8.0	3.0	0.6
FG37	0.0754	46	31	7.3	2.7	0.4
FG36	0.0295	19	13	3.9	1.8	0.4
G15a	0.0295	19	13	3.9	1.8	0.4
G15a-G16	0.0295	19	13	3.8	1.7	0.4
G16	0.2051	114	74	16	6.5	1.2

PROPOSED CONDITIONS - SCS MAP

FIGURE 5

No. | Revisions | Date | Init. | Appr. | Date

TECH CONTRACTORS
11886 STAPLETON DRIVE
FALCON, CO 80831
TELEPHONE: 719.495.7444
FAX: 719.495.3349

MERIDIAN RANCH

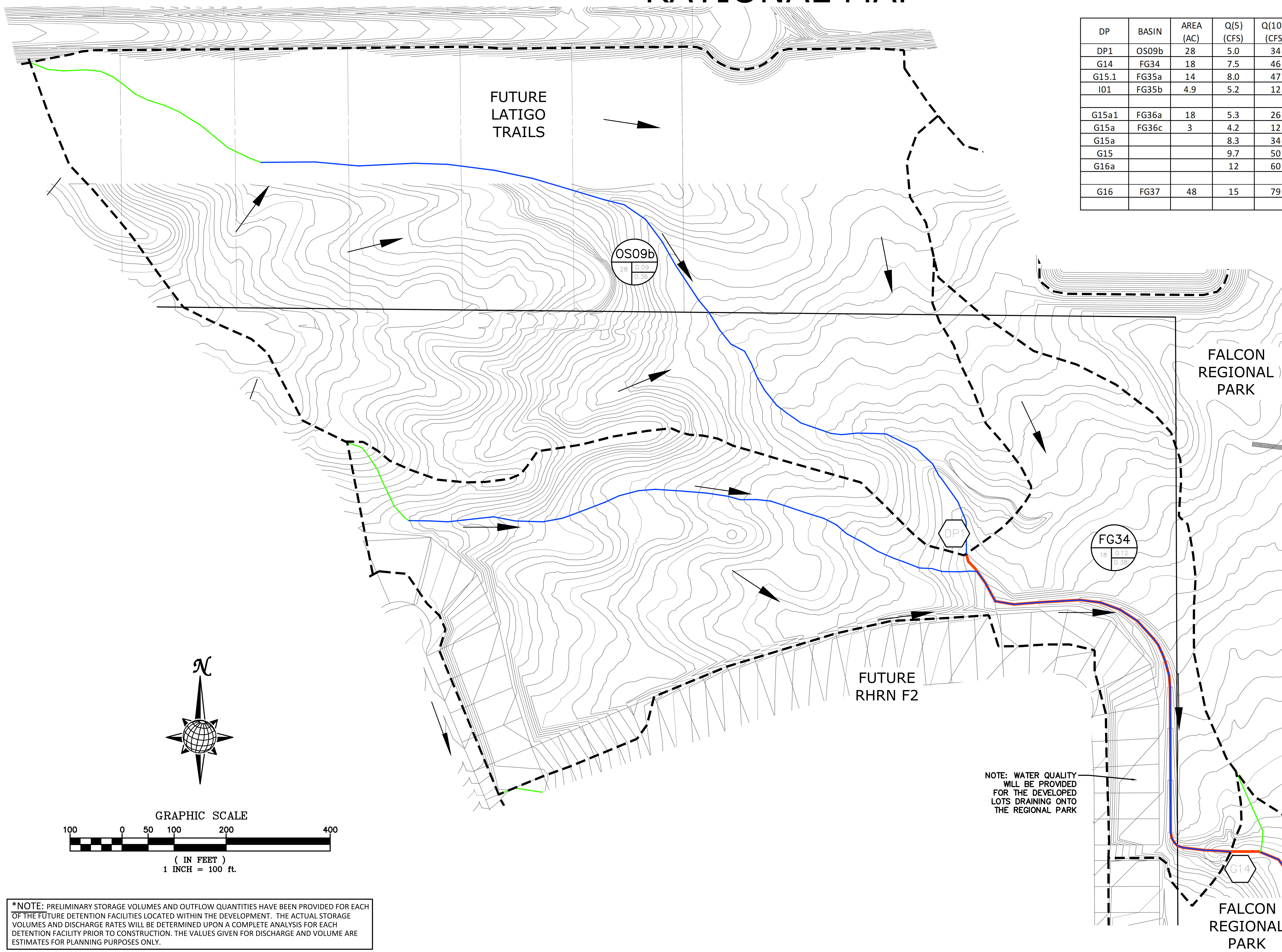
PROPOSED CONDITIONS - SCS MAP
REX ROAD
PDR - FDR

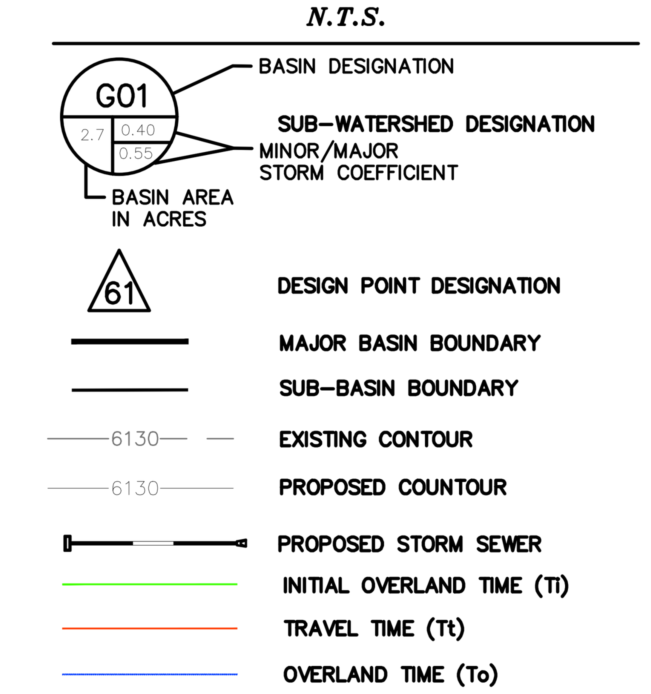
Drawn by TJK
Checked by
Date XXX 2023
Scale AS SHOWN
- of -

REX ROAD - PDR/FDR

RATIONAL MAP

DP	BASIN	AREA (AC)	Q(5) (CFS)	Q(100) (CFS)		INLET	Q(5) (CFS)	Q(100) (CFS)	PIPE
DP1	OS09b	28	5.0	34					
G14	FG34	18	7.5	46					
G15.1	FG35a	14	8.0	47		PR 36 " FES	8.0	47	36 " RCP
I01	FG35b	4.9	5.2	12		PR 20 ' FLOW-BY INLET	9.7	50	36 " RCP
G15a1	FG36a	18	5.3	26		PR 24 " FES	5.3	26	24 " RCP
G15a	FG36c	3	4.2	12		PR GRASS SWALE	4.2	12	
G15a			8.3	34		PR GRASS SWALE	8.3	34	
G15			9.7	50		PR GRASS SWALE	9.7	50	
G16a			12	60		PR GRASS SWALE	12	60	
G16	FG37	48	15	79		EX REX ROAD CULVERT	15	79	





*NOTE: PRELIMINARY STORAGE VOLUMES AND OUTFLOW QUANTITIES HAVE BEEN PROVIDED FOR EACH OF THE FUTURE DETENTION FACILITIES LOCATED WITHIN THE DEVELOPMENT. THE ACTUAL STORAGE VOLUMES AND DISCHARGE RATES WILL BE DETERMINED UPON A COMPLETE ANALYSIS FOR EACH DETENTION FACILITY PRIOR TO CONSTRUCTION. THE VALUES GIVEN FOR DISCHARGE AND VOLUME ARE ESTIMATES FOR PLANNING PURPOSES ONLY.

FIGURE 6

No.	Revisions	Date	Init.	Appr.	Date

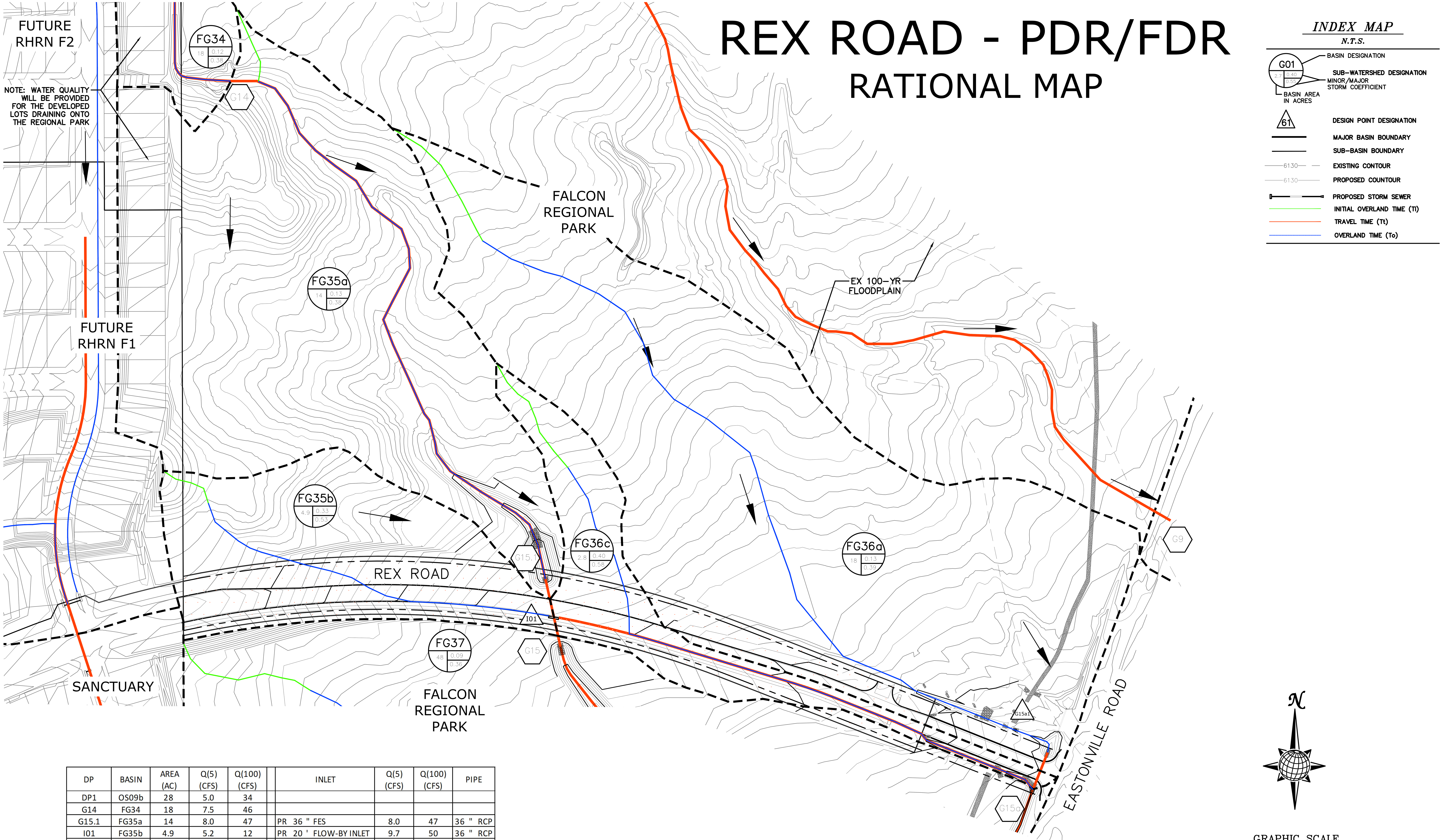
TECH CONTRACTORS
11910 TOURMALINE DR #130
FALCON, CO 80831
TELEPHONE: 719.495.7444

MERIDIAN RANCH

PROPOSED CONDITIONS RATIONAL MAP REX ROAD - PDR - FDR

Drawn by TJK
Checked by .
Date APR 2023
Scale AS SHOWN
1 of 3

REX ROAD - PDR/FDR
RATIONAL MAP



DP	BASIN	AREA (AC)	Q(5) (CFS)	Q(100) (CFS)		INLET	Q(5) (CFS)	Q(100) (CFS)	PIPE
DP1	OS09b	28	5.0	34					
G14	FG34	18	7.5	46					
G15.1	FG35a	14	8.0	47		PR 36 " FES	8.0	47	36 " RCP
I01	FG35b	4.9	5.2	12		PR 20 ' FLOW-BY INLET	9.7	50	36 " RCP
G15a1	FG36a	18	5.3	26		PR 24 " FES	5.3	26	24 " RCP
G15a	FG36c	3	4.2	12		PR GRASS SWALE	4.2	12	
G15a			8.3	34		PR GRASS SWALE	8.3	34	
G15			9.7	50		PR GRASS SWALE	9.7	50	
G16a			12	60		PR GRASS SWALE	12	60	
G16	FG37	48	15	79		EX REX ROAD CULVERT	15	79	

*NOTE: PRELIMINARY STORAGE VOLUMES AND OUTFLOW QUANTITIES HAVE BEEN PROVIDED FOR EACH OF THE FUTURE DETENTION FACILITIES LOCATED WITHIN THE DEVELOPMENT. THE ACTUAL STORAGE VOLUMES AND DISCHARGE RATES WILL BE DETERMINED UPON A COMPLETE ANALYSIS FOR EACH DETENTION FACILITY PRIOR TO CONSTRUCTION. THE VALUES GIVEN FOR DISCHARGE AND VOLUME ARE ESTIMATES FOR PLANNING PURPOSES ONLY.

FIGURE 6

No.	Revisions	Date	Init.	Appr.	Date

TECH CONTRACTORS
11910 TOURMALINE DR #130
FALCON, CO 80831
TELEPHONE: 719.495.7444

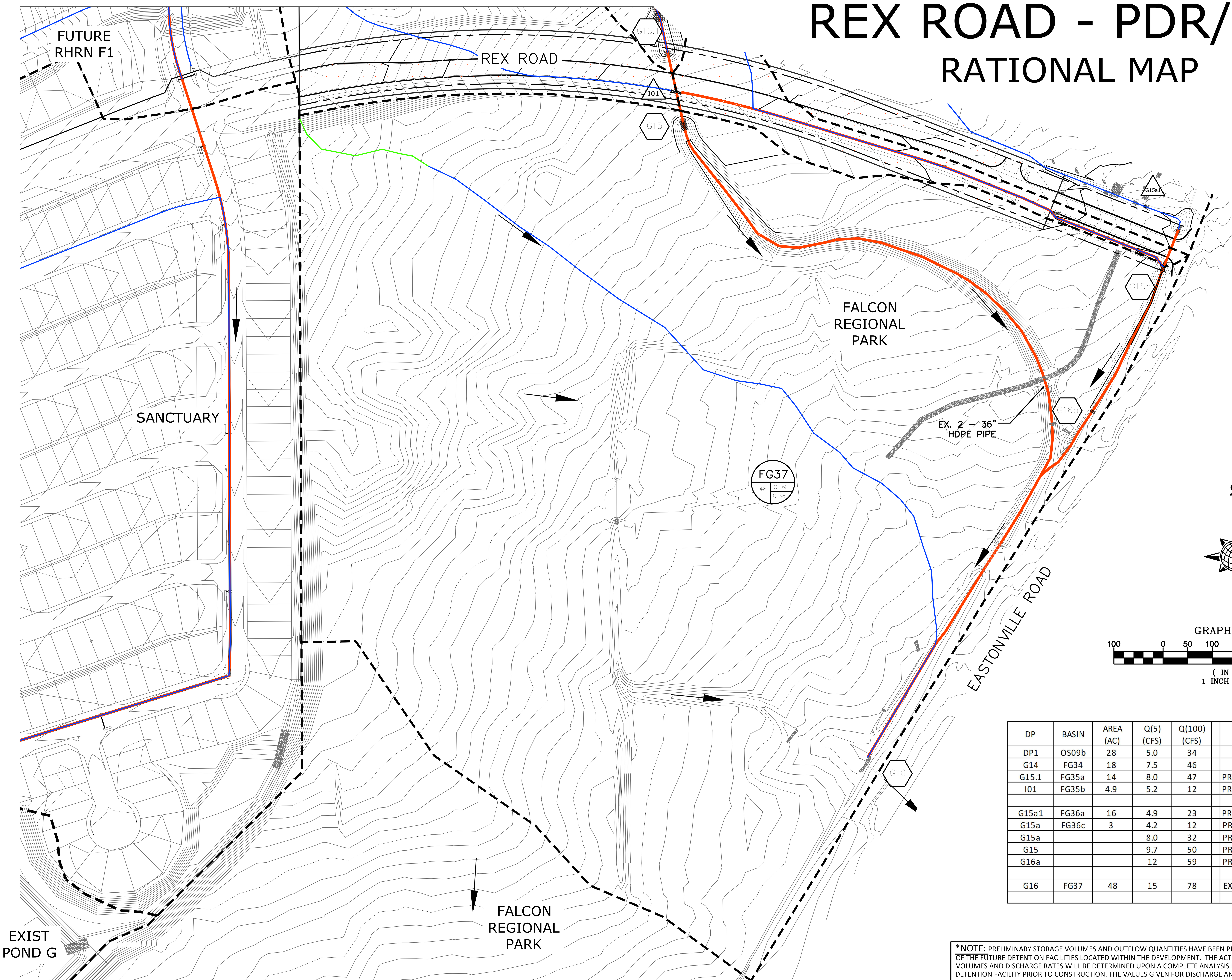
MERIDIAN RANCH

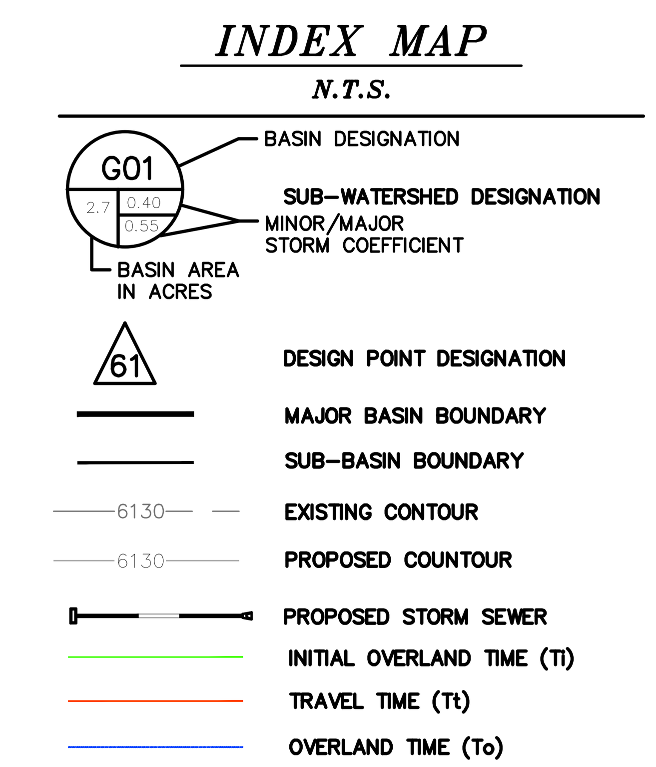
PROPOSED CONDITIONS RATIONAL MAP REX ROAD - PDR - FDR

Drawn by TAK
Checked by .
Date APR 2023
Scale AS SHOWN
2 of 3

REX ROAD - PDR/FDR

RATIONAL MAP





N

GRAPHIC SCALE

100 0 50 100 200 400

(IN FEET)
1 INCH = 100 ft.

DP	BASIN	AREA (AC)	Q(5) (CFS)	Q(100) (CFS)	INLET	Q(5) (CFS)	Q(100) (CFS)	PIPE
DP1	OS09b	28	5.0	34				
G14	FG34	18	7.5	46				
G15.1	FG35a	14	8.0	47	PR 36 " FES	8.0	47	36 " RCP
I01	FG35b	4.9	5.2	12	PR 20 ' FLOW-BY INLET	9.7	50	36 " RCP
G15a1	FG36a	16	4.9	23	PR 24 " FES	4.9	23	24 " RCP
G15a	FG36c	3	4.2	12	PR GRASS SWALE	4.2	12	
G15a			8.0	32	PR GRASS SWALE	8.0	32	
G15			9.7	50	PR GRASS SWALE	9.7	50	
G16a			12	59	PR GRASS SWALE	12	59	
G16	FG37	48	15	78	EX REX ROAD CULVERT	15	78	

*NOTE: PRELIMINARY STORAGE VOLUMES AND OUTFLOW QUANTITIES HAVE BEEN PROVIDED FOR EACH OF THE FUTURE DETENTION FACILITIES LOCATED WITHIN THE DEVELOPMENT. THE ACTUAL STORAGE VOLUMES AND DISCHARGE RATES WILL BE DETERMINED UPON A COMPLETE ANALYSIS FOR EACH DETENTION FACILITY PRIOR TO CONSTRUCTION. THE VALUES GIVEN FOR DISCHARGE AND VOLUME ARE ESTIMATES FOR PLANNING PURPOSES ONLY.

FIGURE 6

No.	Revisions	Date	Init.	Appr.	Date
-					
-					
-					

TECH CONTRACTORS
11910 TOURMALINE DR #130
FALCON, CO 80831
TELEPHONE: 719.495.7444

MERIDIAN RANCH

PROPOSED CONDITIONS
RATONAL MAP
REX ROAD - PDR - FDR

Drawn by TAK
Checked by .
Date APR 2023
Scale AS SHOWN
3 of 3

REX ROAD - PDR/FDR

WATER QUALTIY MAP

N

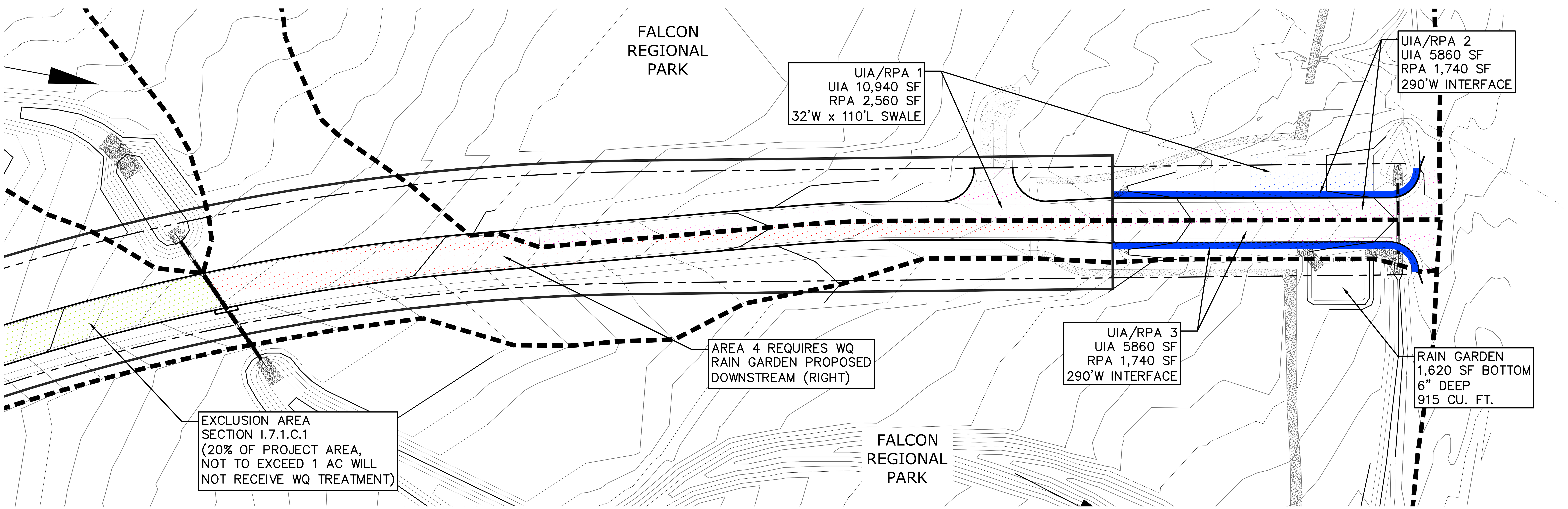
GRAPHIC SCALE

50 0 25 50 100 200

(IN FEET)
1 INCH = 50 ft.

INDEX MAP
N.T.S.

- G01 — BASIN DESIGNATION
- SUB-WATERSHED DESIGNATION
- MINOR/MAJOR STORM COEFFICIENT
- BASIN AREA IN ACRES
- 61 — DESIGN POINT DESIGNATION
- MAJOR BASIN BOUNDARY
- SUB-BASIN BOUNDARY
- 6130 — EXISTING CONTOUR
- 6130 — PROPOSED COUNTOUR
- PROPOSED STORM SEWER
- EXCLUSION I.7.1.C.1 AREA
- RECEIVING PERVIOUS AREA (RPA)
- DIRECT CONNECTED IMPERVIOUS AREA (DCIA)
- UNCONNECTED IMPERVIOUS AREA (UIA)



*NOTE: PRELIMINARY STORAGE VOLUMES AND OUTFLOW QUANTITIES HAVE BEEN PROVIDED FOR EACH OF THE FUTURE DETENTION FACILITIES LOCATED WITHIN THE DEVELOPMENT. THE ACTUAL STORAGE VOLUMES AND DISCHARGE RATES WILL BE DETERMINED UPON A COMPLETE ANALYSIS FOR EACH DETENTION FACILITY PRIOR TO CONSTRUCTION. THE VALUES GIVEN FOR DISCHARGE AND VOLUME ARE ESTIMATES FOR PLANNING PURPOSES ONLY.

FIGURE 7

No.	Revisions	Date	Init.	Appr.	Date

TECH CONTRACTORS
11910 TOURMALINE DR #130
FALCON, CO 80831
TELEPHONE: 719.495.7444

MERIDIAN RANCH

WATER QUALITY CAPTURE VOLUME
BASINS MAP
REX ROAD - PDR - FDR

Drawn by T.K.
Checked by
Date JUNE 2023
Scale AS SHOWN
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